Feeding the village – Reflections on the ecology and resilience of the medieval rural economy

Survivre au village – Réflexions sur l'écologie et la résilience de l'économie du village médiéval

Überleben im Dorf – Überlegungen zur Ökologie und Krisenresistenz mittelalterlicher Dorfwirtschaft

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In recent decades, archaeological research has shown that the development of rural settlements in Europe was more complex than previously thought. There are important changes within the settlement system seen not only in colonization, abandonment, and concentration but also in ecology, society and mentality. These changes are poorly understood.

Models reflecting on the ecology and resilience of the medieval rural economy provide important possibilities to explain these changes. This contribution will present some theoretical concepts derived from system theory recently discussed in environmental history. As all pre-modern cultures were based on solar energy, food production is a central element of every human-ecological system.

Medieval village ecosystems mainly in western central Europe are reconsidered in light of these concepts, in an attempt to understand their changes and to evaluate the risk of starvation and the need for continuous adaptation.

In this article I want to suggest an ecological approach to analyze these changes and to broaden the archaeological perspective. I will do this in a rather theoretical way, as it is not the intention to analyze a specific landscape but to look at medieval food production and its role for changing settlement systems in a more general way.

This contribution aims:

- to call attention to the ecological dimensions of food production, storage, and consumption
- to examine dynamics underlying changes in settlement systems and food production
- to evaluate the usefulness of archaeological approaches based on systems theory.

Food production as a limit to growth

Starvation and poverty are one of the most important and probably one of the most popular perceptions of the 'dark' Middle Ages. As population increased continuously from the Merovingian period until the late medieval crisis in the 14th century, historians understand food production as a determining as well as a limiting factor of medieval history. They deal with colonisation as well as with technological innovation as a reaction to increasing population (*Herrmann 1987*). Colonisation opened new land for agriculture (*Erlen 1992*). Technological innovation in agrarian tools and production strategies increased rural productivity (*White, Jr. 1968*). However, the Middle Ages have been seen as a prominent example for a Malthusian crisis, as the increase in food production did not meet the needs of growing population (*Malthus 1977*; *Postan 1966*).

In dealing with these changes, historians have focussed on aspects of the economic market and have emphasised the role of demography. In recent years an ecological perspective has gained more importance among historians. It has been suggested that over-exploitation and deforestation were responsible for at least some of the problems of the late medieval crisis (*Schreg 2009b*). The crisis of the 14th century including processes of settlement abandonment, economic problems, starvation and a major decline in population has been understood as an ecological crisis (*Bowlus 1988*).

There is ongoing debate about the extent to which late medieval events can be understood as a Malthusian crisis. Desai criticized the notion of a Malthusian crisis in 14th century England by arguing that the famines of the early 14th century had no long-lasting

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effects (*Desai 1991*). More general critics focus on the lack of explanatory value or they suspect that the interpretation as "crisis" is a projection of our own modern concepts of crises back to the medieval past (*Schuster 1999; Winiwarter in press*).

It is the case that over large areas of Europe many villages, farmsteads and agrarian fields were abandoned in the 14th century, and there are many other arguments for some kind of crisis (*Abel 1976*; *Siedlungsforschung 1994*; *Seibt 1984*). There are numerous studies, mainly in physical anthropology, which show that medieval populations were deficient in nutrition, both in terms of the quantities of food consumed, as well as in the necessary balance of minerals and vitamins (*Haidle 1997*). We also know of pestilence, heavy rain events, and climate change as well as changes in settlement systems, economy, society, and mentality (*Dahlerup 2009*). It is hardly possible to think of them as isolated processes.

At present, medieval settlement abandonment is poorly understood. The fact that we must take into account many factors, regional differences and complex interactions means that it is a great methodological challenge to build a more objective basis for argumentation.

With respect to changes in food production in an historical perspective, it is necessary to use a long-term perspective and to analyse changes using a structural or systemic approach. It is not enough to describe the changes; we also need to evaluate them.

Theoretical approaches to cultural and environmental changes

It is one of the most challenging tasks of global history to analyze processes of cultural and ecological change as an interaction of several quite different historical, anthropological or natural factors. There are several difficulties to overcome. The lack of data is a serious issue, but it is probably not the most important challenge, as controversies about cultural changes in well documented historical situations show (*Brüggemeier – Rommelspacher 1991*). Rather more important are the intellectual concepts which are used to understand historical processes (*Radkau 2002*). In many cases the value judgements of modern researchers and their preconceptions of nature and humans affect the insights more fundamental.

Changes in past political and social systems have often been understood as the evolution of our own present. German historiography provides an example. The evolution of historical thought has been heavily dependent on political history after the Napoleonic wars, reflecting nostalgia for the lost national state, the development of the Prussian concept of State and nation, and national socialistic ideology as well as democratisation, westernisation and European integration of Germany after WWII and after 1989. For a very long time German medieval history leaned towards an imperial national state as an aim of history. A strengthening of central power has been seen as progress, while decentralisation or processes which balance interests of different social groups were denounced as weaknesses of the state. Changes were often perceived as progress or decline relative to the values of the present. Even today, history and especially medieval and modern history foms part of our modern identities and therefore is part of a teleological view concentrated on continuities rather than on changes. Historians, archaeologists, and geographers primarily follow a genetic approach, seeking origins, continuity of traditions, and preconditions of the present (or at least later situations).

Classical historical research traditions, as represented by historism – which has not been a purely German phenomenon (*Oexle 1996*) – emphasized human action. Many historians were very sceptical about abstract factors and many approaches of social or economic history were appreciated as deterministic, functionalistic or more generally as "ahistoric". History was linked with events, juridical institutions and human action; history has been seen as a teleological process driven by human individuals, human polities or nations. Even Marxist historical materialism followed this teleological view of history leading to a communist society as the aim of history. Transformations leading to this goal were thought of as a series of revolutions realized by humans, but determined by dialectical conditions of the socio-economic situation. Today several modern historical schools are reconsidering daily life, mentality and socio-economic conditions. They showed different processes of cultural adaptation, cultural exchange, and cultural change lasting over generations. When Fernand Braudel and the French Annales introduced their concept of different time scales – which gives priority to long-term historical structures over conjunctures and short-time events – it was possible to integrate economic and social history with their mid- and long-time perspective (*Braudel 1958*).

Today environmental history gains more and more importance and requires again a broadening of the historic perspective. Because environmental research gains its topics mainly from current debates on climate change and ecological problems, its key concepts go beyond historical perceptions of the environment and cannot be taken from historical texts. Environmental history has three levels: 1) the study of natural environments of the past to understand ecological interdependencies irrespective of human activities; 2) human modes of production to understand the socioeconomic

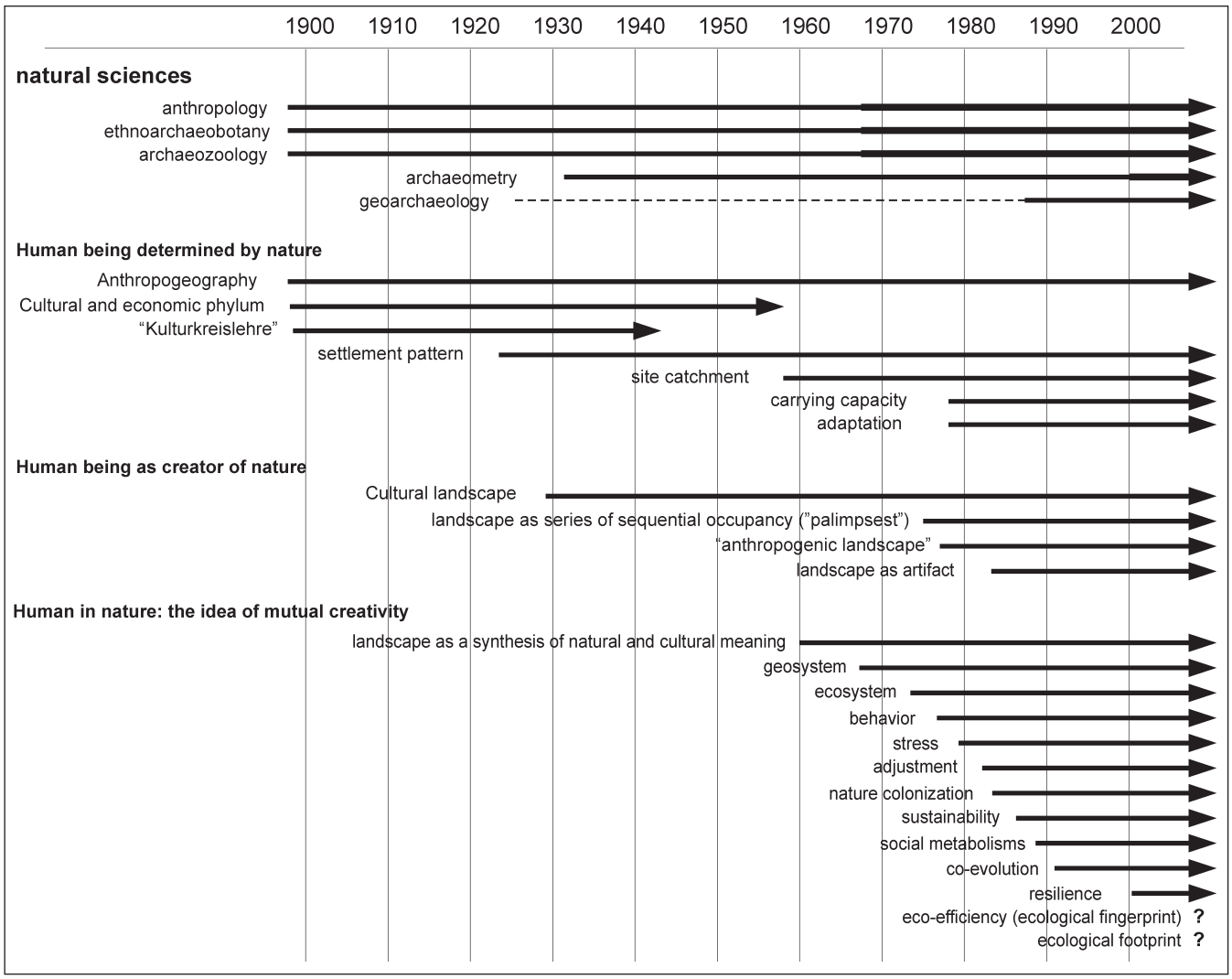

Fig. 1. *Archaeological concepts related to man and environment ((*Schreg in press b*), adapted from* Smyntyna 2003*).*

