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Plague and Desertion – A Consequence of Anthropogenic Landscape Change? Archaeological Studies in Southern Germany

Abstract: The formation of villages and the introduction of systematic three-field crop rotation transformed the landscape of western central Europe in the twelfth and thirteenth centuries. These processes have often been seen as an important progress of the medieval agriculture. This paper examines these developments from the perspective of human ecology. There is some evidence to suggest a connection between village formation and the transformation of the cultural landscape in the High Middle Ages on the one hand and the Black Death in the late Middle Ages on the other. Recent archeological data suggests that these changes to the cultural landscape were in fact major factors in or preconditions for the fourteenth-century crisis.

Keywords: village formation, agriculture, open field system, plague, human ecology

1 Economic Expansion, Colonization, and Population Growth during the High Middle Ages

The eleventh to thirteenth century in central Europe was a time of rapid growth: An expanding economy produced a surplus that funded the construction of huge churches, castles, and towns. As the population grew, there were more mouths to feed, even as more and more people moved from agrarian areas into urban centers. Silver mining and increasing long-distance trade within Europe, but also in the Far East, India, and sub-Saharan Africa, were important sources of wealth,¹ but regional agrarian production was still the foundation of the economy and the central, crucial element providing

¹ Ralph A. AUSTEN, *Sahara. Tausend Jahre Austausch von Ideen und Waren* (Schriftenreihe der Bundeszentrale für politische Bildung 1364), Bonn 2013; Sam NIXON, *The rising trade with Africa*, in: Martin CARVER/ Jan KLÁPŠTĚ (eds.), *The Archaeology of Medieval Europe*, vol. 2: Twelfth to Sixteenth Centuries, Aarhus 2011, pp. 361–369.

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sustenance for the population. This agrarian system combined rain-fed grain production with animal husbandry, which yielded the manure crucial for fertilizing fallow fields.

Without any doubt, this economic expansion, agrarian production, and population growth were mutually interdependent. For a long time, historians ascribed to the idea of a Malthusian cycle and suggested that the inability of increasing agricultural production to keep pace with the growing population had culminated in the fourteenth-century agrarian crisis.²

Due to a lack of statistical sources, there is no confirmed demographic data for the Middle Ages, but only rough estimations and reconstructed trends that suggest that the total population may have tripled or even quadrupled between the Carolingian period and the thirteenth century.³ Population growth is assumed based on the increasing evidence of settlements, especially in marginal landscapes. These colonization processes are notably characteristic of the High Middle Ages and reflect the growing need for arable land. At the European level, these processes included German eastward expansion as well as the *Reconquista* in Spain and the crusades to the Near East.⁴ At the regional level, internal colonization pushed into marginal land such as mountains, coastal areas, and river plains. In western and central Europe, many low mountain ranges – such as the Puy-de-Dôme, the Vosges, the Palatinate Forest,⁵ the

2 Compare for the idea of a crisis e. g.: Wilhelm ABEL, *Agrarkrisen und Agrarkonjunktur. Eine Geschichte der Land- und Ernährungswirtschaft Mitteleuropas seit dem hohen Mittelalter*, Hamburg, Berlin 1966; Jan A AERTSEN/ Martin PICKAVÉ (eds.), “Herbst des Mittelalters“? Fragen zur Bewertung des 14. und 15. Jahrhunderts. Akten der 33. Kölner Mediaevistentagung (Miscellanea Mediaevalia 31), Berlin 2004; Charles R. BOWLUS, *Die Umweltkrise im Europa des 14. Jahrhunderts*, in: Rolf Peter SIEFERLE (ed.), *Fortschritte der Naturzerstörung (edition suhrkamp 1489 = Neue Folge 489)*, Frankfurt /M. 1988, pp. 13–30; John Victor DRENDEL (ed.), *Crisis in the later Middle Ages. Beyond the Postan-Duby paradigm (The medieval countryside 13)*, Turnhout 2015; Frantisek GRAUS, *Pest – Geissler – Judenmorde. Das 14. Jahrhundert als Krisenzeit (Veröffentlichungen des Max-Planck-Instituts für Geschichte 86)*, Göttingen 1988; Peter SCHUSTER, *Die Krise des Spätmittelalters. Zur Evidenz eines sozial- und wirtschaftsgeschichtlichen Paradigmas in der Geschichtsschreibung des 20. Jahrhunderts*, in: *Historische Zeitschrift* 269 (1999), pp. 19–55; Rainer SCHREG, *Die Krisen des späten Mittelalters – Perspektiven, Probleme, Potentiale*, in: Falko DAIM/ Detlef GRONENBORN/ Rainer SCHREG (eds.), *Strategien zum Überleben. Umweltkrisen und ihre Bewältigung (Römisch-Germanisches Zentralmuseum - Tagungen 11)*, Mainz 2011, pp. 195–214.

3 David HERLIHY, *Outline of Population Developments in the Middle Ages*, in: Bernd HERRMANN/ Rolf SPRANDEL/ Ulf DIRLMEIER (eds.), *Determinanten der Bevölkerungsentwicklung im Mittelalter*, Weinheim 1987, pp. 1–23; Bruce M. S. CAMPBELL, *The great transition. Climate, disease and society in the late-medieval world*, Cambridge 2016, pp. 58–65.

4 Peter ERLEN, *Europäischer Landesausbau und mittelalterliche deutsche Ostsiedlung. Ein struktureller Vergleich zwischen Südwestfrankreich, den Niederlanden und dem Ordensland Preußen (Historische u. landeskundliche Ostmitteleuropa-Studien 9)*, Marburg 1992.

5 Heidi PANTERMEHL, *Haltestelle Zentralort – Anwendung von Modellen der Zentralortsforschung auf Mittelgebirgszonen am Beispiel des Pfälzerwaldes*, in: Peter ETTTEL/ Lukas WERTHER (eds.), *Zentrale Orte und zentrale Räume des Frühmittelalters in Süddeutschland. Tagung des Römisch-Germanischen Zentralmuseums Mainz und der Friedrich-Schiller-Universität Jena vom 7. - 9.10.2011*

Black Forest,⁶ the Spessart, the Solling,⁷ the Harz, the Bohemian Forest, and the Ore Mountains⁸ – represent cultural landscapes characterized by rather extensive land use mainly forest economy and raising livestock. Patterns of settlement and cultivation were quite different than in neighboring agrarian landscapes that were more densely settled. Historians have typically viewed the opening of these low mountain ranges as beginning with the clearance of forests and programmed colonization of formerly unsettled landscapes under the influence of nobles or clerical authorities.

However, there is the risk of a circular argument: Models of population growth are mainly based on the idea that settlement names, regular village plans, castles, and monasteries represent the establishment of new settlements and therefore indicate the opening and clearance of previously unsettled, forested landscapes. However, the idea of a systematic clearance of forested landscapes assumes demographic growth as a precondition.

In this situation, landscape archeology and geo-archeological research provide important insights, because detailed case studies challenge common views on the nature of medieval colonization and offer new impetus for alternative interpretations.

2 New Perspectives

Recent studies in medieval landscape archeology have questioned the previously established idea that clerical or secular authorities organized the colonization. They also show that rural history is far more complex than was thought until quite recently. For a long time, scholars viewed rural life as immutable over centuries; Oswald SPENGLER went as far as to claim that peasants had no history.⁹ For this reason, both villages and houses were regarded as conservative elements of culture. When nineteenth-century historians first became interested in rural life of the past, they expected peasant culture to be determined more by ethnic identity than by historical processes.

in Bad Neustadt an der Saale (Römisch-Germanisches Zentralmuseum - Tagungen 18), Mainz 2013, pp. 175–191.

6 Rainer SCHREG, Development and abandonment of a cultural landscape - archaeology and environmental history of medieval settlements in the northern Black Forest, in: Jan KLÁPŠTĚ/ Petr SOMMER (eds.), *Medieval rural settlement in marginal landscapes* (Ruralia 7), Turnhout 2009, pp. 315–333.

7 Hans-Georg STEPHAN/ Hans Dieter TÖNSMEYER, *Der Solling im Mittelalter. Archäologie - Landschaft - Geschichte im Weser- und Leinebergland. Siedlungs- und Kulturlandschaftsentwicklung; die Grafen von Dassel und Nienover* (Hallesche Beiträge zur Archäologie des Mittelalters und der Neuzeit 1), Dormagen 2010.

8 Hauke KENZLER, *Die hoch- und spätmittelalterliche Besiedlung des Erzgebirges. Strategien zur Kolonisation eines landwirtschaftlichen Ungunstraumes* (Bamberger Schriften zur Archäologie des Mittelalters und der Neuzeit 4), Bonn 2012.

