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EDITORIAL

Human landscapes and climate change during the Holocene

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Introduction

Palaeoecological and archaeobotanical studies of past environments are essential for understanding the kinds of natural settings in which agriculture and prehistoric societies evolved. They increase our knowledge of how human activities have changed environment and vice versa. Human impact on vegetation cover was recognised from the beginning of modern palynological research (Firbas 1937; Iversen 1941). Based on plant communities described from traditional agriculture and the evidence from archaeobotanical records, Behre (1981) identified palynological anthropogenic indicators. They comprise pollen of cultivated plants together with their associated arable weeds and ruderals. These indicators have been widely used and adapted in different European regions (e.g. Rösch 1996; Brun 2011) and the Near East (e.g. Behre 1990). Apart from reconstructing the vegetation dynamics caused by humans, current palynological research attempts to identify the spatial scale and variation of human activities, and their precise duration and location in given landscapes. Recent advances in quantification and numerical analyses of pollen data including climate reconstruction and vegetation/land-cover modelling, which allow for more precise estimates of the opening of woodlands in past times as well as simulating possible scenarios of human impact on the vegetation and landscapes (e.g. Gaillard et al. 2008). With these methodologies, past and future anthropogenic land cover change can be explored (Gaillard et al. 2010). However, until now most applications of these approaches have mainly concentrated on northwestern Europe. Extending them to further regions would be of great interest.

Numerical analyses are of increasing importance for estimating human impact on vegetation and to allow disentangling the human and climatically induced vegetation changes in some cases (Feurdean et al. 2010; Bakker et al. 2012). Climate models can be used for the interpretation of human–environment interactions (e.g. Riehl et al. 2009). However, climatic changes of the last millennia are usually too small in amplitude to be detected by most of the quantitative climate reconstructions using pollen data (Kühl et al. 2010).

Also, micro- and macro-charcoal records in palaeoecological and archaeobotanical studies serving as climate and human indicators are becoming increasingly relevant (Carcaillet et al. 2002). Investigations of charcoal in soil have focussed on the tropics, the boreal zone and around the Mediterranean, however recently the temperate zone has been integrated as well. In addition, on-site wood charcoal analyses can contribute to reconstructing the human impact on vegetation, especially in areas where no suitable pollen archives are available near human occupation sites (Riehl and Marinova 2008).

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Multiproxy approaches allow the correlation of observations of environmental change with changes of climate and human societies (Dearing et al. 2008; Röpke et al. 2011). Moreover, direct $\Delta^{13}C$ measurements on grains of cereal crops deriving from ancient settlement layers can serve as proxies for precipitation/drought stress (Riehl 2008, 2012) or irrigation of ancient fields. $\Delta^{13}C$ measurements from *Sphagnum* peat could be an independent proxy of climate change, as they are not affected by human activities in the surroundings of the peat bogs (Kühl et al. 2010). This may allow the precise inference of the human and climatic signal in the palaeoecological record from areas with peat accumulation. Such multiple facets of palaeoecological and archaeobotanical research offer a broad variety of sources and archives to obtain insights into ancient landscapes and their development.

Reconstruction of the inter-relationship between human societies, their environment and past climates may serve as a basis for possible anthropogenic determinants that shape modern ecosystems. The identification of anthropogenic drivers of environmental change has recently become an important issue for society because of increasing difficulties in sustaining healthy environments for humans at a local as well as at a global scale. Public concern about the effects of human induced climate, land and ocean change is growing (Zalasiewicz et al. 2011). The (pre)historical perspective therefore gains importance as we can learn from the past to shape our future.

This special issue contains selected papers from the symposium "Human landscapes and climate change" held at the 8th European Palaeobotany and Palynology Conference, in Budapest, Hungary, in July 2010. They show recent progress of research on the interaction between human societies, environment and climate change in different regions of Europe and adjacent areas through the last 10,000 years. Geographically, the papers cover a range from southwest Anatolia to northern Germany and from the Trans-Uralian peneplain to the Iberian peninsula. This allows the tracking of parallel or contemporary tendencies in the development of human landscapes as well as of regional and local discrepancies in land use strategies and human impact in general for the whole region. One focus lies upon the reconstruction of the spatial scale of human driven woodland clearance and of crop cultivation activities that are directly linked to specific archaeological settings of the Neolithic and later periods. Further, these landscape and vegetation changes are put into the broader framework of the main palaeoclimatic events during the Holocene and a long term perspective on natural and human induced vegetation and landscape changes is given.