realm as it interacts with the environment; and 3) the perception, ideology and value of the environment as a basis for human decisions, reactions and activities (*Worster 1988, 293ff*).

As environmental history took its origins from modern ecological disasters and problems, the analysis of ecological systems, interrelations of natural and cultural factors and understanding of systems or regimes is the most important research topic. A systemic view is therefore quite often characteristic for an environmental perspective. Human culture and action is seen within the framework of ecological systems. However, there are several concepts within environmental history which do not form one coherent general theory (*Winiwarter 2007*). As they pay attention to different aspects of cultural changes and provide alternative perspectives, they may be able to give new insights even to well established discussions. Environmental history promises a synthesis of quite different approaches to historical processes and changes, providing also some concepts which deal specifically with the role of culture and human perceptions of the environment.

Food production is a key element of every human society since the Neolithic; and consequently changes in food production are crucial for environmental history. The analysis of food production in the Middle Ages provides deeper insights into settlement history, periods of historical expansion and crises, and may also bring to mind the complexity and ecological sensibility of modern food production.

The close association of archaeology with physical geology, anthropology, botany and zoology has ensured that the relationship of man and environment has played an important role in archaeological research since the 19th century (*Fig. 1*). Discussions of diluvial human fossils as well as the pile dwellings of the circum-Alpine region, or the kitchen middens of Southern Scandinavia, have referred to man-environment relations. Though historians emphasized the role of man as an active agent in history, early 20th century

archaeologists generally viewed human actions as being determined by nature. Even in the late 1970s, Herbert Jankuhn's introduction to settlement archaeology viewed the environment as a determining factor for settlement (*Jankuhn 1977*). However, several new approaches were also developed in those years.

Within Anglo-American archaeology in particular, researchers had begun to focus on processes of cultural changes since at least the 1960s. They favoured an anthropological point of view which was interested to a much higher degree in general observations than in the specific historical situations. Many theoretical concepts were adopted from the natural sciences, especially from ecology (*Jochim 1981*; *Butzer 1982*). Processual archaeologists tried to explain culture as the non-biological adaptation of man to his environment and emphasized the functions of distinct system elements (*Binford 1962*; *Johnson 2003, 75f*). Early processual archaeologists preferred systemic models which emphasized the dependencies of humans in their environment. Typical approaches included site catchment analysis, carrying capacity assessment, or cultural adaptation. It showed however, that these approaches reduced humans to a rather passive element of closed systems (*Preucel 1991*). In one reaction, aspects of human cognition and agency gained importance. Another consequence was a refinement of the systemic approach by referring to ecosystems (*Butzer 1982*), and by integrating ideas of stress, nature colonization, sustainability and metabolism. Early deterministic approaches have developed towards the idea of mutual creativity of man and nature (*Smyntyna 2003*). In recent years, however, complexity theory has been introduced to archaeology producing new models which are more abstract on the one hand, but which provide new questions and insights on the other (*Bentley 2003*; *Redman 2005*).

We can understand systems only by describing them within simplified models. In practice, archaeologists primarily analyzed small sub-systems. As archaeologists depend on material data sources, they have preferred a materialistic point of view, neglecting the humans as agents who depend on cognition, ideology and religion. It is not the purpose of these models to describe the past reality or to show the totality of all factors and all relations. They are simply a methodological tool to detect possible interrelations and to make research questions more precise. Depending on the research questions, they select certain elements and spatial/temporal scales in order to get a simplified, understandable, more abstract idea about the interaction, which can be used as an hypothesis for further research.

Systemic models suitable for dealing with changes in medieval food production need: 1) to concentrate on the level of single settlements or landscapes; 2) to describe ecology and society in one complex system; and 3) to deal with regimes and their stages through time.

Pre-industrial village ecosystems

Models of pre-industrial village ecosystems provide a perspective which allows us to reflect on specific functions and characteristics at the scale of a rural settlement community (*Fig. 2*).

The village ecosystem comprises the totality of the settlement, its inhabitants, its surrounding landscape and their mutual activities as a dynamic and organic whole. The function of a village ecosystem mainly depends on the major bio-productive systems such as agricultural lands, grasslands, forest and wetland. Plants transform the solar energy which is basic for every pre-industrial ecosystem. Other central aspects of the village ecosystem are the extent and nature of the available land as well as the labour reserve. Technological skills, subsistence strategies, land tenure, social structures, reproduction, and power relations, as well as social values and world-view are crucial for the specific layout of the village ecosystem.

Within the village ecosystem several elements are in mutual dependency. For example, in most European agrarian village ecosystems, cattle were required for manuring fields to preserve their fertility. As cattle herding produces lower yields per hectare than arable production, this may place stress on agrarian societies. The needs for more agrarian products could not be met by converting meadows into fields, because fertility would decline. Food production, storage and consumption form another subsystem, as consumption influences production in different ways (*Fig. 3*).

Sonnlechner and others have sketched a model of the pre-industrial village ecosystem on the basis of some villages in Austria (*Sonnlechner-Winiwarter 2001*; *Sieferle et al. 2006*). Less abstract approaches which are closer to the written record have also been pursued, and Rainer Beck described the small village of Unterfinning in Southwestern Bavaria, representing the "typical" village with around 220 inhabitants, approximately 165 hectares of fields and 237 hectares of meadows in 1721 (*Beck 2004; Freudenberger 1998*). Based on late medieval / early modern data on yields, taxes, family sizes, and food requirements, several studies calculated the sufficiency of nutrition. For example, David Sabean has shown that peasants' wealth in the decades before the 16th century peasant's war was quite good generally – in contrast to their complaints. However some families were at great risk of poverty and famine (*Sabean 1972*).