9 Oswald SPENGLER, *Der Untergang des Abendlandes*, Düsseldorf 2007, p. 668.

They therefore projected the characteristics of pre-industrial nineteenth-century rural societies back in time, taking for granted the existence of villages and the feudal system in the early Middle Ages or even the Migration Period.¹⁰

In the mid-twentieth century, historians and geographers gradually became attuned to changes in rural institutions, as well as in systems of cultivation and village structures. Limited sources and insufficient dating methods, however, curbed these insights. Beginning in the 1980s, researchers excavated an increasing number of medieval rural settlements and started landscape research in the field of medieval archeology. New methods such as large-scale excavation with backhoes, dating by radiocarbon and OSL (optic stimulated luminescence), and remote sensing based on aerial photographs, geophysics, and LiDAR (light detection and ranging) gave archeologists more insight into rural history.¹¹ This research permanently transformed understanding of early and high medieval settlement patterns and established the late formation of the medieval village. In many regions, the villages that characterize the landscape of pre-industrial and modern times only developed in the eleventh or twelfth century. This is true for fertile agrarian landscapes, but there were also similar processes in marginal landscapes of medieval colonization. This new research also has significant implications for the historical role of the kind of ordinary people who typically go unnoticed. In fact, the colonization of marginal land, the transformation of the landscape, and formation of the village was essentially founded on their labor and can be explained by their own interests. Previous research has underestimated the agency of peasants because the written sources are biased by the position of authorities and therefore tend to reflect a top-down perspective.¹²

Recently, Bruce CAMPBELL has developed a new perspective, bringing together economic stress, war, climate change – from the Medieval Climate Anomaly of the eighth to thirteenth centuries to the beginning of the Little Ice Age – and the Black Death.¹³ His broad perspective may be complemented by drawing on landscape archeology. This essay contributes some thoughts based primarily on archeological studies of the medieval settlement landscape of western central Europe, or, more specifically, southwestern Germany.

10 Rainer SCHREG, Die Archäologie des mittelalterlichen Dorfes in Süddeutschland. Probleme – Paradigmen – Desiderate, in: *Siedlungsforschung. Archäologie – Geschichte – Geographie* 24 (2006), pp. 141–162.

11 Rainer SCHREG, Mittelalterliche Feldstrukturen in deutschen Mittelgebirgslandschaften – Forschungsfragen, Methoden und Herausforderungen für Archäologie und Geographie, in: Jan KLÁPŠTĚ (ed.), *Agrarian technology in the medieval landscape (Ruralia 10)*, Turnhout 2016, pp. 351–370.

12 Rainer SCHREG, Uncultivated landscapes or wilderness? Early medieval land use in low mountain ranges and flood plains of Southern Germany, in: *European Journal of Post-Classical Archaeologies* 4 (2014), pp. 69–98.

13 CAMPBELL (note 3).

2.1 No Unsettled Wilderness

The top-down perspective of the medieval sources and nineteenth-century historical thinking created the impression that powerful clerical or secular authorities organized medieval colonization by giving orders to open unsettled wilderness and clear forests. Recent archeological studies in low mountain ranges in western and central Europe challenge this perspective.

An increasing number of cases clearly shows that village plans were not created as part of a strategic colonization but rather were a secondary development transforming earlier settlement activity. Examples come from various landscapes, such as the Black Forest, the Austrian Waldviertel, or lower Lusatia, east of the Elbe.

Oberwürzbach, an abandoned settlement in the northern Black Forest, was, for example, a forest village with long strip plots behind the farmsteads as was typical of colonization in the eleventh/twelfth centuries. Geo-archeological research however examined early medieval land use in this area (Figure 1). Furthermore, a closer survey of the remains of the past cultural landscape found some traces of settlements distinct from the late medieval village, which probably represent an earlier dispersed settlement.¹⁴ Only when economic changes resulted in lords and authorities having more direct control were settlements recognized as entities and given a distinct place name. Settlement names therefore do not represent the founding of a settlement *per se*, but rather a shift in social meaning.¹⁵

The abandoned settlement of Hard in the Waldviertel in Lower Austria is characterized by a regular plan of two rows of farmsteads with one prominent farmstead at the end of the rows. This larger farmstead is the only site where weaponry and artifacts indicating written literacy were found. The settlement was established in the second half of the thirteenth century and abandoned during the fourteenth century. It was clearly planned, but it does not represent the time of “colonization.” In Kleinhard – a short distance away – the remains of an earlier settlement dating back to the time around 1100 have been discovered.¹⁶

This later formation of regular layouts within a preexisting settlement organization is also characteristic of the villages east of the Elbe. In lower Lusatia/ Niederlausitz, a formerly swampy landscape along the Neisse ongoing open-pit brown coal

14 Rainer SCHREG, Würzbach – ein Waldhufendorf im Nordschwarzwald, in: Claudia THEUNE-VOGT et al. (ed.), *Stadt – Land – Burg. Festschrift für Sabine Felgenhauer-Schmiedt zum 70. Geburtstag* (Internationale Archäologie. Studia honoraria 34), Rahden / Westf. 2013, pp. 189–202.

15 Rainer SCHREG, *Before Colonization. Early Medieval Land-Use of Mountainous Regions in Southern and Western Germany*, in: Christoph BARTELS/ Claudia KÜPPER-EICHAS (eds.), *Cultural Heritage and Landscapes in Europe – Landschaften – kulturelles Erbe in Europa*. Internationale Konferenz 6.-10. Juni 2007 im Deutschen Bergbau-Museum Bochum (Veröffentlichungen aus dem Deutschen Bergbau-Museum Bochum 161), Bochum 2008, pp. 293–312; SCHREG (note 12).

16 Sabine FELGENHAUER-SCHMIEDT, *Hard. Ein Wüstungskomplex bei Thaya im niederösterreichischen Waldviertel* (Archäologische Forschungen in Niederösterreich 6), St. Pölten 2008.

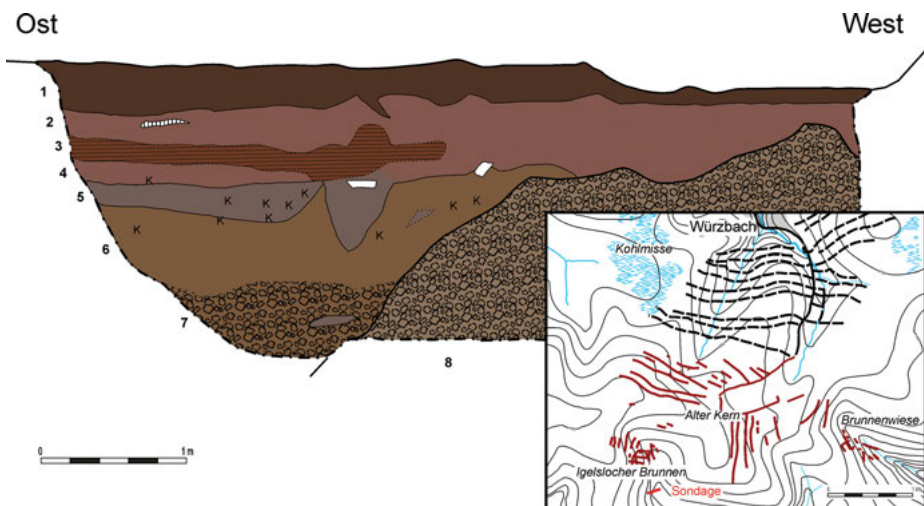


Figure 1: Geo-archeological sondage with early medieval sediments, Northern Black Forest (Graphic: R. SCHREG / J. PITTORI).

mining provides the opportunity for archeological research in many villages. Linear villages and green villages (“Angerdörfer”) had long been associated with German eastward settlement, but archeological data shows the pre-existence of “Slavic” settlements on the one hand and the late genesis of the regular village plan on the other.¹⁷

Settlement activities often predate the common dating of colonization as represented by settlement forms, but also by their place names.¹⁸ In southwestern Germany, scholars have categorized by ending and dated them using a combination of the earliest written records, early medieval burial sites, and geographical location. However, archeological settlement sites often result in finds which predate the established chronology and provide evidence of earlier settlement.

Geo-archeological research supports this idea of early activities and challenges the narrative of a pioneering colonization. In the Vosges and Palatinate Forest, as well as in the Black Forest, recent research shows early medieval soil erosion¹⁹ patterns

¹⁷ Ines SPAZIER, Die Genese hoch- und spätmittelalterlicher Dörfer in der Niederlausitz, in: Felix BIERMANN/ Günter MANGELSDORF (eds.), Die bäuerliche Ostsiedlung des Mittelalters in Nordostdeutschland. Untersuchungen zum Landesausbau des 12. bis 14. Jahrhunderts im ländlichen Raum; Beiträge einer interdisziplinären Tagung des Lehrstuhls für Ur- und Frühgeschichte der Universität Greifswald, 16. und 17. April 2004 (Greifswalder Mitteilungen. Beiträge zur Ur- und Frühgeschichte und Mittelalterarchäologie 7), Frankfurt /M. 2005, S. 255–268.