Contributions

An overview on the human environment under changing climatic conditions in southwestern Anatolia is presented by Bakker et al. discussing the environmental constraints of the Beyşehir Occupation Phase as revealed by studying several intramontane basins in the Taurus mountains surrounding the ancient city of Sagalassos, Turkey. The new results suggest that the end of the Beyşehir Occupation Phase was much less abrupt than considered so far and that it was accompanied by climate shifts to drier conditions and cooler winters.

Further to the West, the history of human impact on the vegetation in Attica, Greece, is presented through a pollen record from the eastern coast of the peninsula covering the last 5,000 years (Kouli). A pollen record for this region was long desired and fills a research gap. Human presence in the vicinity of ancient Athens, documented by archaeological studies, appears to have been continuous since at least the early Neolithic. The pollen profile records the vegetation development since the early Bronze Age giving an overview of the vegetation exploitation by human societies in the area.

Shaping of the landscape by human activities in the Balkans is compiled from pollen records and archaeological sites in southwest Bulgaria by Marinova et al. The authors define the main changes in land use strategies on the background of the main events of vegetation history and cultural changes for the last 8,000 years. The first visible human impact on the landscape on a regional scale appears in the final stages of the Neolithic around 6900 cal. B.P. (ca. 5000 cal. B.C.). First signs of large scale loss of woodland in the study area, as well as the whole region of southeast Europe were recorded at ca. 3600–3200 cal. B.P. (1650–1250 cal. B.C.).

The paper by Magyari et al. on the northeastern Hungarian plain sharpens awareness for the need of multidisciplinary research. The results contrast the hypothesis on a discontinuity of settlements within the Hungarian Neolithic (Willis and Bennett 1994) and allow tracing the initial stages of the Neolithic impact of farming and animal husbandry on the landscape of the central European middle Tisza floodplain.

Palaeoecological investigations by Wieckowska et al. conducted on small islands of inland lakes from Ostholstein, northern Germany, show the dependency of human activity on lake level fluctuations. Phases of low lake levels representing stable hydrological conditions correspond with periods of strong human impact. In contrast, land use on the islands diminished during periods with high water levels, when lower areas on the islands were waterlogged. The study proved that the accumulation of peat layers in kettle holes on the respective islands was climatically driven and thus indicative of climate change.

Insight into the human occupation of the Russian steppe areas is given by the papers of Lapteva and Korona as well as Novenko et al. Analyses of a cave deposit in the forest-steppe zone of the southern Trans-Urals provide one of the few palaeoecological records for this region. In the presented pollen diagram human impact is difficult to trace for the early to middle Holocene, but is obvious for the late Holocene when cultivated fields and pastures penetrated the region of natural forest-steppe meadows (Lapteva and Korona). Novenko et al. present a record of the forest-steppe vegetation zone of the upper Don river basin in European Russia. Climatic reconstructions show that landscape dynamics in the region were most probably driven by changes in effective moisture when precipitation exceeded evaporation. Subtle human disturbance of vegetation is visible in the pollen and plant macrofossil records since ca. 7200 cal. B.P. (ca. 6000 B.C.). However, large-scale human-induced landscape changes and a degradation of the natural vegetation become conspicuous quite recently, in early modern times.

The paper of Mercuri et al. integrates pollen investigations from the Po plain, Italy, with those from a marine record, including the sediment source area of the Po valley, to reconstruct the development of the cultural landscape from the Bronze Age to the medieval period and modern times. The combination of on-site and off-site records in a region that nowadays is a completely cultivated area, and where natural archives for pollen analyses are rare, focuses on the reconstruction of the timing of climate and of human forces that have shaped the Italian cultural landscapes.