These studies represent a pre-industrial situation of

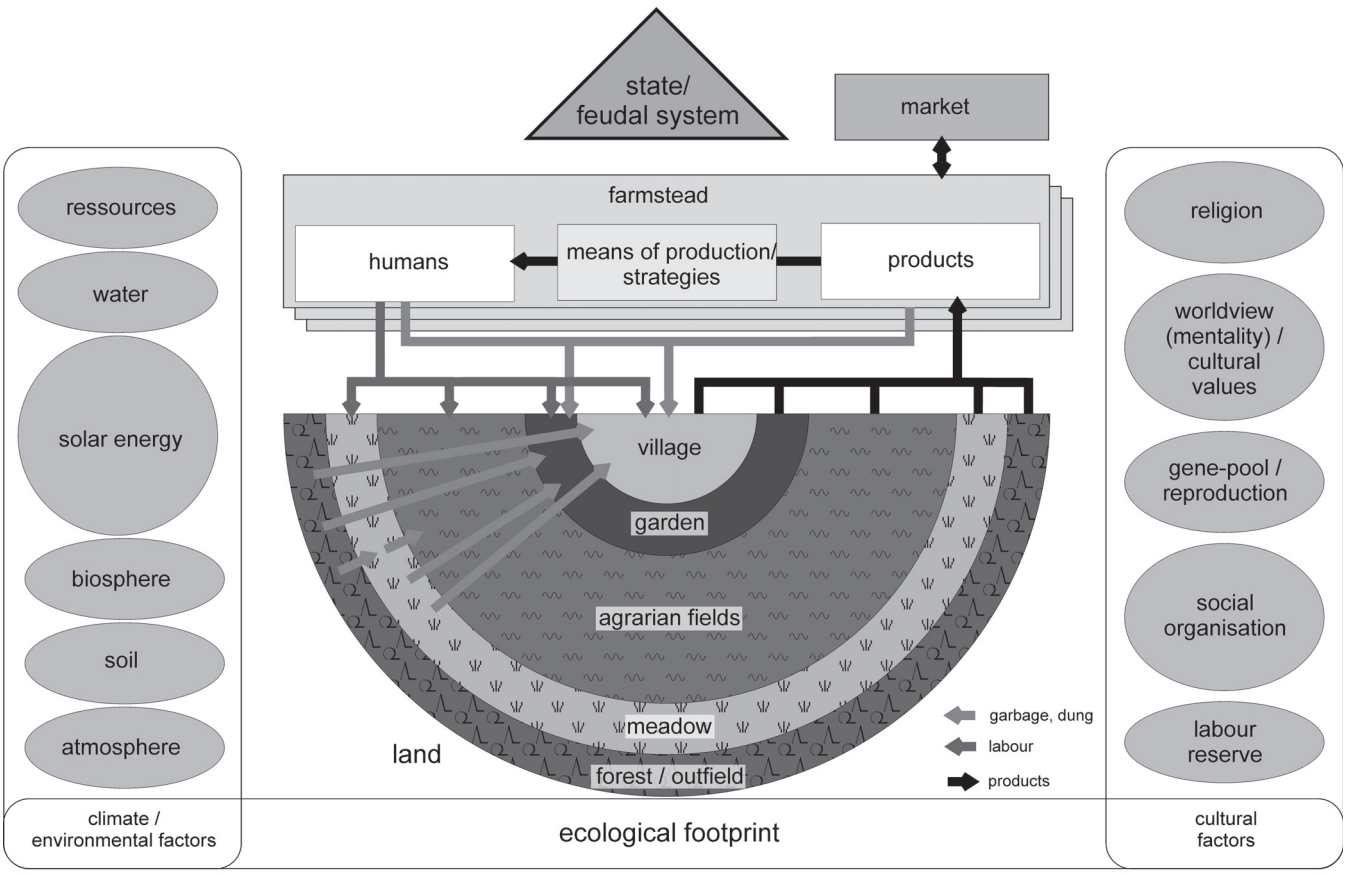

Fig. 2. *Model of the European agrarian village ecosystem of pre-industrial period (graphics by R. Schreg).*

the late middle ages/ early modern period, as they are based on distinct farmsteads which are understood to have been largely independent economic units. There are some common regulations regarding land management ("Zwing und Bann") but storage and distribution of food are mainly organized at the level of single farmsteads. The models used are rather static and provide little basis for understanding change.

Recent archaeological research has shown in many regions that settlement patterns were not static, as farmsteads gradually shifted their position and there were substantial restructurings during the later middle ages. We must ask whether these changes were more than just a spatial reorganization or if they were even a systemic transformation.

Ebersbach's recent studies of Neolithic cattle breeding (*Ebersbach 2002*; *Ebersbach 2008*) has drawn on historical and ethnographical data from several villages, mainly within temperate climate zones, to sketch different models of village ecosystems. Most of her examples do not come from Europe, but she included Unterfinning and the data from Peterborough abbey during the 12th/13th century (*Biddick 1989*), representing medieval village ecosystems, even if the latter is part of a monastic economy. Based on the relative sizes of population, or more specifically labour capacity, usable land and livestock, she distinguished different models of village ecosystems (*Fig. 4*).

The "closed system" is associated with a relatively small territory suited for agriculture. Land use intensity is not very high, there is ploughing and manuring, and the yields rarely exceed 1000 kg per hectare. The

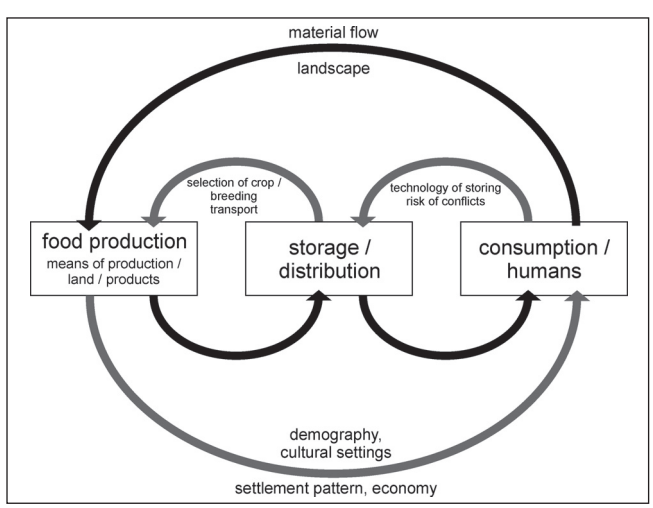

Fig. 3. *The system of food production, storage and consumption (graphics by R. Schreg).*

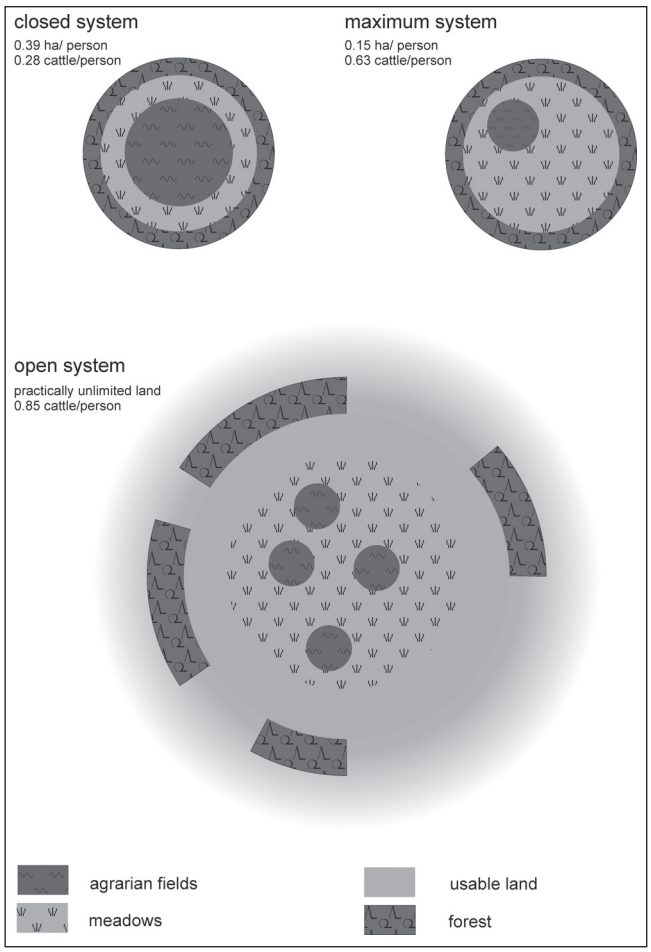

Fig. 4. *Closed, maximum and open village systems (graphics by R. Schreg).*

amount of farmland that each person needed to cultivate is quite high, averaging 0.39 ha. The amount of meadow within closed system villages is rather limited. Cattle are used mainly for their work and to a lesser degree for their dung. Because they are of secondary importance for nutrition, they are often in a bad state; there are only 0.28 cattle per person. This type of village ecosystem typifies the pre-industrial late medieval village.

Within the "maximum system," villages have restricted areas of arable land, which could be used as meadows as well. The economy is based on livestock, but the farmland is used very intensively. On average only 0.15 ha is cultivated per person; but yields average nearly 2400 kg per hectare. The land is intensively manured, ploughed repeatedly and often heavily transformed by terraces or irrigation. Land use is therefore a kind of garden cultivation. In contrast to arable fields, villages of the maximum systems comprise large areas of meadows. The number of animals is not limited by the area but rather by the human labour reserve which is needed for the farmland. According to the case studies used by Ebersbach, the average livestock is around 0.63 cattle per person, more than double the number in the closed system. Examples of villages corresponding to the maximum system are Alpine villages. Anthropologist Robert McNetting's influential study of the Alpine village of Toerbel in Switzerland gave more emphasis to the ecological balance between the community's inhabitants and its environment (*McNetting 1981*). His study, entitled "balancing on an Alp", investigated population, resources, and environment which have been in balance in the village of Toerbel because of compensating social mechanisms. Integrating aspects of geography, technology and land-use management with historical demography and social practices and their adaptation to varying conditions, the idea of the ecological system is less static and offers an understanding of cultural changes. In contrast to the north-Alpine examples, Toerbel represents a maximum village ecosystem where food production is based on a restricted area of agrarian fields.

The "open system" represents a third model of the balance between agrarian land use, livestock breeding and labour. Within this system, the amount of land is not limited. Village territories can be up to several days' walking distances and composed of several areas with different land use. Land management can comprise relatively small "infields" and large areas of less intensively worked "outfields," sometimes associated with seasonal settlements. Today, examples of these systems are quite rare within Central Europe, but early medieval economies in low mountain ranges or mountainous landscapes were probably organized in this way. Stock breeding is most often extensive, without indoor housing of animals, fodder storage or the collecting of dung, but with relatively large stocks of animal per person. On average 0.85 cattle were kept per person. Labour needed for the infield economy is the most important limiting factor for the size of live stock-herds.

Ebersbach's models were intended to deal with early Neolithic economy and therefore they are not completely adequate for our questions concerning the Middle Ages and the early modern period. Factors such as centralisation, social diversity, and specialisation and organisational complexity of polities or states lead to an increasing need for surplus and to an increasing pressure on land use. Urban centres tend toward export-orientated systems in which a market economy plays an increasing role. Therefore we need to add an export-orientated system. There is a huge material and energetic flow from rural landscapes to urban centres. For the rural economy, this means an intensification of agrarian production limited mainly by the available land. In the early modern period, the introduction of the potato offered the possibility of a more productive use of agrarian land. Cattle breeding is a less ef-

ficient use of land area but is important for the urban market. In many regions, feudal authorities reorganized land use in the early modern period in favour of livestock breeding, which resulted in village abandonment. In England, the enclosure movement strengthened wool production; the Turkish cattle economy in the Carpathian basin exported meat to German towns; and the "Vereinödung" in the pre-Alpine landscapes of Southern Germany was largely oriented towards cheese production.