¹⁸ SCHREG (note 15).

¹⁹ PANTERMEHL (note 5); Thomas KNOPF et al., Landnutzung im frühen Mittelalter. Eine archäopedologische Prospektion im mittleren Schwarzwald, in: Archäologisches Korrespondenzblatt 42 (2012), pp. 123–133; Rainer SCHREG et al., Geoarchäologische Untersuchungen im Umfeld der Wüstung, in: Archäologische Ausgrabungen in Baden-Württemberg (2010), pp. 228–230.

indicative of human land use having destroyed the trees that, in this temperate European climate, protected the soil from erosion.²⁰

In other words, the colonization of marginal land did not entail taking over unsettled wilderness but rather repurposing marginal land that had already been used for grazing, timber, firewood, and other forms of forest economy (e.g. honey production, glass industry, charcoal burning, etc.), or even mining for new, more intensive agrarian ends. The failure to consider an indigenous population, the myth of the conquest of wilderness, and the top-down perspective are all typical of an obsolete colonialist view. There are two important lessons to be learned from this:

First, we need to understand that written sources and settlement names hardly reflect rural economies. Many of the peasants' activities were beyond the scope of the written sources, which primarily served manorial interests or the trade or transfer of precious goods. Land use in marginal areas was probably of little interest to the authorities; as a result, local peasant communities were free to organize this as they saw fit. As long as this was the case, there was little need for distinct place names within the manorial written record. Conversely, the appearance of settlement names represents an increasing interest on the part of the emerging authorities.

Second, in light of these findings, we need to consider the actual human impact of colonization. Population growth was likely less significant than previously thought, and, recognizing that marginal land had some productivity even in the early Middle Ages, the growth of agrarian resources was accordingly smaller, as well. The added value of the agrarian transformation of the former marginal outlands is hard to determine. The marginal lands were not ideally suited for agriculture. At a local level, there was surely some new value created during "colonization." On the one hand, the position of medieval castles indicates that the available resources sufficed for the establishment of noble dominions, at least in some regions.²¹ On the other hand, regional historical studies – on the Picardie in France, for example – point to a succession of colonization and a large number of children.²² Obviously, peasants could exercise some agency by participating in new settlements and thereby – with some luck – improve the economic situation of their families.

20 Hans-Rudolf BORK, *Bodenerosion und Umwelt. Verlauf, Ursachen und Folgen der mittelalterlichen und neuzeitlichen Bodenerosion, Bodenerosionsprozesse, Modelle und Simulationen (Landschaftsgenese und Landschaftsökologie 13)*, Braunschweig 1988.

21 Werner MEYER, *Rodung, Burg und Herrschaft. Ein burgenkundlicher Beitrag zur mittelalterlichen Siedlungsgeschichte*, in: ID. (ed.), *Burgen aus Holz und Stein. Burgenkundliche Kolloquien*, Basel 1977 (Schweizer Beiträge zur Kulturgeschichte und Archäologie des Mittelalters 5), Olten, Freiburg / Br. 1979, pp. 43–80.

22 Rolf SPRANDEL, *Grundlinien einer mittelalterlichen Bevölkerungsentwicklung. Anmerkungen zu den 'Outlines of Population Developments in the Middle Ages' von David Herlihy aus mitteleuropäischer Sicht*, in: Bernd HERRMANN/ Rolf SPRANDEL/ Ulf DIRLMEIER (eds.), *Determinanten der Bevölkerungsentwicklung im Mittelalter*, Weinheim 1987, pp. 25–35.

Models of a Malthusian crisis or of Bosuperian growth are obviously much too simple to explain “colonization” or medieval settlement changes more generally.

2.2 Shifting Land Use and Shifting Settlements

A crucial point in understanding medieval settlement history is the fact that settlements in the early and High Middle Ages often shifted their location. In several cases, archeological excavations have shown not only that settlements relocated in the process of forming a village out of a cluster of earlier farmsteads and hamlets, but also that they sometimes relocated repeatedly even before forming the village. It is methodologically difficult to provide evidence of possible relocations, as this requires both large-scale study of the landscape and detailed spatial analysis of pottery finds. Formation processes as strategies of waste deposits or a secondary movement of finds by erosion or modern agriculture make it difficult to trace settlement relocations by the spatial distribution of finds. However, in some cases, we can trace shifting settlements via local pottery distribution based on surface collections or patterns determined in small rescue excavations.²³

Only a few large-scale excavations to date could provide more detailed insights into the ways that settlements actually altered over generations. An excavation at Speyer-Vogelgesang, for example, traces the relocation of farmsteads along the bluff of a river terrace above an old channel of the Rhine. Even though these farmsteads remained at the same spot for a few generations, they moved roughly 700 meters over the course of approximately 700 years.²⁴ Excavations at Mengen im Breisgau were too small to show the full picture of settlement relocation over time, but indicate that, in this case, farmsteads developed independently. One plausible scenario could be that two farmsteads relocated in opposite directions. Prominent examples of these shifting settlements come from landscapes adjacent to the North Sea, such as Odoorn in the Netherlands²⁵ or Vorbasse in Jutland.²⁶

23 Rainer SCHREG, *Kontinuität und Fluktuation in früh- und hochmittelalterlichen Siedlungen*, in: Carola FEY/ Steffen KRIEB (eds.), *Adel und Bauern in der Gesellschaft des Mittelalters. Internationales Kolloquium zum 65. Geburtstag von Werner Rösener (Studien und Texte zur Geistes- und Sozialgeschichte des Mittelalters 6)*, Korb 2012, pp. 137–164.

24 *Ibid.*

25 Harm Tjalling WATERBOLK, *Odoorn im frühen Mittelalter. Bericht der Grabung 1966*, in: *Neue Ausgrabungen und Forschungen in Niedersachsen 8* (1973), pp. 25–89.

26 Steen HVASS, *The Status of the Iron Age Settlement in Denmark*, in: Heinrich BECK/ Heiko STEUER (eds.), *Haus und Hof in ur- und frühgeschichtlicher Zeit. Bericht über zwei Kolloquien der Kommission für die Altertumskunde Mittel- und Nordeuropas vom 24. bis 26. Mai 1990 und 20. bis 22. November 1991 (Abhandlungen der Akademie der Wissenschaften in Göttingen, Philologisch-Historische Klasse 3 218)*, Göttingen 1997, pp. 376–413.

More research is needed to verify this scenario of land use practices. In fact, it is difficult to understand the background of the settlements' shift, which cannot be traced through written sources. This is also true regarding the redistribution of land during the formation of the village and the introduction of open-field crop rotation. Although a vast number of written documents deals with the purchase or donation of land in the Middle Ages, there is no written evidence of organized land reform connected with the reorganization of the cultural landscape. This is a clear indication that land rights were handled on the communal level, which seems to suggest that shifting of settlements was also arranged within the illiterate local peasant community.

Similar relocations are already known in the context of prehistoric settlements, where shifting cultivation has been offered as an explanation.²⁷ However, these medieval farmsteads were normally relocated over small distances. They did not develop new arable land but practiced long-term crop rotation which also included the central inhabited area of the farmstead. This alternating usage of plots as settlements, gardens, fields, or even scrub fallow was probably an important strategy in maintaining fertility. The accumulation of nutrients around farmhouses was an important aspect of pre-modern soil management. Instead of bringing the dung to the fields, this system was based on bringing the fields to the fertile land around previous house sites. Unlike urban settlements, rural settlements typically had no latrines. Judging by phosphate analysis of soil samples, excrement was deposited within the farmsteads.²⁸

The establishment of villages and the introduction of the open-field system meant the end of shifting settlements as a land use strategy. There was probably no initial strategy of manure-spreading to replace it; according to archeological data, the systematic collection and distribution of manure on the field was only introduced after the fourteenth-century crisis. Field archeologists are quite familiar with a common but rarely analyzed phenomenon: field-walking results in hundreds of late medieval and early modern pottery shards spread all over ploughed fields. These fragments have not been brought to the surface by modern agricultural activities destroying archeological structures in the soil but rather have lain at the surface for a very long time, which is why they are often heavily fragmented and weathered. Whereas in England or in the lower Rhine area, there is evidence of Roman or Carolingian shard

²⁷ SCHREG (note 23).

