The ethnography of prehistoric forest fires

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The impact, or lack thereof, of pre-Neolithic hunter-gatherers on their environment has been debated since at least the 1960's (Lee & Devore, 1968). The common assumption in European archaeology is that human impact only started when farming was introduced, at the start of the Neolithic period. The potential impact of hunter-gatherers is presumed hard to notice in pollen-diagrams due to the low-impact nature of their inferred activities such as hunting, fishing and gathering (Marquer *et al.*, 2017). This assumed invisibility and low-impact lifestyle stand in stark contrast with evidence of modern and historic hunter-gatherer groups, such as Native Americans and Aboriginals, who influence their environment through burning, sowing, weeding, etc. Controlled firing of vegetation could also have played a role in the daily subsistence activities of pre-Neolithic hunter-gatherers in Northwestern Europe. For this research a background for the use of fire within (sub) recent hunter-gatherer groups was established in order to better understand the use of fire in human niche construction by hunter-gatherers.

1. Ethnographic background

The use of fire as a tool for utilizing, manipulating and even shaping the environment is a well-known and well-documented phenomenon in ethnographic groups, both modern and historic, spread all around the globe (Mellars, 1976). In the present study information on different Native American tribes and Australian Aboriginal groups was used. The reason for this was primarily because of the many ethnographic and historic accounts on the use of fire by these different groups beginning at least in the 18th century and continuing well into the 20th century.

Within North America more than 100 hunter-gatherer groups are known that utilized fire during their daily subsistence activities (Stewart, 1956; Anderson, 2005), *e. g.* during hunting or gathering (Lewis, 1973). The present study focusses on present day California, Alberta and New-England as these regions provide the best-documented and studied examples of controlled forest burning by hunter-gatherer groups. The same holds for the western desserts, Queensland, Arnhemland and Tasmania, in Australia (Jones, 1969; Gould, 1971; Bird *et al.*, 2005).

From both these regions an ethnographical framework could be established for the different uses of fire in niche construction as well as the frequency, intensity and timing of burning activities performed by these groups. Although the details of these activities differ between groups, a lot of similarities can be observed in the overall exploitation strategies. Even though different studies have been performed on the usage of fire by different groups within North-America and Australia, for example Jones (1969), Gould (1971), Lewis (1973), Hallam (1985) and Bird *et al.* (2005), there still is a lack of research on the long-term effects on a landscape scale.

1.1. Goals

The long-term effects of hunter-gatherer niche construction and landscape management is still under debate, with critics (such as Mooney *et al*., 2011 and Williams *et al*., 2015) presuming at most local and temporary influences; and defenders (such as Jones, 1969; Miller *et al*., 2005 and Bliege Bird *et al*.,2008) postulating large-scale and long-term changes in vegetation and habitats. These debates are still ongoing and will not be expanded upon here, yet the short-term local effects of the fires and the extensive knowledge the different hunter-gatherer groups possessed on the use of fires have not been up for debate and should be acknowledged.

Burning vegetation could serve a large number of goals. An almost universal objective for controlled forest burning in both North America and Australia, and in differing vegetation types, was improving mobility and visibility. The removal of high grasses, shrubs, undergrowth and plant detritus, thereby creating an almost park-like landscape, greatly improves both visibility and travel speed. Different Aboriginal and Native American groups applied controlled firing as a way of cleaning up their environment and caring for its health (Lewis, 1989; Cochcrane, 2009). After the removal of crown-vegetation, sunlight and rain can better reach the soil and nutrients were added through the ashes. This improved the growth, quality and quantity of early-stage, productive vegetation such as berry-plants and grasses, up to 400 % according to some studies (Einarsen, 1946; Swank, 1956; Dills, 1970; Mellars, 1976). This was not only beneficial to human groups, but also to wild game which was attracted by these open spaces rich in new and fresh undergrowth vegetation. This concentration of game, coupled with greater mobility and visibility, greatly improved the chances of a successful hunt. However, these beneficial effects were mostly temporary and restricted to the first couple of years after a fire.

Fire was further actively used: 1° during hunts to drive game or to surround it, 2° during gathering activities for clearing undergrowth or detritus in order to provide better access to nuts, roots or tubers, 3° as a means of communication, 4° as a safety precaution to reduce the risks of natural wildfires, 5° to collect materials for different crafts such as branches for weaving baskets or cordage, 6° to remove insects and others pests, 7° for warfare, and more. Lewis, in his 1973 study of vegetation burning practices within different Native American groups in California, listed more than 70 reasons for the burning of vegetation (Lewis, 1973; Williams, 2003; Anderson, 2005). These seem almost universally shared among hunter-gatherer groups spread all around the globe.

On a landscape-scale the usage of fire to create small openings in the vegetation cover results over long periods of time in a mosaic landscape with patches of vegetation in different stages of ecological succession. This produces a large number of ecotones and increased edge-effects throughout the environment and therefore a more heterogenous and diverse landscape (Williams, 2003). Long-term selective usage of fire could alter not only the appearance and structure of forests, but could also alter the vegetational composition of forests and grasslands (Anderson, 2005; Bliege Bird *et al*., 2008). The created open patches could be linked by long stretches of recently burned vegetation, which formed corridors through which travel was made easier (Lewis & Ferguson, 1988).