Archaeologists have long made use of these kinds of ecosystem models. In processual archaeology since late 1960s, many studies have analyzed small communities as ecological systems (*Moran 1990*; *Jochim 1981*). Such studies have mainly concerned hunter-gatherer communities, to a lesser degree Neolithic settlements, and quite seldom permanent villages (*Flannery 1976*). Jochim investigated resource procurement strategies among Mesolithic groups in the Upper Danube. Based on assumptions on the early Holocene landscape, he drew on ethnographic examples to come up with a model of hunter-gatherer decision-making, based on efficiency and risk minimization, and he used that model to develop hypotheses about Mesolithic subsistence and settlement (*Jochim 1976*).

For medieval archaeology the calculations at the early medieval settlement of Kootwijk in the Netherlands are of special interest (*Pals 1987*). Based on archaeological data and ethnographic and historical analogies it was possible to provide some estimations of livestock, farmland, yields, and inhabitants. In most cases the archaeological application of the village ecosystem does not aim at exact calculations of food production and consumption, but rather shows the limits of certain land use strategies. Estimates of the early medieval settlement region at Geislingen, situated at the northern rim of the Swabian Alb in Southwest Germany, showed that there was probably a shortage of land as early as the Merovingian period (*Schreg 2009a*).

Archaeological studies have usually not attempted to analyze rural villages as ecosystems because crucial data is missing in most cases. It is rarely possible to get accurate estimates of land surface, population and agricultural yields. For medieval archaeology, it is possible to use data from late medieval or early modern texts, even if there is the risk of not recognizing substantial changes through time. However, even if such estimates cannot be taken as an accurate reconstruction of the past, these estimates might provide substantive information about the limits of rural economy at a specific location or landscape. Estimates of population and yields can be compared with the site catchment and carrying capacities. This may help to determine possible stress situations and to recognize the risks coming from climatic and ecological changes.

Stress, risk, and crisis

The concept of stress was introduced from psychology to cultural anthropology and to archaeology to explain socio-economic as well as ecological changes (*Friesen 1999*). Early studies dealt mainly with hunter-gatherers, but the idea of socio-economic stress was also applied to 7th century Anglo-Saxon England (*Hodder 1979*; *Arnold 1982*). Socio-economic changes were thought of as a cultural adaptation to changed circumstances. External hazards such as climate change or military invasions have usually been advanced as causal factors, but the concept of stress also allows for a consideration of internal factors. Stress has been understood as a state of disequilibrium in an organism or a system (*Brothwell 1998*). Within the village ecosystem there must be a balance between agrarian yields, labourers and the number of cattle. If these factors are out of balance a stress situation will develop.

To identify situations of socio-economic stress, Cohen proposed fourteen criteria more than 30 years ago (*Cohen 1977, 78ff*):

1. increasing foraging distances
2. expansion of settlement into new ecological zones
3. concentration on previously ignored micro niches while continuing to exploit the old niches
4. reduced selectivity of food
5. concentration on water-based resources relative to its use of land-based resources
6. a shift from large to small animal resources
7. a shift from organisms at a high trophic level to such of a lower trophic level
8. a shift from the utilization of foods requiring little or no preparation to foods requiring more preparation
9. environmental degradation
10. significant increase of skeletal evidence of malnutrition
11. a steady decline of quality and size of individuals exploited through time
12. disappearance of exploited species
13. local specialisation (within hunter-gatherer societies) as a result of increasing competition for resources or increasing request of labour for their exploitation
14. sedentism and increasing role of food storage.

Cohen was mainly interested in the origins of agrarian production in Neolithic times. He focussed on population pressure and nutritional stress within a prehistoric situation of hunter-gatherers or early farmers. For application to the pre-industrial village ecosystem this list must be modified and enlarged:

15. an intensification of land use
16. disproportionate distribution of wealth

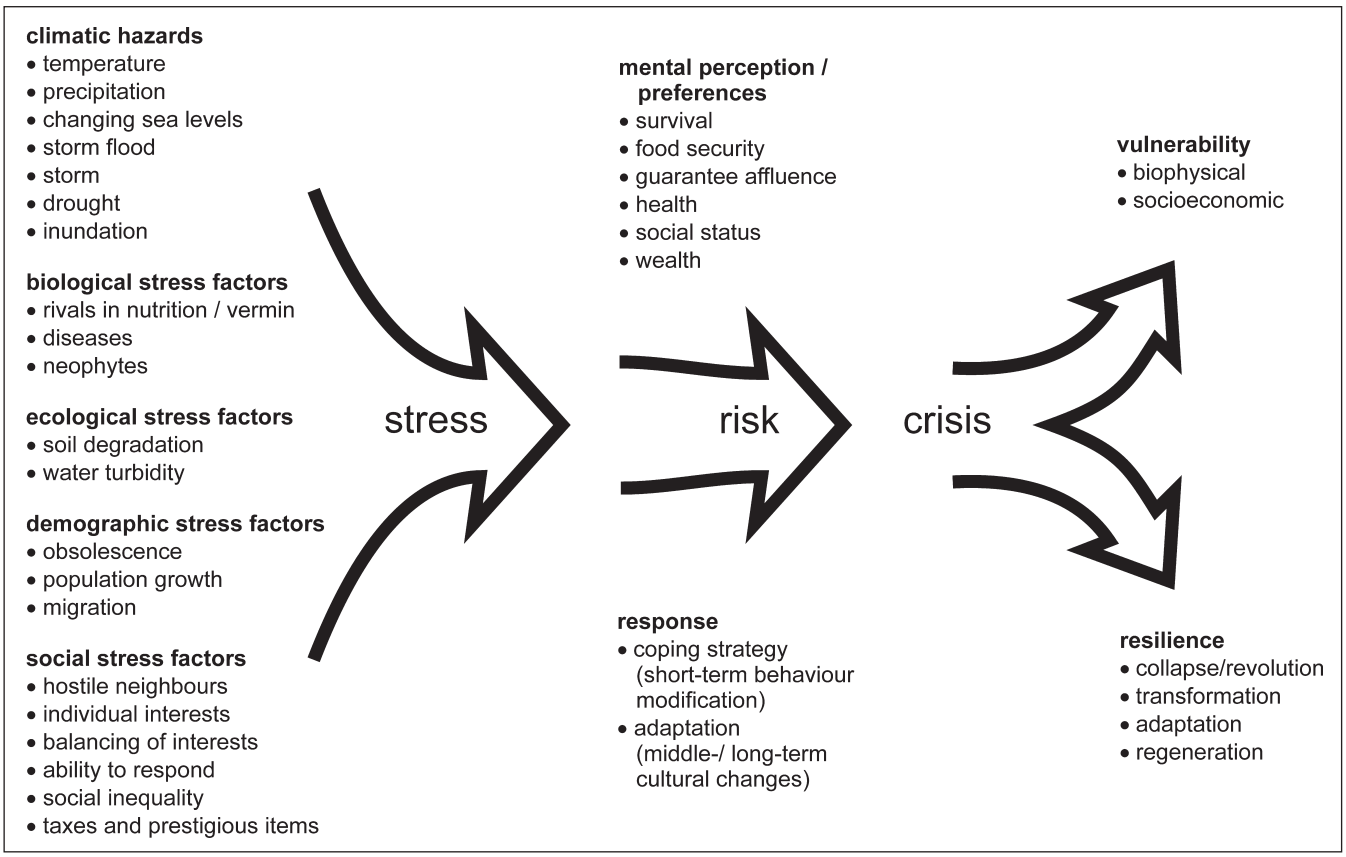

Fig. 5. *Stress factors and Cultural effects (graphics by R. Schreg).*

17. a shift in labour and energy efforts
18. abandonment of farmsteads and settlements
19. traces of violence, either as trauma on skeletons or as destruction horizons
20. safeguards, such as fortifications or hoards, especially defended storage.

Single criteria are not adequate to indicate stress. Settlement abandonment, for example, may have many causes. Within a system of shifting settlement locations it could be the consequence of a successful land-use strategy (*Schreg in prep.*). Not all of these criteria are directly visible in the archaeological record; rather they represent a meta-level. For example, the detection of increased storage capacities has to be seen in relation to population size, while shifts in animal resources must be examined closely with respect to possible taphonomic processes. Indicators of stress may vary within the different village ecosystems as defined above. Furthermore, these criteria represent some kind of reaction to, or consequence of stress, either acute or structural.