²⁸ Rainer SCHREG/ Sonja BEHRENDT, Phosphatanalysen in einem frühmittelalterlichen Haus in Schalkstetten (Gde. Amstetten, Alb-Donau-Kreis), in: *Archäologisches Korrespondenzblatt* 41 (2011), pp. 263–272.

scatters,²⁹ in most German landscapes, such fragments date to the fourteenth century at the earliest.³⁰

2.3 The Formation of the Medieval Village

The introduction of a regulated three-field crop rotation into an open-field system was part of deeper changes in rural society. In many regions of central Europe, it was in the eleventh to thirteenth centuries that closed villages and local municipalities developed (Figure 2). Archeologically, this process of medieval village formation can be characterized as a re-arrangement of settlements in the central agrarian landscapes that had been settled early.³¹ Up until this time, settlements shifted within the landscape; they stayed at the same location only a few generations and then shifted over a rather short distance. Until the eleventh to thirteenth centuries, farmsteads and hamlets scattered over some distance and established a nucleus, which afterwards stayed constant over centuries. Many villages were deserted during the following centuries, but the centers of most existing villages go back to this period of medieval village formation.

In northern France, farmsteads and hamlets first converged to form fixed villages in the tenth or eleventh century. In Bavaria, archeological data hints at the same period, whereas in modern southwestern Germany, the most prominent settlement concentration dates only to the twelfth and thirteenth centuries.³²

This physical formation of the village also witnessed a remarkable social transformation: in the tenth century peasants were first recognized as a social class, and institutions such as the village mayor or the village commons gained in importance during the twelfth century.

29 Richard JONES, Signatures in the Soil. The Use of Pottery in Manure Scatters in the Identification of Medieval Arable Farming Regimes, in: *Arch. Journal* 161 (2005), pp. 159–188; Iris WESSEL/ Christine WOHLFARTH/ Renate GERLACH, *Archäologische Forschungen auf der Rheinbacher Lößplatte. Ein Projekt zur Prospektion in einem geographischen Kleinraum (Rheinische Ausgrabungen 62)*, Mainz 2008; Nicolas POIRIER, Archaeological evidence for agrarian manuring. Studying the time-space dynamics of agricultural areas with surface-collected off-site material, in: Jan KLÁPŠTĚ (ed.), *Agrarian technology in the medieval landscape (Ruralia 10)*, Turnhout 2016, pp. 279–290.

30 Rainer SCHREG, Mittelalterliche und neuzeitliche Funde vom Heidengraben, in: Thomas KNOPF (ed.), *Der Heidengraben bei Grabenstetten. Archäologische Untersuchungen zur Besiedlungsgeschichte (Universitätsforschungen zur prähistorischen Archäologie 141)*, Bonn 2006, pp. 201–210.

31 Rainer SCHREG, Dorfgenese in Südwestdeutschland. Das Renninger Becken im Mittelalter (Materialhefte zur Archäologie in Baden-Württemberg 76), Stuttgart 2006.

32 Rainer SCHREG, Siedlungen in der Peripherie des Dorfes. Ein archäologischer Forschungsbericht zur Frage der Dorfgenese in Südbayern, in: *Berichte der Bayerischen Bodendenkmalpflege* 50 (2009), pp. 293–317.

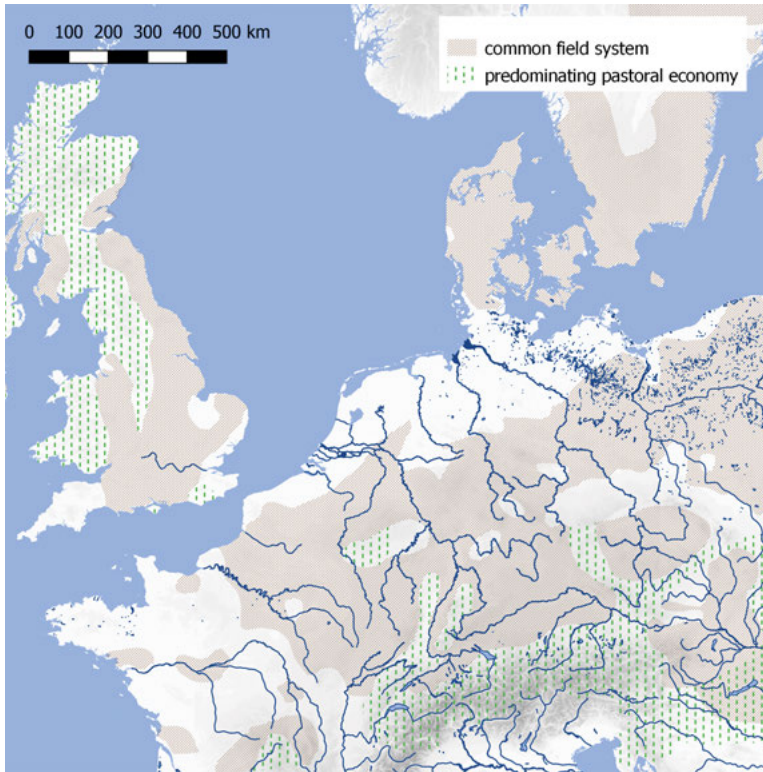


Figure 2: Agricultural systems in northwestern Europe, 13th/14th century (Graphic R. SCHREG, base map SRTM, data according to Richard C. HOFFMANN, *An environmental history of medieval Europe* [Cambridge medieval textbooks, Cambridge 2014] fig. 4.5).

Villages typically developed around a church or perhaps an older manor house. This should not necessary be read as evidence that the local secular or clerical authorities took an active role in this process. The lack of written evidence explicitly connected with village formation indicates rather that the (illiterate) local rural population was the crucial agent in this process.³³ However, village formation was a long and complex process that lasted for centuries and involved a huge number of factors and agents (Figure 3).

³³ Rainer SCHREG, *Bauern als Akteure. Beobachtungen aus Süddeutschland*, in: Jörg DRAUSCHKE/ Ewald KISLINGER/ Karin KÜHTREIBER/ Thomas KÜHTREIBER/ Gabriele SCHARRE-LIŠKA/ Tivadar VIDA (eds.), *Lebenswelten zwischen Archäologie und Geschichte. Festschrift für Falko Daim zu seinem 65. Geburtstag* (Monographien des Römisch-Germanisches Zentralmuseums 150). Mainz 2018, pp. 553–563.

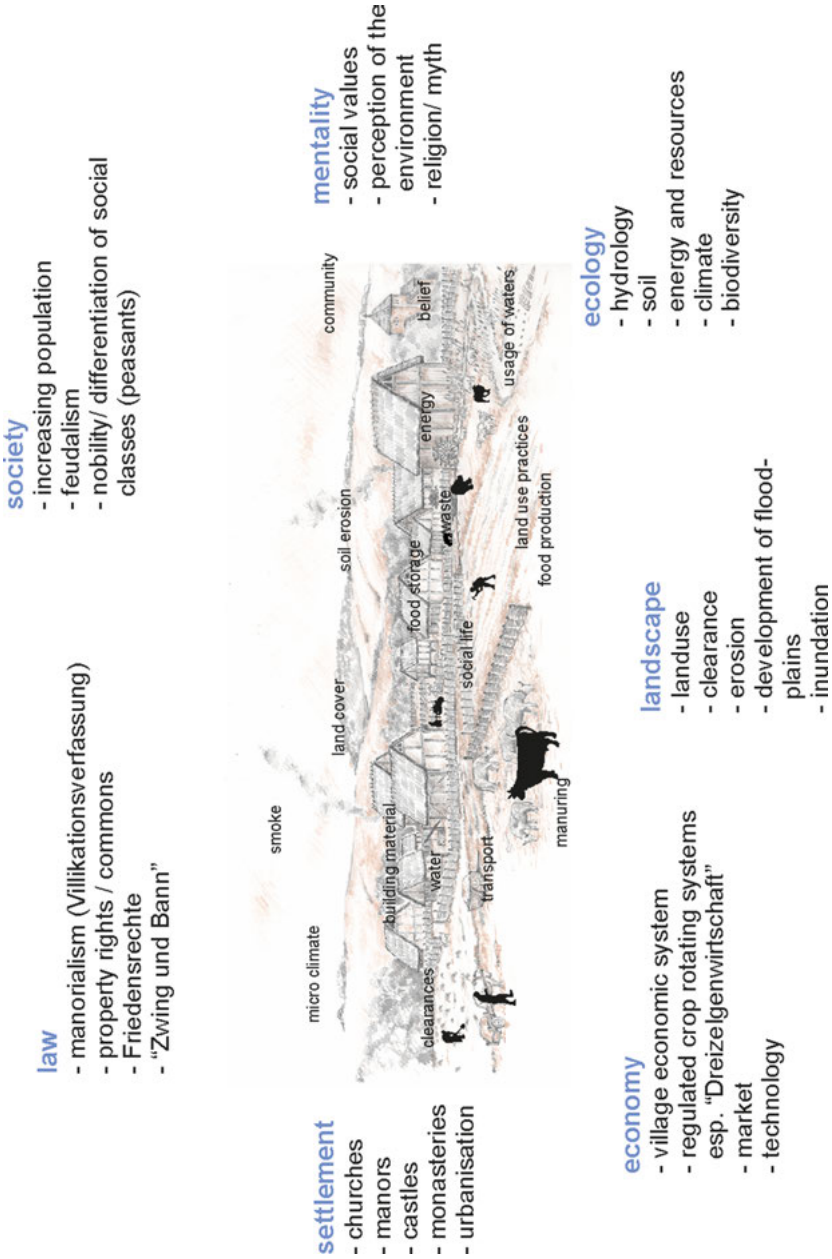


Figure 3: Factors in the formation of the medieval village (R. SCHREG).