Three papers deal with the role of the humans' activities in the western Iberian peninsula. The paper by Rubiales et al. combines pollen and microscopic charcoal analyses in a late Holocene mountain area to get insight into the responses of pines to fire events and further into the nature and the magnitude of past human disturbances. The authors propose fire disturbance related to human woodland clearance as a main driver of vegetation turnover. A second study, particularly on the Pyrenees, focuses on tree line changes during the last 11,000 years based on soil charcoal (pedo-anthracological) records that are heavily dependent on human activity (Cunill et al.). The altitudinal variations and composition of the tree line during the Holocene has been caused by both climatic and anthropogenic factors, which have interacted throughout history and are responsible for the fluctuations and extension of the upper woodland limits. Pérez-Obiol et al. reconstruct the human impact on the vegetation in the Pyrenees inferred from pollen analyses and supported by macro charcoal evidence from peat sequences. The first signs of land-use are in the Neolithic period. However, most remarkable is the expansion of agricultural areas into high altitudes during the Middle Ages, including cereal cultivation above 2,200 m a.s.l.

Summing up

The main palaeoclimatic events as the 8.2 ka event, are traced in records from two papers: in northern Germany it is indicated by a rise in ground water level (Wieckowska et al.), whereas by cold conditions in the mountain areas of southwest Bulgaria, and by drought occurring in the eastern Mediterranean (Marinova et al.). In several of the records included in the special issue like those from southern Pyrenees (Perez-Obiol et al.), western Anatolia (Bakker et al.), southwest Bulgaria (Marinova et al.), the great Hungarian plain (Magyari et al.) and Don river basin (Novenko et al.), the first visible impact starts at ca. 7250–6950 cal. B.P. (around 5000 B.C.). At that time in all of those regions, though each with its specific features, human impact is visible in a broader scale due to increasing pasture, settlement activities etc.

Throughout Europe around 6000 cal. B.P. (ca. 4000 cal. B.C.) there are events that might correspond with rising lake levels and cooler conditions like those reported for northern Germany and the alpine region (Wieckowska et al.; Magny 2004). From 5700 until 5100 cal. B.P. (3750–3150 cal. B.C.) aridity increased in the Po plain of northern Italy (Mercuri et al.), and approximately at the same time similar changes also occurred in the southern Pyrenees (Perez-Obiol et al.), western Taurus mountains (Bakker et al.), Attiki, southeastern Greece (Kouli), the Don river basin (Novenko et al.) and southern Trans-Urals (Lapteva and Korona). In southwest Bulgaria there is hardly any evidence for human activity in the pollen records during this period (Marinova et al.).

From the time of ca. 3000 cal. B.P. (1000 cal. B.C.) onwards in most records, especially in southern Europe, human impact on the vegetation is rather strong and in many cases it masks or biases the climatic signals.

The Little Ice Age seems to be the only late Holocene climate signal that is not overwritten by traces of human activity in palaeorecords and strong enough to be regularly observable throughout Europe (Bakker et al., Kouli, Marinova et al., Novenko et al., Perez-Obiol et al.) and even beyond (e.g. Kirleis et al. 2011).

The current issue presents recent advances of palaeoecological and archaeobotanical studies in a wide geographical range showing the beginnings of the human induced shaping of landscapes and the regional differences in timing and extension of those changes. However, in many of the regions well dated and high resolution data on human environments are still missing and need further gathering of evidence. Still, we have to admit that the separation of human impact and natural change in Holocene palaeoecological records is hardly possible. One possibility to overcome this could be detailed comparisons with earlier periods when human interference can be excluded, such as the Eemian, and by investigating remote regions. The combination of both, investigations in the core area of human landscapes and in remote landscapes that were untouched by humans, is one clue for the modelling of future scenarios on human–environment interactions.

References

Bakker J, Kaniewski D, Verstraeten G, de Laet V, Waelkens M (2012) Numerically-derived evidence for late Holocene climate change and its impact on human presence in the southwest Taurus Mountains, Turkey. Holocene 22:425–438

Behre K-E (1981) The interpretation of anthropogenic indicators in pollen diagrams. Pollen Spores 23:225–245

Behre K-E (1990) Some reflections on anthropogenic indicators and the record of prehistoric occupation phases in pollen diagrams from the Near East. In: Bottema S, Entjes-Nieborg G, van Zeist W (eds) Man′s role in the shaping of the eastern Mediterranean landscape. Balkema, Rotterdam, pp 219–230

Brun C (2011) Anthropogenic indicators in pollen diagrams in eastern France: a critical review. Veget Hist Archaeobot 20:135–142