It is necessary to distinguish between stress, risk and crisis (*Fig. 5*). Whereas stress is a state of disequilibrium or refers to environmental challenges to organisms and polities, risk points to the possibilities of consequences inherent in systems and statistically predictable; commonly seen as dangers to the system itself. This definition, taken from sociology and environmental history is in contrast to the definition of risk in archaeology (*Beck 2007*; *Sieferle – Müller-Herold 1997*). Many archaeologists who apply ecological theory define risk as the probability of loss, danger, or failure associated with certain decisions or courses of action. Risk minimization has been defined as a main motivation for economic as well as social organisations (*Jochim 1981, 90ff 101ff*). Crisis has been defined as a significant interference in the maintenance of vital resources due to natural factors and/or the man-environment interaction (*Knopf in press*). In addition, crisis must be seen as a situation when decisions have to be made because of high risks for the further functions of the system. Resulting changes or innovations, including ecological reactions as well as cultural responses, lead to new stress and new risks. Sieferle and Müller-Herold evolved the idea of the risk spiral as a dynamic principle in the development of complex societies (*Sieferle – Müller-Herold 1997*). The reduction of a particular risk leads to new types of stress which in turn require further, risky innovations. Cultural response may be a rather short-term reaction trying to deal with the immediate problems, or a strategy of adaptation. Mental preferences are crucial for the decisions; social structures and the political system de-

termine how the interests of different groups will be taken into account.

However, as the terms "stress", "crisis" and "risk" have a component of subjective recognition they have a restricted explanatory value (compare *Winiwarter in press*; *Schreg in press a*). In common speech stress is an individual perception. The same is true for crisis. Therefore there has been a discussion about its justification as a useful technical term in history. The semantics of risk have only developed in the modern period, even if humans have always been subjected to a level of risk either by non-human or by anthropogenic forces. But usually the responsibility for risk has been seen with non-human forces and it is only in modern "risk society", based on scientific research, that risk has been developed towards the anticipation of crisis or catastrophe and has become a central point of politics (*Beck 2007*).

Within discussions of the middle ages, stress situations have been identified in the contexts of resource shortage and social conflicts (*Arnold 1982*; *Rösener 1984*). The Malthusian situation in particular could be described in these terms. The stress of population growth leads to the risk of food security. The recognition of this risk, in terms of the presence of real starvation, gives rise to a crisis which requires adaptation or transformation.

Vulnerability and resilience

The concept of stress, crisis and risk (*Fig. 5*) is a rather linear one. It provides a framework for discussion and argumentation and helps to evaluate possible interrelations. However, it does not explain why in some situations hazards or stress may have remarkable effects on the system – even its collapse – while in other situations these effects do not occur. When are changes part of a long-term process and when they are revolutionary? To understand cultural and ecological changes a more complex idea of an ecosystem is needed; one "that views ecosystems as complex adaptive systems that possess intriguing structural qualities, such as resilience, hierarchy, scale, nesting, dissipative structures, and autocatalytic design, and descriptors of dynamics, such as nonlinearity, irreversibility, self-organization, emergence, development, directionality, history, co-evolution, surprise, indeterminism, pulsing, and chaotic dynamics" (*Abel 2003*). To understand past situations we have to deal with open and complex systems (*Bentley 2003*).

Resilience theory is such a concept recently introduced to archaeology (*Redman 2005*). As the theory aims to understand changes within complex systems, including all possible factors, the concept is also called "panarchy" theory (*Gunderson 2002*; *Holling 2001*). Panarchy describes the totality of non-hierarchical organized systems which are determined by a constant interaction within a regime of ecological, social, economic, and cultural forces. It is based on the idea of an open system changing through time.

Three dimensions have been determined to describe changes within the system (*Gunderson – Holling 2002*):

- Potential: this dimension refers to the accumulated "capital" of biomass, material, skills/knowledge, or established relationships within a system.
- Connectedness refers to the complexity of the system. The more elements and interrelationships, the higher the connectedness within the network of forces.
- Resilience refers to the ability of the system to absorb stress caused by internal interaction as well as by external factors. The lower the resilience the higher the vulnerability of the system.

Panarchy theory describes changes within self-organizing systems as an adaptive cycle characterized by a succession of four stages which differ in regard to the three dimensions (*Fig. 6*). The stages are (re)organisation (α-stage), exploitation (r-stage), conservation (k-stage) and release (Ω-stage). In a first stage some fundamental decisions on the organisation of the system are made. As there is few accumulated capital and a very low connectedness there is a broad variety of opportunities. Decisive factors on the direction of the development are either external (the inter-

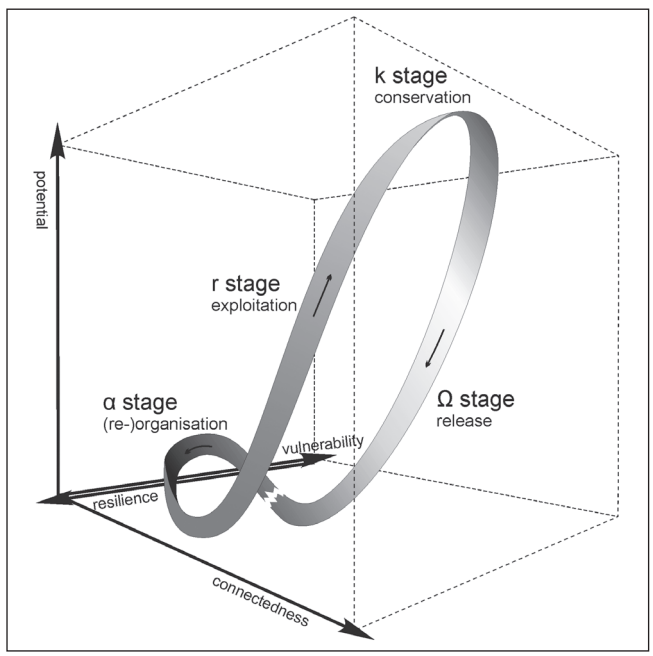

Fig. 6. *The adaptive cycle within panarchy (redrawn after* Gunderson – Holling 2002 *by R. Schreg).*

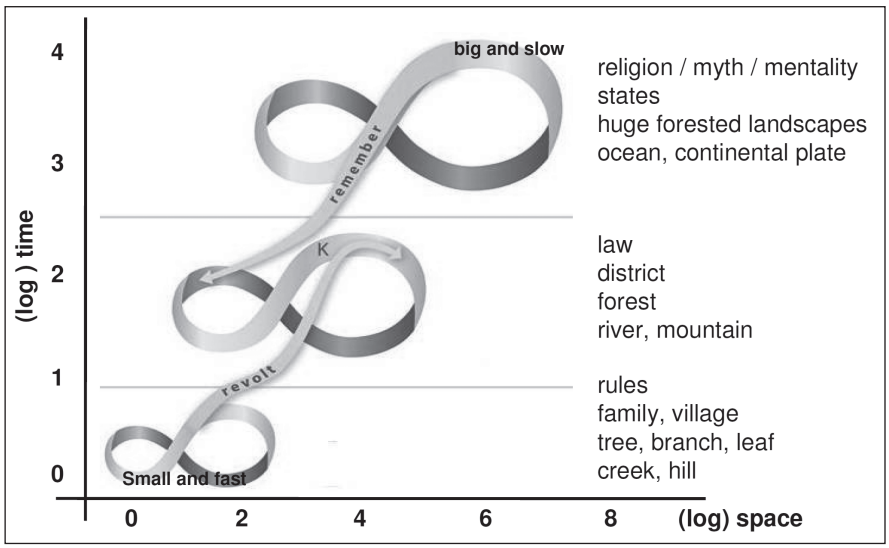

Fig. 7. *Selected adaptive cycles within the panarchy system (modified from* Gunderson – Holling 2002*).*

action with neighbouring systems or systems at other scales) or based on a kind of tradition from previous cycles. Within the exploitation stage the system becomes increasingly complex, that means, the degree of connectedness between internal controlling variables and processes becomes more numerous. In the next stage, the conservation stage the system therefore has a low flexibility and therefore is increasingly vulnerable to stress. A crisis easily leads toward the Ω-stage which means that most of the potential or capital accumulated in the system during the previous stages is released. This release most often comprises a short period of time and appears as a collapse. Afterwards the system has to be reorganised; its starting conditions have changed, but there may still be some elements of the system left – or some cultural traditions vivid, which influence the further development of the system during the next cycle. The fact that the development of the system is shown as a cycle just refers to the three dimensions and not to real history. Panarchy theory does not imply that the system comes back to a certain point and history repeats. Every pass of the adaptive cycle is historically unique and the specific outline of the system depends on history. During earlier passes of the adaptive cycle the environment has been transformed and provides new preconditions. Reorganisation therefore does not have the full range of possibilities as it depends on material preconditions as well as on cultural traditions which prefer specific forms of organisation.

Systems cannot be considered as isolated. A panarchy is a nested set of adaptive cycles. An open and complex system is interacting with many other systems on different scales. Systems reach from a micro scale to global dimensions and their adaptive cycle may take a very short or a very long time (*Fig. 7*). With respect to the spatial scale, the village ecosystem is somewhere in the middle. It is part of the landscape ecosystem and it interacts with the geosystem, but it is also part of the social system of a political district or even state, or indeed the whole world. On the other hand, one village system comprises several other systems, such as the household or family level, the ecosystem of an agrarian field or the ecosystem of rodents or worms. At the time scale it is important to notice, that the adaptive cycle of large systems may be rather slow, because changes in their subsystems may or may not revolt the large system. For example the collapse of a village ecosystem has limited effects on the whole medieval state. We recognise several periods of settlement abandonment in the course of the middle ages, but it is only in the 14th century that a general crisis comes into being.