2.4 Innovation in Agrarian Technology

It was in this context that innovations in agrarian technology led to a remarkable increase of agrarian productivity. These included the invention of the moldboard or wheeled plough, the collar that improved harnesses, and the establishment of mills. Our written sources do not provide sufficient information to trace these innovative developments in detail, which is one reason that historians continue to debate over the idea of a medieval technological revolution even after decades of research.³⁴

In many cases, the language of the sources does not refer explicitly to innovative features, and it is difficult to determine the date of the invention or its widespread application. The archeological record indicates some changes in the forms of ploughshares,³⁵ as well as the introduction of spades reinforced by metal fittings.³⁶ However, archeological studies on agrarian tools are more interested in the early Middle Ages than in the time period considered here.³⁷ Furthermore, the number of excavated late medieval abandoned settlements is quite small, and these sites often yield only a few metal artifacts, primarily nails and knives. For this reason, caution is necessary when reconstructing regional timelines of innovation.

While mills did not directly affect the productivity of the fields, they were a crucial step forward in effectively processing the harvest. Archeological evidence found in recent years indicates that watermills were invented during the early Middle Ages. There was major technological progress in the profile of the waterwheel, as well as of the millworks, but the few extant material remains do not allow a more detailed description of these innovations.³⁸

Advances in agrarian technology were not restricted to tools, but also a question of land management practices such as crop rotation or pest and weed control by ploughing or draining fields. According to the written record, the commons gained

34 Lynn WHITE, *Medieval Technology and Social Change*, Oxford 1962; Grenville G. ASTILL/ John LANGDON (eds.), *Medieval farming and technology. The impact of agricultural change in Northwest Europe (Technology and Change in History 1)*, Leiden 1997.

35 Lars AGERSNAP LARSEN, *The mouldboard plough in the Danish area 200–1500 AD*, in: Jan KLÁPŠTĚ (ed.), *Agrarian technology in the medieval landscape (Ruralia 10)*, Turnhout 2016, pp. 225–236.

36 Janken MYRDAL/Alexandra SAPOZNIK, *Spade cultivation and intensification of land-use 1000–1300. Written sources, archaeology and images*, in: Jan KLÁPŠTĚ (ed.), *Agrarian technology in the medieval landscape (Ruralia 10)*, Turnhout 2016, pp. 203–223.

37 E. g. Joachim HENNING, *Pflug*. Archäologisches, in: *Reallexikon der Germanischen Altertumskunde* 23 (2003), pp. 104–114; Janine Claudia FRIES, *Vor- und frühgeschichtliche Agrartechnik auf den Britischen Inseln und dem Kontinent. Eine vergleichende Studie (Internationale Archäologie 26)*, Espelkamp 1995.

38 Folke DAMMINGER, *Bemerkungen zur Bedeutung von Wassermühlen im frühmittelalterlichen Südwestdeutschland*, in: Hermann AMENT (ed.), *Studia Antiquaria. Festschrift für Niels Bantelmann zum 60. Geburtstag (Universitätsforschungen zur prähistorischen Archäologie 63)*, Bonn 2000, pp. 221–230.

new importance in the High and late Middle Ages,³⁹ which is an indication of agriculture's changing social organization. Another new development in many regions of central Europe was the invention of open-field agriculture, which transformed the medieval landscape.⁴⁰

2.5 Open-Field Cultivation and Systematic Crop Rotation

The new three-field system (*Dreizelgen-* or *geregelte Dreifelderwirtschaft*) was characterized by compulsory crop rotation (*Flurzwang*) and some common rights on private land, such as trespassing and grazing during fallow periods.⁴¹ Cultivation changed between fallow, winter, and spring grain over a cycle of three years. According to the written evidence, crop rotation was already known in the early Middle Ages and practiced by individual farmers on single fields. The innovation of the High Middle Ages was the coordination of this practice over the entirety of a village's agrarian land. The local peasants' commune (*Markgenossenschaft/ Gemeinde*) controlled these regulations, which – with a few exceptions – also applied to land in the possession of nobles.⁴² The dating of the introduction of the open-field system in central Europe has been the subject of much debate. Because some of the terms related to the open-field system appear even in early medieval texts, it has been considered to be an early form of land use organization. Previous research, however, has often neglected the important distinction between individual and compulsory crop rotation. The communal organization of systematic three-field crop rotation only dates back to the High Middle Ages⁴³ and is closely connected to the formation of villages.

This system of land management made more effective use of the available land. Neighbors could coordinate in such a way that enclosures were no longer necessary. Without this coordination, individual farmers had had to enclose their fields to prevent livestock on neighboring fields from damaging their crops; within the regulated open-field system, enclosures for the livestock during fallow periods were no longer necessary. Fences and hedges were removed, which eliminated inconvenient

39 Uwe MEINERS/ Werner RÖSENER (eds.), *Allmenden und Marken vom Mittelalter bis zur Neuzeit. Beiträge des Kolloquiums vom 18. bis 20. September 2002 im Museumsdorf Cloppenburg* (Kataloge und Schriften des Museumsdorfs Cloppenburg 14), Cloppenburg 2004.

40 Hans RENES, *Landscape history and archaeology of Open fields in Europe*, in: Jan KLÁPŠTĚ (ed.), *Agrarian technology in the medieval landscape* (Ruralia 10), Turnhout 2016, pp. 255–265.

41 MEINERS/ RÖSENER (note 39).

42 Hans JÄNICHEN, *Markung und Allmende und die mittelalterlichen Wüstungsvorgänge im nördlichen Schwaben*, in: Karl Heinz SCHRÖDER (ed.), *Die Anfänge der Landgemeinde und ihr Wesen 1* (Vorträge und Forschungen 7), Sigmaringen 1986, pp. 163–222.

43 Helmut HILDEBRANDT, *Studien zum Zelgenproblem. Untersuchungen über flürlichen Anbau aufgrund methodenkritischer Interpretationen agrargeschichtlicher Quellen aus dem deutschsprachigen Raum* (Mainzer geographische Studien 14), Mainz 1980.

barriers when ploughing the fields. Because of the large turning radius of a harnessed team of draft animals, it had not been possible to plough to the very edge of the fields. In the new open-field system, however, the plough could be turned on the neighbor's field. This increased the cultivated area within fertile settled areas tremendously.

The new open-field system brought important benefits for the daily experience of peasants more so than for noble lords. The introduction of regulated crop rotation and open-field cultivation certainly had many long-term consequences; it meant both a social reorganization within rural communities regarding land ownership and regulation of agricultural practice, which gave new power to the rural elites. The open-field system was also an intensive intervention that changed the cultural landscape both in terms of appearance and ecology.

3 Long-Term Consequences

In conclusion, the many transformations of rural society, settlement patterns, agrarian technology, and the cultural landscape must be understood as a complex, long-lasting process that occurred along different paths and at different paces in different regions. These changes had consequences both for the landscape and for society. As written sources contain hardly any information about peasants' concerns, a detailed assessment is impossible. In this situation, it is helpful to understand settlements as human ecosystems (Figure 4), because this perspective makes it possible to identify possible interconnections. Teleconnections over large distances, but also in time may be understandable by looking at the ecological backgrounds. Human ecology is an interdisciplinary field of research, involving topics of demography, food, energy, resources, waste, and environment with a special focus on their interdependencies and their roles in environmental and cultural change.⁴⁴ Human behavior, although an important factor in how people recognize and deal with nature, only plays a minor role. Approaches aimed at understanding the social and cultural dimensions of human impacts on landscapes and the ecosystem are subsumed as cultural ecology.⁴⁵ Whereas human ecology most often implies a background in natural sciences, cultural ecology is rooted in the humanities.

⁴⁴ Wolfgang NENTWIG, *Humanökologie. Fakten – Argumente – Ausblicke*, Heidelberg 2005.

⁴⁵ Peter FINKE, *Kulturökologie*, in: Ansgar NÜNNING/ Vera NÜNNING (eds.), *Einführung in die Kulturwissenschaften. Theoretische Grundlagen – Ansätze – Perspektiven*, Stuttgart 2008, pp. 248–279.