Carcaillet C, Almquist H, Asnong H, Bradshaw RHW, Carrión JS, Gaillard MJ, Gajewski K, Haas JN, Haberle SG, Hadorn P, Müller SD, Richard PJH, Richoz I, Rösch M, Sánchez Goni MF, von Stedingk H, Stevenson AC, Talon B, Tardy C, Tinner W, Tryterud E, Wick L, Willis KJ (2002) Holocene biomass burning and global dynamics of the carbon cycle. Chemosphere 49:845–863

Dearing J, Jones R, Shen J, Yang X, Boyle J, Foster G, Crook D, Elvin M (2008) Using multiple archives to understand past and present climate–human–environment interactions: the lake Erhai catchment, Yunnan Province, China. J Paleolimnol 40:3–31

Feurdean A, Willis KJ, Parr CL, Tanţău I, Fărcaş S (2010) Post-glacial patterns in vegetation dynamics in Romania: homogenization or differentiation? J Biogeogr 37:2,197–2,208

Firbas F (1937) Der pollenanalytische Nachweis des Getreidebaus. Zeitschr Bot 31:447–478

Gaillard M-J, Sugita S, Bunting M, Middleton R, Broström A, Caseldine C, Giesecke T, Hellman S, Hicks S, Hjelle K, Langdon C, Nielsen A-B, Poska A, von Stedingk H, Veski S, POLLANDCAL members (2008) The use of modelling and simulation approach in reconstructing past landscapes from fossil pollen data: a review and results from the Pollandcal network. Veget Hist Archaeobot 17:419–443

Gaillard M-J, Sugita S, Mazier F, Kaplan JO, Trondman A-K, Broström A, Hickler T, Kjellström Kuneš P, Lemmen C, Olofsson J, Smith B, Strandberg G (2010) Holocene land-cover reconstructions for studies on land cover-climate feedbacks. Clim Past 6:307–346

Iversen J (1941) Landnam i Danmarks Stenalder. (Land occupation in Denmark's stone age). Danmarks Geologiske Undersøgelse II 66:7–68

Kirleis W, Pillar VD, Behling H (2011) Human–environment interactions in mountain rainforests: palaeo-botanical evidence from Central Sulawesi, Indonesia. Veget Hist Archaeobot 20: 165–179

Kühl N, Moschen R, Wagner S, Brewer S, Peyron O (2010) A multiproxy record of late Holocene natural and anthropogenic environmental change from the Sphagnum peat bog Dürres Maar, Germany: implications for quantitative climate reconstructions based on pollen. J Quat Sci 25:675–688

Magny M (2004) Holocene climate variability as reflected by mid-European lake-level fluctuations and its probable impact on prehistoric human settlements. Quat Int 113:65–79

Riehl S (2008) Climate and agriculture in the ancient near east: a synthesis of the archaeobotanical and stable carbon isotope evidence. Veget Hist Archaeobot 17:43–51

Riehl S (2012) Variability in ancient near eastern environmental and agricultural development. J Arid Environ. doi:10.1016/j.jaridenv.2011.09.014

Riehl S, Marinova E (2008) Mid-Holocene vegetation change in the Troad (W Anatolia): man-made or natural. Veget Hist Archaeobot 17:297–312

Riehl S, Pustovoytov KE, Hotchkiss S, Bryson RA (2009) Local Holocene environmental indicators in Upper Mesopotamia: pedogenic carbonate record vs. archaeobotanical data and archaeoclimatological models. Quat Int 209:154–162

Röpke A, Stobbe A, Oeggl K, Kalis AJ, Tinner W (2011) Late-Holocene land-use history and environmental changes at the high altitudes of St Antönien (Switzerland, Northern Alps): combined evidence from pollen, soil and tree-ring analyses. Holocene 21:485–498

Rösch M (1996) New approaches to prehistoric land-use reconstruction in south-western Germany. Veget Hist Archaeobot 5:65–79

Willis KJ, Bennett KD (1994) The Neolithic transition—Fact or Fiction? Palaeoecological evidence from the Balkans. Holocene 4:326–330

Zalasiewicz J, Williams M, Haywood A, Ellis M (2011) The Anthropocene: a new epoch of geological time? Philos Trans Royal Soc A Math Phys Eng Sci 369:835–841