There are several connections between the single adaptive cycles. The collapse of a small and fast regime can influence or "revolt" the adaptive cycle of a bigger and slower regime if it meets the conservation-stage with low resilience. The reorganisation of a regime can be influenced by the "remember" connection, which facilitates renewal by utilising potential from a higher scale. In a human ecosystem "remembering" could also refer to a more specific sense: the reorganisation after a collapse will probably use traditional ways of organisation. Human experiences, perception and values are crucial for the outline of the new regime. For example, settlement patterns of the migration period in the former Roman territories still benefit from the remains of Roman infrastructure – such as roads –, and they also depend on the presence of former Roman farmsteads (*Schreg in prep a.*).

Stress, crisis and risk may be integrated within this concept. In principle stress may occur at every stage of the adaptive cycle. External factors such as climatic hazards or natural catastrophes like earthquakes and volcanoes have a steady risk of occurrence. Internal

stress increases with the connectedness between internal controlling variables and processes and reduced potentials. The possibilities for responses reduce. Within the k-stage of conservation there will be a high level of stress and a high number of critical situations. Because connectedness is quite high at this point, innovations can easily cause stress and a very high risk, because resilience is low at that point. Regarding medieval settlements this was probably the case in the late Middle Ages, when there was an increasingly complex organisation of polities at the local as well as on the statial level. Land-use was very intensive and organised within a very rigid rotation system. Vulnerability was high and when the climate changed in the 14th-century and land-use pressure came to its maximum, there were few possibilities for response. As discussed below in some more detail, the crisis of the 14th-century, connected in many regions with a high quantity of late deserted villages, can be understood as a consequent collapse of many village ecosystems.

The usefulness of resilience theory for archaeology is not in modelling past cultural processes using specific quantitative data, since adequate data is missing for most periods. Geo- and bioarchaeological research is probably best suited to produce proxy data which could be used to identify the single stages within the adaptive cycle (*Dearing 2008*). Serial data are an important precondition at a practical level; a more much more general problem lies in the precondition that human behaviour is difficult to reduce to calculable reactions. "Stress" and "crisis" which could be understood as a specific situation within an adaptive cycle, are in reality determined by human recognition and mentality. However, stress, risk, and crisis as well as vulnerability and resilience may be important categories to provide new questions and a possibility to see food production in a broader context.

Food production, stress and resilience in the medieval village ecosystem

The following case study will try to use these theoretical concepts as a framework to look at changes in medieval settlement pattern, economy, and food production and to explore the dynamics underlying these changes. Data used for this case study come mainly from medieval rural settlements in South-western Germany.

In recent decades, archaeological research in many European landscapes has shown substantial changes within the settlement system during the middle ages and modern period, which clearly indicates that the typical village is only the product of a long process (*Fabre 1996*; *Schreg 2006*; *Schreg 2009c*). This is especially true for South-western Germany.

We have to start with a characterisation of the early medieval village ecosystem. Even if we do not have exact data for numbers of inhabitants, yields and herd sizes, it seems possible to refer to the ecosystem models sketched previously.

Case studies at Schleitheim and Geislingen

At Schleitheim in Northern Switzerland models of diet and demography have been calculated for the middle of the 7th century, the middle of the 14th century and the late 19th century (*Hotz – Rehazek – Kühn 2002*) (*Tab. 1*). It appeared that food supply in the early Middle Ages and in the 14th century was better safeguarded than in the 19th century. Based on demographic data from the Merovingian cemetery, it has been argued that there were 210 inhabitants of Schleitheim in the 7th century.[1] The land required for this population can be calculated as 63 hectares for grain and 5 hectares for legumes per year. Based on the assumption of a closed village ecosystem with ley farming (Feldgraswirtschaft), consisting of two years of fallow to one year of cultivation, the early medieval settlement would have needed about 205 hectares of agrarian land. The modern village boundary of Schleitheim covers 2154 hectares; about 1000 ha of which are suitable for cultivation. There is enough tolerance that the village ecosystem at Schleitheim in the early Middle Ages could have been an open system with ley farming. Outfields could have been located in the periphery of the village territory as represented by late medieval boundaries, or even at a greater distance in the Southern Black Forest.

At Geislingen the situation seems to be quite different (*Tab. 2*). Whereas in Schleitheim in the 14th century the carrying capacity even of ley farming was not yet reached, we can assume that at Geislingen the population was probably already in the early middle ages near the limit (*Schreg 2009a*). The population was too large to be supplied from local resources by the time the town was founded in the 13th century. Geislingen is located within a small basin at the rim of the Swabian Alb, a low mountain range in Southwestern Germany. The surrounding slopes as well as the presence of bogs in the valley itself have limited or constrained the location of cultivable fields. If the village was limited to the valley, its ecosystem could only have worked as a closed, a maximum or an import-based system.

Archaeological surveys on the surrounding Alb pla-

[1] Estimates of livestock numbers based on minimum individual counts (*Hotz et al. 2002*, 460f) are of limited value because of fundamental methodological problems, especially taphonomic, of this approach. The number of 0.1 cattle/person seems far too low.

	7th c.	14th c.	Late 18th c.	Late 19th c.
Estimated inhabitants and field sizes				
Number of inhabitants	210 inhabitants (based on cemetery)	360–400 inhabitants (based on written documents)	1438 inhabitants (1790)	2450 inhabitants (statistical data 1860)
Estimated land use	Agrarian fields: 250 ha meadows: 750 ha (estimation)	Agrarian fields: 150 ha fallow: 75 ha meadows: 75 ha	?	Agrarian fields: 1207.8 ha meadows: 251.1 ha forest: 642.4 ha
Assumed land use management	Ley farming	Regulated three-field crop rotation	Regulated three-field crop rotation with beginning of the abandonment of fallow	Regulated three-field crop rotation with permanent cultivation, introduction of potato
Maximum Carrying capacity				
Maximum number of inhabitants		1040 individuals (based on closed system with ley farming)	1235–1380 individuals (based on closed system with regulated three-field crop rotation)	
Maximum possible agrarian fields	1000 ha (agrarian fields: 250 ha fallow: 750 ha)	1000 ha (agrarian fields: 500 ha fallow: 250 ha meadows: 250 ha)		

Tab. 1. *Schleitheim: calculation of population and field sizes (*Hotz et al. 2002*).*

	7th c.	15th c.	mid 19th c.
Estimated inhabitants and field sizes			
Number of inhabitants	> 116 inhabitants probably 200-400 inhabitants (based on cemeteries)	1488 inhabitants (written documents, 1544)	3120 inhabitants (statistical data, 1842)
Estimated land use	Agrarian fields: 200 ha fallow: 100 ha meadows: max. 670 ha (extended swamps and lakes) forest: 580 ha	Agrarian fields: 275 ha fallow: 135 ha meadows: max. 555 ha forest: 580 ha	Agrarian fields: 416.14 ha meadows: 247.01 ha garden: 314.69 forest: 578.26 ha
Assumed land use management	Closed system with unregulated three-field crop rotation	Closed or even maximum system irrigated meadows) with regulated three-field crop rotation supply of the town of Geislingen	Regulated three-field crop rotation with reduced fallow
Maximum Carrying capacity			
Maximum number of inhabitants	<480 individuals (based on regulated three-field crop system)	≤670 individuals (based on regulated three-field crop system)	
Maximum possible agrarian fields	300 ha (maximum of 415 ha minus swamps and lakes, turn-around area for ploughing teams and hedges are not considered)	<415 ha	415 ha Increased by drainage and terraces at the slopes

Tab. 2. *Geislingen: calculation of inhabitants and field sizes (*Schreg 2009a*).*

teau showed a remarkable number of early medieval settlements. The toponyms of these villages at the plateau come from Merovingian or early Carolingian times, and local historians have seen them as an expansion of that time that is connected with clearance and the founding of new villages. In some cases, however, archaeological finds from the 5th century predate the toponyms by at least several generations. This is an indication that settlements on the Alb plateau developed over a long period. The naming of the settlements marks a later stage of this process, probably when the settlement had become self-sufficient and gained enough economic importance to be mentioned by manorial institutions as a separate unit. At least at an early stage, settlements on the plateau and in the valley formed one community which could be understood as an open system.

As the examples of Schleitheim and Geislingen show, at some point the number of inhabitants exceeded the carrying capacity of the landscape. This is a clear indi-

cation that the village ecosystem was in stress as food production and consumption diverged. At Geislingen, in its narrow valley, this occurred earlier than it did at Schleitheim.

From open to closed settlement systems – Expansion and intensification in the early Middle Ages

Open settlements may have been characteristic for the Migration period (4th/5th century) and possibly even for the Merovingian period (late 5th–late 7th century) in Central Europe, but the transition to a closed system should have taken place soon thereafter – depending on the site catchment and the specific landscape potentials.

Growing population as well as the emergence of seigneurial power and Christianisation may have been stress factors which created the need for a surplus production. Large quantities of grave goods in Merovingian cemeteries, which probably were not only signs of religion but also of social competition, caused an increasing need for raw materials (*Arnold 1982*). Stress is indicated not only by reaching carrying capacities, but also by archaeozoological data showing that livestock declined in body height (*Stephan 2008*).

Within an open system, yields had to increase by intensification of land-use, causing the transition to a closed system. In consequence outlying areas of the village ecosystem became more self-contained and developed into independent villages.