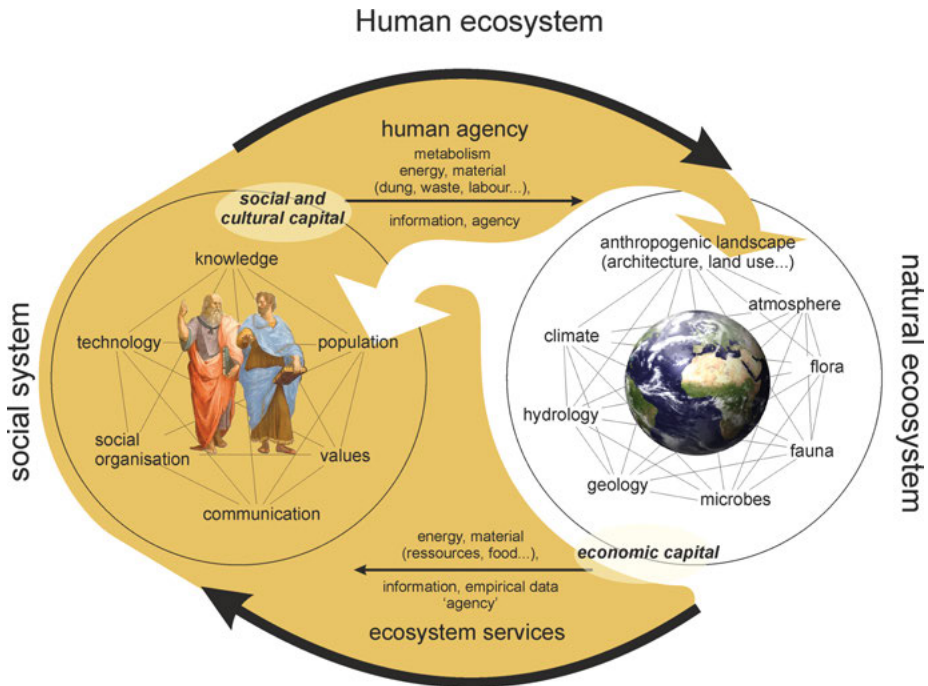


Figure 4: The idea of human ecosystem integrates the social system and the natural ecosystem and their various interrelations (R. SCHREG).

The natural ecosystem comprises flora and fauna, soils, atmosphere, hydrology, and the physical landscape. These elements may already have been altered by humans and are not necessarily natural in the sense of being pristine. The social system includes everything that represents human culture: people, knowledge, technology, value systems (including religion), social organization, and communication. Societies impact their environments differently depending on their specific ideas and values. The possibilities for their behavior to influence their environment also depends largely on the technological innovations available to them. Social structures and social norms determine which methods are actually implemented. The social system and the natural system interact with each other via the exchange of energy, materials, and information.

In order to apply this theoretical concept to the fourteenth-century crisis, the focus must be on landscapes or settlements as ecosystems. In order to understand the transmission of the Black Death, we must see towns as ecosystems that include the living conditions of fleas, rats, and other small animals, systems of waste disposal, and burial customs. However, a broader understanding of the preconditions of the fourteenth-century crisis requires a closer look at rural settlements and village ecosystems. This perspective, which was first developed in environmental history in

the 1980s, leads to a better understanding of possible connections between various factors and agents.⁴⁶

3.1 Changes in the Human Ecosystem

Thinking of medieval rural settlements as human ecosystems helps to identify several possible connections between the described processes of colonization, village formation, and open-field systems and the situation in the fourteenth century.⁴⁷ Due to the nature of the written sources, there will inevitably be gaps in some aspects of the hard historical data. The idea of human ecosystems, however, provides scenarios or models that function as hypotheses in need of verification.

In developing these hypotheses, it is not enough to identify relationships of cause and effect; we need, instead, to take into account phenomena of thresholds or retarded effects, questions of intensity, and positive and negative feedback. Within human ecosystems, the perception and reaction of human society to certain situations of stress or to emerging risks is crucial. Without modern scientific analysis, and with a pre-modern worldview, medieval humans often did not react in the way we might expect.

Understanding long-term processes requires an awareness of the chronological dimension of ecosystems. Initially, ecology postulated equilibrating states of ecosystems. As a consequence, change was seen as a disturbance that was usually the result of external influences. Nowadays, ongoing change is understood to be a basic characteristic of ecosystems. Ecosystems are complex, self-adaptive systems, with processes and dynamics resulting from the interaction of internal factors and agents.⁴⁸ However, for heuristic reasons, we must focus on selected aspects that enable us to identify possible interconnections which are verifiable with archeological or historical sources.

46 E. g. Robert McC. NETTING: *Balancing on an Alp. Ecological change and continuity in a Swiss mountain community*, Cambridge 1981; Rainer BECK, *Unterfinning. Ländliche Welt vor Anbruch der Moderne*, München 2004; for an archaeological application: Rainer SCHREG, *Ecological approaches in medieval rural archaeology*, in: *European Journal of Archaeology* 17 (2014), pp. 83–119.

47 Compare Rainer SCHREG, *Feeding the village - Reflections on the ecology and resilience of medieval rural economy*, in: Jan KLÁPŠTĚ (ed.), *Food in the Medieval Rural Environment - Processing, Storage, Distribution of Food (Ruralia 8)*, Turnhout 2011, pp. 301–320; SCHREG, (note 46).

48 Lance H. GUNDERSON/ C. S. HOLLING (eds.), *Panarchy. Understanding transformations in human and natural systems*, Washington / DC 2002.

3.2 The Social Impact of Open-Field Crop Rotation

The introduction of regulated three-field crop rotation required drastic changes in land ownership. A functioning open-field system necessitates equal distribution of farmland over all three zones of crop rotation. Field plots had to be exchanged between farmers to ensure that each had fields in each of the three zones.

In the past, historical and geographical research assumed that the nobility had organized the introduction of the regulated three-field system. However, this idea was rooted in the philosophy of historicism, which emphasized the role of powerful people and the state as a major driver in history. The actual sources provide little evidence to confirm this modern idea of a systematic state-driven colonization of wilderness. Rather, the data available suggests that “colonization” and the open-field system grew out of the needs of the rural population. The coordination of land use, as was necessary within a regulated open-field system, touched on basic economic interests of every single household within the settlement system. The need for equal distribution of field property over all three field blocks required a redistribution of land rights and certainly caused many conflicts. The fact that there are few documents highlighting disputes over these questions reveals a practice of land transfer very different from the common donation and sales of land to which signed charters attest. It was not noble authorities but rather local communities who oversaw this reorganization of land ownership. It is likely that this reorganization was realized within the same social organizations that had previously led the repeated shifts in settlement and field locations. Living together within village communities reshaped local societies. Municipal peasant institutions gained in importance during the twelfth and thirteenth centuries; the status of peasants and the nobility was established, and rural lower classes developed. This social process was certainly related to the urbanization occurring during this same period.⁴⁹

One aspect that may be important for understanding the later fourteenth-century crisis is the concentration of farmsteads and people within closed villages. In earlier times, larger villages existed, but now they became characteristic in most parts of western central Europe. People lived closer together than they had previously – not just in towns, but also in the rural settlements. The lack of archeological excavations within existing villages means that we cannot trace the development of farmsteads in detail. In the long term however, the dispersed farmsteads with wooden houses, pit houses, and stilted granaries were replaced by more compact farmhouses that integrated different functions such as the stables.

⁴⁹ Rainer SCHREG, Die Entstehung des Dorfes um 1200. Voraussetzung und Konsequenz der Urbanisierung, in: Ralph RÖBER et al. (ed.), Zum Wandel der Stadt um 1200. Die bauliche und gesellschaftliche Transformation der Stadt im Hochmittelalter (Materialhefte zur Archäologie in Baden-Württemberg 96), Stuttgart 2013, pp. 47–66

3.3 The Appearance of the Landscape

Village formation and the introduction of the open-field system drastically changed the appearance of the cultural landscape (tab. 1). Hedges that had been necessary to keep livestock within the single plots during the fallow period were cut down, making it possible to turn ploughs on neighboring fields. Because these fields were cultivated in the same rhythm, turning the plough and crossing neighboring fields caused no crop damage. In effect, the space formerly occupied by hedges was adapted as space for operating the plough and use as a track. The introduction of the open-field system meant a notable increase in the total area of land cultivated.

3.3.1 Changes in Hydrology and Microclimate

The removal of hedges also changed patterns of soil erosion and the microclimate. The creation of an open-field system resulted in large areas planted in the same crops; this in turn increased heat emission and water runoff from these larger unbroken surface areas.