After the fall of the Roman Empire, lower numbers of settlements are observed, and palynological data also supports the view of quite low population numbers and a reduction of land-use. Merovingian cemeteries and early place names reveal an agrarian land use orientated toward the fertile lowlands. Only in some regions did settlement also include low mountain ranges. In the following centuries, settlements expanded in more marginal areas. When we have written sources on colonisation processes they are often organized by noblemen and typically included the foundation of new settlements which were populated with farmers from remote areas. As in many cases, observations from later periods have been used to describe earlier processes of colonisation. Consequently early medieval colonisation in Southern Germany has been seen as a similar process of clearance and subsequent foundation of new villages, as a conquest of the wilderness by adventurous pioneers. The process should have been a multiplication of grain- and cattle-based villages in a nearly wild environment – or we could say: colonisation is understood as a process of growth (compare *Schreg 2008*).

However, the idea of conquering the forests is probably rather a modern one (*Blackbourn 2007*). Settlement of marginal landscapes probably began in many regions with seasonal outfield use (*Schreg 2008*). Subsequent intensification of land use due to factors such as population growth, increasing manorial needs and strengthening of authorities brought an orientation towards agrarian fields and grain production. Close connections between villages in the core settlement landscapes and the marginal landscapes became less intensive and there was an increasing need for new mechanisms of exchange.

Village formation and three-field crop rotation

Parallel to land-use intensification in marginal areas, we can trace a process of village formation in many core areas of Central Europe. In the beginning the landscape was characterised by an increasing number of small settlements, arranged around some larger ones, but with slightly shifting locations over centuries. Later, a concentration and local stability around the parish church and the churchyard developed. In some regions this concentration at the location of the early modern villages began as early as 1000 AD, while in other regions it belongs mainly to 12th/13th centuries, shortly before the rise of towns. These changes in settlement pattern surely were correlated with changes in land use and food production. One important factor was probably the introduction of the regulated three-field crop rotation ("Dreizelgenwirtschaft"). This system of land management was much more effective in the exploitation of space. Coordination of working rhythms between neighbours made it possible to relinquish enclosures and turn-around areas of harnessed ploughing teams. At the same time fallow periods were reduced. The introduction of this new system also meant that the village itself became concentrated and stationary.

This transformation brought new risks. The early medieval settlement system was characterized by shifting settlement locations. Proposed explanations for these shifts include shifting cultivation as well as generational changes. As farmsteads were typically shifted only short distances it is not likely that each generation relocated the settlement, and these ideas are not convincing. It is more probable that the relocation of a settlement was part of a traditional land-use management where settlement areas shifted to avail of more fertile lands as former areas became exhausted. There are other arguments supporting this interpretation. In several rural settlements there were relics of dark earth similar to the dark earth of late antique towns. They were preserved only in topographic depressions, but *in situ* archaeological finds and structures indicate they were not colluvial deposits. If this is true, the introduc-

tion of the regulated three-field crop rotation was not a total success, but had some major risks. The clearance of hedges, the development of large fields ploughed at one time, permanent cultivation with only short periods of fallow, and manuring by livestock dung brought about a decline in biodiversity, soil exhaustion, and increasing erosion (*Schreg in prep.*). Geoarchaeological studies in the last decades across several landscapes have revealed a recurring pattern of erosion and stabilisation, or in other words of dynamic and stable periods of landscape change. The studies have shown significant landscape changes during the Middle Ages, such as over-exploitation, erosion, and degradation of soils. These can be understood as consequences of the expansion and intensification of food production (*Bork et al. 1998*).

One can therefore conclude that the processes of village formation and three-field crop rotation, which are commonly seen as representing moments of major progress in medieval history, probably brought new risks. In a long-term perspective, the change from shifting settlements with soil amelioration by long-term manuring towards permanent villages and three-field crop rotation did not reduce stress, but produced new risks and caused a higher social complexity. Within the village communities, which went through a period of institutional structuring during the high Middle Ages, the peasants had a limited range of options. The economic change from subsistence farming with its associated strategies of risk minimisation (see Thomas Meier, this volume) towards a market orientation leads to dependencies outside the village. The development of the feudal system and later of towns brought a permanent need for increasing surplus production, which meant higher yields per labourer.

The late medieval "crisis" – a system collapse?

There has been a long debate about the 14th-century crisis (*Harvey 1991*). Historians pointed to quite different phenomena to understand the late middle ages as a kind of crisis (*Seibt 1984*). There are also many contemporary statements indicating that people even felt a crisis of morality and faith (*Bergdolt 2003*). It is a challenging question whether we can understand the situation as a system collapse or, in contrast, as an example of a successful reorganisation.

There is yet to be any consensus on whether the term "crisis" is adequate to characterize the 14th century. The main critique is related to the term "crisis" itself, which is thought to lack explanatory value (*Winiwarter in press*). It has been pointed out that the crisis of the 14th century may be primarily a re-projection of our own present and current problems (*Schuster 1999*). Certainly, the concept of crisis is a modern one, as ecological thinking is a modern development. Investigating past ecosystems therefore requires a terminological framework independent of written documents and of the perceptions of past humans, who used other categories to understand their environments. In light of the concepts outlined above, we need to ask whether the late middle ages could be understood as a crisis, as a release within the adaptive cycle, or as a collapse of the medieval village ecosystem.

A number of observations point to a late medieval landscape degradation that had significant impact on villages. Archaeobotanical and geoarchaeological research document the formation of heath, and the expansion of dunes (*Kirleis 2003, 97*; *Groenewoudt 2009*; *Hirsekorn 2003*) as well as the formation of erosion gullies (*Bork – Beyer – Kranz in press*; *Bork et al. 1998*). Currently, most indications come from central Germany, while in Southern Germany there are relatively few reports of late medieval land degradation. This is probably due to the state of research rather than to lower stress.

Some of these processes are man-made and are directly linked with less sustainable land-use strategies. However others are due to climatic changes (*Behringer et al. 2005*). In the 14th century, cooling brought extreme weather events. Usually such climatic change may have little effect, but in the cleared landscape of the late Middle Ages vulnerability was high. The stress of demographic and climatic factors brought the risk of declined food security by degradation and erosion. At the same time, the social organisation of the village with the regulated three-field crop rotation, and the increased power of sovereigns created a situation of high connectedness which made adaptation quite difficult. In contrast to the settlements of early and high Middle Ages, which shifted their position probably as part of a sustainable land-use strategy, the permanent villages lost an important opportunity for soil regeneration in favour of a complicated social organisation that included rigid rules on land-use. Some villages collapsed, others succeeded. The abandonment of many villages can be understood as the collapse of the specific village ecosystem – at least in some more vulnerable environments. On a higher spatial scale, however, villages were just reorganised in a process of concentration, and early modern agriculture followed strategies that existed before. However, the late medieval crisis altered labour-land ratios in favour of the peasantry (*Moore 2003*). In some cases villages of the closed system may have transformed for a time to an open system, because they gained land which has been used mainly for extensive herding (compare *Schreg 2009b*).

Only later, in the 18th and 19th centuries, when there were again situations of stress, risk and crisis were there major reorganisations in the whole village

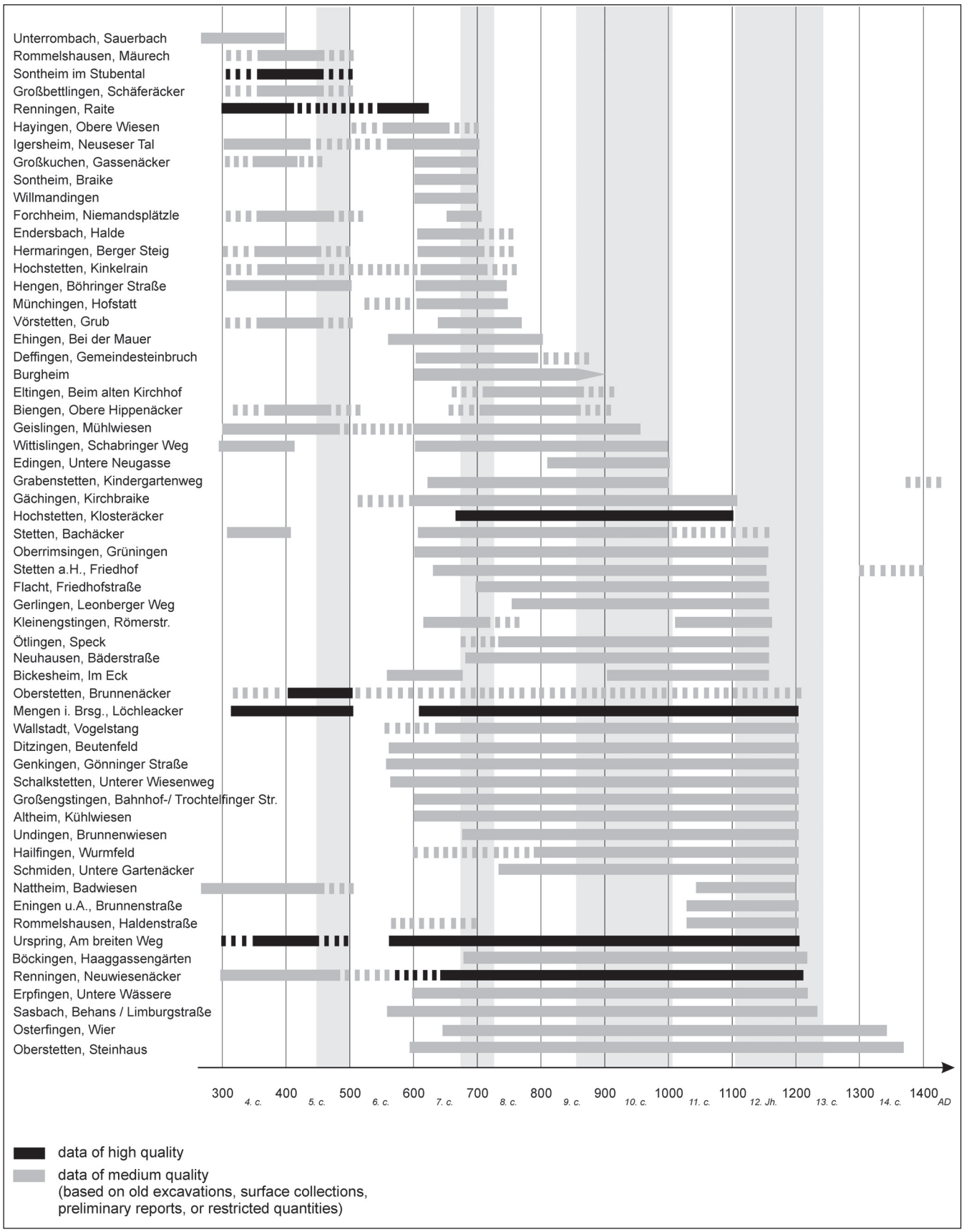

Fig. 8. *Duration of medieval settlements in Southwestern Germany indicating some periods with higher risk of abandonment (*Schreg 2006*).*

ecosystem. The reduction of fallow, the introduction of the potato and increasing efforts in manuring introduced a new ecosystem – probably on the verge a maximum system, which was the basis for modern industrialized agriculture. There are several examples of starvation periods, or famine, in the early modern period, and these may be indications of further passes through adaptive cycles.

Reorganisation of the village ecosystem after a crisis does not mean that there is always a complete system restructuring after a collapse, because not all the potential has been lost. The mechanism of the 'remembering connection' results in a reorganisation depending on earlier system organisations. Nevertheless, settlement abandonment could be an indication for reorganisation and could be used to determine single passes of adaptive cycles. The abandonment of settlements need not be connected with single events, such as the thunderstorms of 1342 or the pestilence of 1347/48. In reality there may have been longer periods with high stress and low resilience.

As there were several other periods of settlement abandonment in central Europe and especially in South-western Germany (*Fig. 8*), the late medieval crisis is probably not the only period of reorganization, but is just the best documented one. It could be worth asking if the discontinuities of settlements around 700, in the 9th and 10th centuries and in the 12th/13th century represent passes of the adaptive cycle. Abandonments around 700 could be in relation to the transition from an open to a closed village ecosystem; 9th/10th-century abandonments may reflect a reorganisation of the feudal system at beginning market economy; while12th/13th-century changes could represent the introduction of three-field crop rotation and the formation of permanent villages. At present, these are only hypotheses, which must be checked by specific case studies in different landscapes.

Conclusions and prospects

The panarchy model allows understanding the interaction of different subsystems and offers a more complex explanation for failure and success. Today it meets increasing interest in past crises and collapses. The work of Jared Diamond in particular looked at the circumstances of the rise and fall of societies, and tried to link past and present (*Diamond 2006*). His examples of collapsed past and present societies spread around the world, from the Easter Island, over the Mesoamerican Maya, the Anasazi in the US-Southwest, and Greenland as examples for failed past societies.[2] He used a framework of five factors to analyse failure and success of societies:

- damages that people inadvertently inflict on their environment
- climate change
- hostile neighbours
- support by friendly neighbours
- society's responses to its problems.

Food and food production as a factor of change have to be seen in a broader context of rural economy and village ecosystem. Food and food production are in close interaction with state and polity, with values and mentality as well as with landscape and environment. It indicates that the model of a Malthusian crisis does not explain the changes adequately, as it is does not embrace sufficiently the complexity of change. The late medieval crisis is more than just a Malthusian situation; the idea of a crisis within an adaptive cycle of the village ecosystem seems to be more adequate. Settlement history from the Migration period to the beginning of the late Middle Ages could be understood as an intensification of land use, transforming villages probably from an open system towards a closed and an export orientated system.

Abstract

Archaeological research on food production and consumption is mainly concerned with their material remains. This article calls attention to the ecological dimensions of food production, storage, and consumption. They are a fundamental element of the village ecosystem and an important driving factor for changes within the settlement system.

Models reflecting on the ecology and resilience of the medieval rural economy provide important possibilities to explain these changes. The concept of the village ecosystem enables us to distinguish several models, how pre-industrial villages balanced their agrarian yields, the number of cattle and the disposable manpower. If this balance is disturbed the whole system comes under stress and needs some kind of reorganisation. However, the concept of stress does not suffice to understand the complex dynamics of change which can be recognized in many medieval settlement landscapes. Therefore we need a much more complexe concept dealing with non-linear, adaptive and self-organized socio-cultural systems. Panarchy theory provides a theoretical framework which has recently been introduced to archaeology.

In this article I want to evaluate the usefulness of these archaeological approaches based on systems theory. Medieval village ecosystems mainly in western central Europe are reconsidered in the light of these

[2] See for a critique of Diamonds case studies: *McAnany – Yoffee 2010*.

concepts, in an attempt to understand their changes and to evaluate food production as well as the risk of starvation as a factor of the continuous adaptation of medieval rural communities.

Résumé

Les études archéologiques sur la production et la consommation des aliments s'attachent principalement à la reconstitution de l'alimentation et des pratiques culturelles qui lui sont liées. Production, stockage et consommation sont toutefois aussi un élément essentiel de l'écosystème villageois et le principal facteur de sa transformation. La présente contribution voudrait attirer l'attention sur ces aspects écologiques.

Pour expliquer la transformation, il faut recourir à des concepts abstraits qui, d'une part, comprennent le village médiéval comme un écosystème complexe et d'autre part, définissent la transformation et la résilience des systèmes. La conception de l'écosystème villageois permet de faire la distinction avec les modèles de villages préindustriels sur base de l'équilibre des récoltes, de la taille du cheptel et de la charge de travail. Les perturbations de ces équilibres créent une situation de stress qui aboutit à un changement du système. Le stress ne suffit pas à expliquer les dynamiques complexes du changement observable dans plusieurs paysages. Il faut utiliser un concept qui tienne compte de la complexité et des qualités non-linéaires adaptatives et autorégulées des écosystèmes socioculturels. Le concept de la panarchie depuis peu, aussi discuté en archéologie, développe une théorie pareille.

L'objectif de la présente contribution est d'ouvrir des perspectives et de montrer l'avantage de ces concepts en archéologie. Des écosystèmes de villages médiévaux sont analysés selon ces concepts pour comprendre la dynamique de leurs changements et pour mettre en exergue le rôle de la production alimentaire et ses risques de famine dans le changement à long terme du paysage rural.

Traduction: H. Pantermehl

Zusammenfassung

Archäologische Forschungen zu Produktion und Konsum von Nahrungsmitteln fokussieren hauptsächlich auf die Rekonstruktion der Ernährung und der damit verbundenen kulturellen Techniken. Produktion, Bevorratung und Konsum sind jedoch auch wesentlicher Bestandteil des Dorfökosystems und ein wesentlicher Faktor für dessen Wandel. Vorliegender Beitrag möchte das Augenmerk auf diese ökologischen Aspekte des Themas lenken.

Um den Wandel zu erklären, sind abstrakte Konzepte erforderlich, die einerseits das mittelalterliche Dorf als komplexes Human-Ökosystem begreifen und anderseits den Wandel und die Resilienz von Systemen beschreiben. Das Konzept des Dorfökosystems erlaubt es, anhand der Ausbalancierung von Flächenerträgen, Viehbestand und Arbeitsbelastung verschiedene Modelle vorindustrieller Dörfer zu unterscheiden. Störungen dieser Balancierungen führen zu einer Stresssituation, die zu einer Änderung des Systems führen muss.

Das Konzept der Stresssituationen reicht allerdings nicht aus, um die sehr komplexen Dynamiken des Wandels, wie sie in vielen Siedlungslandschaften beobachtet werden können, ausreichend zu erklären. Dazu bedarf es eines Konzeptes, das gerade die Komplexität und die nicht-linearen, adaptiven und selbst-organisierten Eigenschaften sozio-kultureller Ökosysteme abbildet. Das neuerdings auch in der Archäologie diskutierte Konzept der Panarchie ist solche eine Theorie.

Das Ziel des vorliegenden Beitrages ist es, Perspektiven und Nutzen dieser Konzepte in der Archäologie zu reflektieren. Mittelalterliche Dorfökosysteme werden im Licht dieser Konzepte betrachtet, um die Dynamik ihres Wandels zu verstehen – und um die Rolle der Nahrungsmittelproduktion und des Hungerrisikos für den langfristigen Wandel des ländlichen Raumes herauszustellen.

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