In addition, forested areas were cut and turned into farmland, and previously intact soil was ploughed. Geo-archeological studies in many places – e.g., the Black Forest – have shown that soil erosion increased.⁵⁰ Rates of soil erosion peaked in the fourteenth century, when the landscape was being cleared (Figure 5). In effect, the landscape lost its capacity to buffer rain water. Increased water drainage changed the fluvial dynamics of rivers and the risks of flooding.⁵¹ The increasing importance of water mills and bridges slowed down the water runoff in creeks and rivers and led to higher groundwater levels, but also put expensive investments at risk.

3.3.2 Changed Habitats and Biodiversity

It is difficult to judge the effects of the introduction of the open-field system on flora and fauna. With its annual cycle of cultivation and moderate manuring, three-field crop rotation led to a differentiation between the plant communities of agrarian fields and grassland.⁵² Studies from Scandinavia and the Rhineland show the

⁵⁰ See above note 19–20.

⁵¹ Wolfgang SCHIRMER, *Der menschliche Eingriff in den Talhaushalt*, in: *Kölner Jahrbuch* 26 (1993), pp. 577–584; Renate GERLACH, *Flußdynamik des Mains unter dem Einfluß des Menschen seit dem Spätmittelalter* (Forschungen zur deutschen Landeskunde 234), Trier 1990.

⁵² Joachim HÜPPE, *Zur Entwicklung der Ackerunkrautvegetation seit dem Neolithikum*, in: *Natur- und Landschaftskunde* 23 (1987), pp. 25–33.

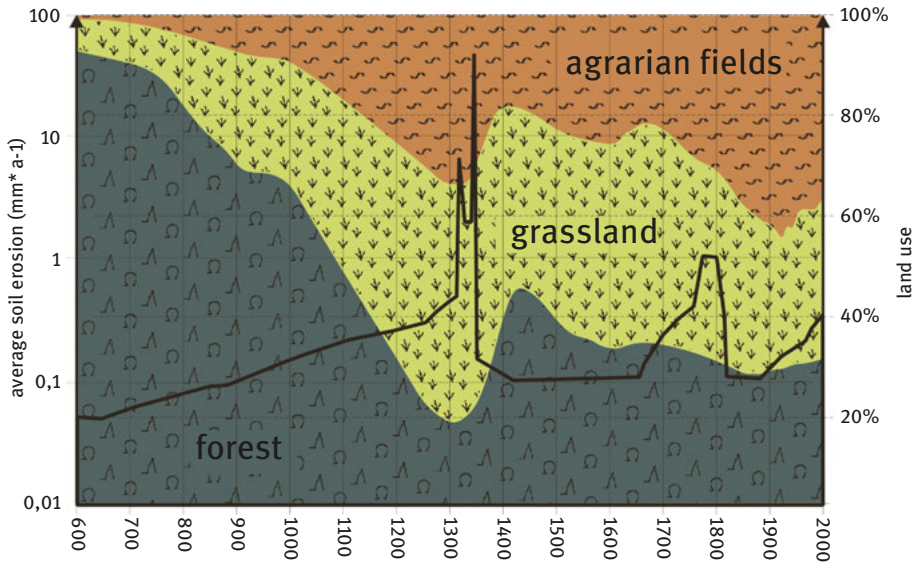


Figure 5: The development of forests, grass land, and agrarian land since the early Middle Ages in Germany, compared with the average rate of soil erosion (Hans-Rudolf BORK 2006, fig. 160).

potential of palynological data for understanding landscape development during the Middle Ages.⁵³ Despite an abundance of palynological and zoological data, however, a modern synthesis for central Europe is still lacking. However, in modern land consolidation, the removal of hedges has often reduced the number and diversity of birds, which in turn causes an increase in vermin.⁵⁴ It is logical to assume that their removal would have had similar repercussions in the Middle Ages. Given the lack of detailed information about the hedges and fields in the High Middle Ages, it is not currently possible to assess the actual quantitative effects. These changes may have also affected in some way the biotopes of rodents, which are known today to be carriers of disease.

⁵³ Per LAGERÅS, *The ecology of expansion and abandonment. Medieval and post-medieval agriculture and settlement in a landscape perspective*, Stockholm 2007; Jutta MEURERS-BALKE et al., *Landschafts- und Siedlungsgeschichte des Rheinlandes*, in: Karl-Heinz KNÖRZER et al. (ed.), *PflanzenSpuren. Archäobotanik im Rheinland: Agrarlandschaft und Nutzpflanzen im Wandel der Zeiten (Materialien zur Bodendenkmalpflege im Rheinland 10)*, Köln, Bonn 1999, pp. 11–66, 52–60; Wolf-Dieter BECKER, *Das Elsbachtal. Die Landschaftsgeschichte vom Endneolithikum bis ins Hochmittelalter (Rheinische Ausgrabungen 56)*, Mainz 2005.

⁵⁴ Klaus PUCHSTEIN, *Zur Vogelwelt der schleswig-holsteinischen Knicklandschaft mit einer ornitho-ökologischen Bewertung der Knickstrukturen*, in: *Corax* 8 (1980), pp. 62–106.

Table 1: Hypothetical changes in the medieval settlement landscape

Landscape with enclosed plots	Open fields with three-field crop rotation
social organization	
– dispersed settlement system	– closed villages
– high individual flexibility in land use	– land use regulated by the community
	– increasing importance of the local municipality
	– changes in land property rights
landscape view	
– small mosaic of different crop	– large areas with uniform crop
– enclosures by hedges	– removal of hedges, terraces, and banks to create
– hedges, terraces, and banks to prevent strong soil erosion	– larger spaces for working with the plough
ecosystem	
– higher biodiversity, mosaic of biotopes	– increased risk of soil erosion
– diminished heat emission	– increased heat emission
– reduced evaporation	– increased water runoff and increased evaporation
– shifting settlements and long-term rotation of cultivation	– sinking groundwater levels
	– high risk in heavy weather event
	– reduced biodiversity
	– altered biotopes of rodents
	– long-term cultivation

Even though the contemporary sources offer little hard evidence, these new agricultural practices certainly introduced changes into the human ecosystem. Table 1 lists some hypothetical changes to the medieval landscape.

In the light of these landscape characteristics, one might ask whether open -field crop rotation does in fact represent great progress for medieval agrarian history. These changes obviously affected both the physical landscape and the ecosystem. Furthermore, by making the cultural landscape more vulnerable, they may have set the stage (at least in part) for the fourteenth-century crisis.

4 The Fourteenth Century – Desertion and Plague

During the fourteenth century, a series of extreme weather events struck central Europe. Within the vulnerable cultural landscape of that age, inclement or even catastrophic weather could have far-reaching consequences and result in impoverishment and increased mortality, which explains the huge number of abandoned settlements at the end of the fourteenth and the beginning of the fifteenth century. Although these late medieval deserted settlements have gained considerable attention in western central Europe, there is to date no detailed register or systematic research

beyond the excavation of specific rather small regions. The aforementioned site of Oberwürzbach, situated in the marginal land of the Black Forest, is just one example. However, it was not only in mountainous regions that settlements were abandoned; there are also numerous abandoned settlements in fertile landscapes that had been settled for some time.

Whereas Wilhelm ABEL emphasized the agrarian crisis and economic factors in his explanation of the fourteenth-century crisis and the phenomenon of desertion, examining these changes to the landscape tells another story. The beginning of the fourteenth century had already seen some epizootic diseases, which may have been triggered by the landscape changes.⁵⁵ However, the situation in the summer of 1342 in particular highlights possible teleconnections between the landscape changes and the emerging crisis. In July 1342, around the feast day of Mary Magdalene, large areas – stretching at least from the Danube in Eastern Bavaria across the low mountain ranges of central Germany to the lower Rhine – were affected by a weather front that caused heavy thunderstorms and flooding at record levels never reached before or since. The inclement weather was caused by a cyclone that came from the Atlantic across the western Mediterranean and then around the eastern Alps in a northwestern direction across central Europe (the so-called “Vb-track”). This phenomenon transports huge quantities of moisture into central Europe, and such storms were responsible for floods in recent years, including the floods along the Oder in 1997, along the Elbe in 2002, and throughout central Europe in 2013.⁵⁶

Such events can be traced in the considerable body of geo-archeological evidence on fourteenth-century soil erosion at sites ranging from southwestern Germany⁵⁷ to

55 J. HAMILTON/ Richard THOMAS, Pannage, pulses and pigs. Isotopic and zooarchaeological evidence for changing pig management practices in 14th century England, in: *Medieval Archaeology* 56 (2012), pp. 234–259.

56 Martin BAUCH, Die Magdalenenflut 1342 – ein unterschätztes Jahrtausendereignis?, in: *Mittelalter. Interdisziplinäre Forschung und Rezeptionsgeschichte* (4.2.2014) [<http://mittelalter.hypothesen.org/3016>]; Hans-Rudolf BORK/ Arno BEYER/ Annegret KRANZ, Der 1000-jährige Niederschlag des Jahres 1342 und seine Folgen in Mitteleuropa, in: *Strategien zum Überleben*, in: Falko DAIM/ Detlef GRONENBORN/ Rainer SCHREG (eds.), *Umweltkrisen und ihre Bewältigung*, (Römisch-Germanisches Zentralmuseum - Tagungen 11), Mainz 2011, pp. 231–242; Gerd TETZLAFF et al., Comparison of maximum precipitation estimates with runoff depths for the 1342 and 2002 Central European flood events, in: G. BLOSCHL et al. (ed.), *Water resources systems – hydrological risk, management and development. Proceedings of an international conference, Sapporo, Japan, 30 June to 11 July 2003* (International Association of Hydrological Sciences publication 281), Wallingford 2003, pp. 59–64.

57 Elena BECKENBACH/ Uwe NIETHAMMER/ Hartmut SEYFRIED, Spätmittelalterliche Starkregenereignisse und ihre geomorphologischen Kleinformen im Schönbuch (Süddeutschland). Erfassung mit hochauflösenden Fernerkundungsmethoden und sedimentologische Interpretation, in: *Jahresberichte und Mitteilungen des Oberrheinischen Geologischen Vereins* 95 (2013), pp. 421–438.

Franconia⁵⁸ and up to the Weser Mountains.⁵⁹ In all these cases, sediment from alluvial fans connected to erosion gullies can be dated to the fourteenth century. Near a Romanesque church which still stands in the deserted village of Winnefeld in the southern part of the Solling Mountains, approximately fifteen kilometers south of Holzminden (Lower Saxony), geo-archeological research has found indications of a severe flash flood, which destroyed a road in the settlement and washed out a gully fifteen meters wide and nearly three meters deep. The rushing water widened the floodplain of the nearby creek and swept away several houses and their contents.⁶⁰

While the dating is not so precise as to allow ascribing this intense soil erosion to a specific event, there is a high probability that they result from the St. Mary Magdalene flood, considering the other available information on climatic events in this period.⁶¹

The landscape changes described above paved the way for such weather extremes to have this destructive power and cause such dramatic soil erosion. At the same time, however, there is some reason to presume that the changes to the cultural landscape themselves actually exacerbated the extreme weather: by increasing heat emission and increasing evaporation and water runoff, these changes likely made the microclimate more prone to thunderstorms.

St. Mary Magdalene's flood occurred in July 1342, just before harvest time. Heavy rain and floods distributed ripe grain over the landscape, where it was free to germinate. This likely caused a plague of rodents; although there are no written sources confirming this in this case, it is a frequently documented problem after other floods. As they fled from flooded areas, rodents searched for food in new areas including human settlements. They would have found plenty of food from the destroyed harvest, and their population presumably exploded after the flood. Seven years later, in 1349, the Black Death reached central Europe.⁶² It has been confirmed that *Yersinia pestis* did in fact cause the Black Death.⁶³ Furthermore, we now know of its even longer history in central Europe, where it dates back to the late Neolithic and has also been linked to the Justinian plague in the sixth century. We know that *Yersinia pestis* had been endemic in Europe since prehistoric times and that over such a long time period, the

58 Markus DOTTERWEICH, High-resolution reconstruction of a 1300 year old gully system in northern Bavaria, Germany: a basis for modelling long-term human-induced landscape evolution, in: *The Holocene* 15 (2005), pp. 994–1005.

59 BORK/ BEYER/ KRANZ (note 56).

60 *Ibid.*

61 *Ibid.*; BAUCH (note 56).

62 Ole J. BENEDICTOW, *The Black Death, 1346–1353. The complete history*, Woodbridge 2004.

63 Summarizing recent research on the Black Death: CAMPBELL (note 3); Ole Jørgen BENEDICTOW, *The Black Death and Later Plague Epidemics in the Scandinavian Countries. Perspectives and Controversies*, Warsaw, Berlin 2016.

population would have developed resistance to the usual plague.⁶⁴ Shortly before the outbreak of the Black Death, however, the bacterium *Yersinia pestis* mutated in such a way⁶⁵ that the human immune system was not well adapted to fend it off. The pathogen thus become considerably more virulent.

After 1347, the plague broke out in cycles of approximately seven to eleven years.⁶⁶ That is why we must ask whether there had been a less deadly outbreak of the plague at the time of St. Magdalene's flood in 1342. It is possible that in the next cycle of plague starting 1347, the combination of the endemic germs and the fact that a new variant of *Yersinia pestis* reached Europe via the Crimea and the Italian harbors suddenly resulted in the fatal outbreak of the Black Death. The Black Death spread from Eurasia to the Black Sea in 1347, across the sea to Italian harbors, and soon to the British Isles. Mass burial sites have been found in England and southern France⁶⁷ but rarely in central Europe.⁶⁸ This is likely due, however, to different coping strategies rather than to a lower mortality.

Linking the St. Mary Magdalene's flood in 1342 with the Black Death postulates that rats were in fact the relevant intermediate hosts, a question which is admittedly still under discussion.⁶⁹ Recent research using genetics may shed new light on this matter.

5 Conclusions

This review of medieval settlement history from an archeological perspective, or more precisely, from a perspective of ecological archeology, had provided a scenario of possible long-term teleconnections (Figure 6). It links settlement changes, landscape characteristics, and land management practices of the eleventh to thirteenth centuries with weather events and the outbreak of the plague in the fourteenth century. It can be argued that systematic, regulated three-field crop rotation was not an une-

64 Simon RASMUSSEN et al., Early Divergent Strains of *Yersinia pestis* in Eurasia 5,000 Years Ago, in: *Cell* 163 (2015), pp. 571–582.

65 Kirsten I. Bos et al. (ed.), A draft genome of *Yersinia pestis* from victims of the Black Death, in: *Nature* 478 (2011), pp. 506–510.

66 Manfred VASOLD, *Die Pest. Ende eines Mythos*, Darmstadt 2003, pp. 124–125.

67 Daniel ANTOINE, The Archaeology of “Plague”, in: *Med. Hist. Suppl. (Medical history)* 27 (2008), pp. 101–114; Sacha KACKI et al., Black Death in the rural cemetery of Saint-Laurent-de-la-Cabrerisse Aude-Languedoc, southern France, 14th century. Immunological evidence, in: *Journal of Archaeological Science* 38 (2011), pp. 581–587

68 New evidence: Mathis HENSCH, Einblick in drei Jahrtausende Siedlungsgeschichte - Ausgrabungen beim ehemaligen Bamberger Spital, in: *Das Archäologische Jahr in Bayern* 2017 (2018), pp. 99–102.

69 Anne Karin HUFTHAMMER/ Lars WALLØE, Rats cannot have been intermediate hosts for *Yersinia pestis* during medieval plague epidemics in Northern Europe, in: *Journal of Archaeological Science* 40 (2013), pp. 1752–1759.

quivocally progressive innovation of medieval agriculture, but also provided crucial preconditions for the fourteenth-century crisis. Furthermore, the Black Death was not just a spontaneous natural event but had an anthropogenic component. The vulnerable status of the cultural landscape in the fourteenth century probably favored the outbreak and transmission of disease.

Methodologically, the nature of the available sources presents a number of challenges. Because the people of the past perceived their environment differently, written sources do not generally comment directly on questions of land use practices, soil erosion, extreme weather, or infection. This necessitates the incorporation of other evidence, mostly material remains. In most cases, archeologists initially unearth such evidence, but analyzing their finds requires the cooperation of various disciplines. Purely chronological correlations are insufficient for synthesizing these various sources of data. This is not due only to the lack of a detailed chronology of the different processes, but also because current correlations of climate change and cultural history most often fail to consider the complexity of connections. The perspective of human ecology, however, can at least produce some hypotheses as it addresses quite a few factors and aspects that have not been discussed in the existing debate about the fourteenth-century crisis.

In conclusion, there is a high probability that the historic situation of landscape development in central Europe played an important role in the fourteenth-century crisis. As a long-term effect of agrarian intensification, “colonization,” and village formation, the ecological system changed in ways that favored the spread of the Black Death. The introduction of open-field cultivation altered the landscape, created new risks, and increased vulnerability. In this situation, a change in the climate induced extreme weather that was fueled by the anthropogenic microclimate. The disturbance of rodents’ ecology in 1342 may have affected the spread of the Black Death seven years later. The scenario presented here is nothing more than a hypothesis and an invitation to challenge old paradigms, test numerous assumptions, and deal with questions that arise from an interdisciplinary, ecological perspective.