1.2. Timing, frequency and scale

The size of the area being burnt was dependent on several factors such as wind-speed, moisture content, the type of vegetation, the goal, the topography, etc. The area could therefore range from a couple of acres to several dozens of square kilometers. In aerial pictures taken in the western desserts of Australia, large burned tracts spanning multiple kilometers have been observed (Burrows *et al*., 2006). Precise dimensions can hardly be deduced from historic accounts, but in more recent ethnographic studies the majority of fires are small, only spanning areas of less than 50 ha (Scherjon *et al.*, 2015). Even when large areas were affected by a single fire, these were generally constrained to the undergrowth and the accumulated plant detritus on the forest floors (Moore, 2001). Crown fires or the burning away of entire sections of forests seem to have been applied only rarely. In deciduous forests burning of crown vegetation was a difficult feat in any case, except in the most dry periods or with the most dedicated methods such a lighting large fires underneath individual trees. It would have been much simpler to make use of natural clearings, resulting from the trampling and grazing of herbivores, treefalls, floods or natural forest fires, and keep these areas open and traversable.

The timing of the burning season differs between groups and between regions and was adapted to the particular ecosystem and to the perceived goals (Phillips, 1985). Most groups performed burnings of their surroundings on a yearly basis. Yet this does not mean that the same places were burned year after year. The return-interval of fires is dependent on several factors such as the length of the growing season, climate, population density, etc., and varies between twice every year to once every 80 years or more (Scherjon *et al.*, 2015). Within North America controlled burning was mostly executed in the spring or autumn (Gruell, 1985; Lewis, 1985; Kimmerer & Kanawha Lake, 2001). In most cases the winter months were too wet in most regions, while vegetation in summer was too dry. Burning in summer, or very dry periods in spring and autumn, would result in uncontrollable forest fires that would not only negate the desired effect of maintaining the woods and encouraging growth, but would also endanger villages, camps and lives. Before a fire was started, all resources such as berries and nuts were first harvested as to not destroy them. This further explains why autumn was often chosen as the preferred season (Scherjon *et al.*, 2015). In Australia, particularly in the northern territories, characterized by only two seasons - a wet and a dry season, the latter occurring during the southern hemisphere's winter months - most wildfires occurred during the dry season. Yet, most manmade fires happened either during the beginning of the dry months when the vegetation was still damp, or at the end of it with the coming of the morning-dew. Again this aimed at reducing the risk of creating too destructive forest fires (Kimber, 1983).

2. Forest fires in pre-Neolithic Northwestern Europe

Within Northwestern Europe there is increasing evidence of forest fires during the pre-Neolithic period. Already in 1994 M. Zvelebil listed more than 20 sites where hunter-gatherer groups are suspected to have used fire to influence their environment. Since then the number of sites has increased mainly in the UK, *e. g.* Star Carr, Rhoin Farm, North Gill and Dartmoor (Simmons & Innes, 1987; Caseldine & Hatton, 1993; Zvelebil, 1994; Innis *et al.*, 2013) but also in other regions of NW Europe, such as Belgium, *e. g.* Kerkhove (Crombé *et al.*, 2019), the Moervaart palaeolake (Bos *et al.*, 2019), Rieme (Bos *et al.*, 2013) and the Liereman (Vanmontfort *et al.*, 2010; Verbruggen *et al.*, 2019), and The Netherlands, *e. g.* the Kreekrak area (Bos *et al.*, 2005a) and Zutphen-Ooijerhoek (Bos *et al.*, 2005b). Most evidence consists of peaks of microcharcoal, observable in pollen slides, indicating the occurrence of forest fires at a local or regional scale, at least from the Late Glacial/Early Holocene onwards. Microcharcoal research involves the detection and quantification of microscopic charcoal fragments. Anomalies such as peaks in microcharcoal concentration or changes in overall dynamics can be considered as burning phases or changes in fire regimes, particularly when they correspond with changes in pollen spectra such as significant shifts in AP/NAP ratios (Moore, 2001; Power *et al.*, 2008; Conedera *et al.*, 2009). Microcharcoal can be scattered over vast distances depending on the size of the charcoal particles and the size and intensity of the fire. Small particles, smaller than 100 µm, can be spread over dozens of square kilometers, while fragments larger than

100 μm generally only spread up to several 1000 meters (Clark, 1988). The selection of large fragments through size distribution analyses could help determine if a fire was local/on-site or originating from a larger area.

The rise in fire-occurrences in the Early Holocene is further supported by macrocharcoal evidence, *e. g* collected from the "Usselo-soil" (Hoek, 1997; Kaiser *et al.*, 2009; van Hoesel *et al.*, 2012) and hundreds of charcoal-rich features formerly interpreted as Mesolithic "pit hearths" but recently reassessed as burnt ant nests (cfr Peeters & Niekus, 2017 versus Crombé *et al.*, 2015; Crombé & Langohr, in press).

Despite the fact that the occurrence of pre-Neolithic forest fires is well attested today, the debate on the origin of these fires – natural or human induced – is still ongoing. An important observation, however, is the tight correlation between pre-Neolithic forest fires and coniferous vegetation. During the Late Glacial the drastic increase in forest fires clearly was synchronic with the rapid expansion of pine trees (*Pinus sylvestris*) in the Final Allerød, covering the sandy lowlands of the NW European plain, including the lowlands of northern Belgium and the Netherlands. Similarly the majority of Holocene forest fires occurred during the Preboreal and (early) Boreal period, when pine was the dominant tree species (Bos *et al.*, 2005b; Crombé, 2017). *Pinus sylvestris* is known as the tree with the highest fire risk within the Eurasian woody taxa today (Dreibrodt *et al.*, 2010; Rowe & Scotter, 1973; Timbal *et al.*, 2006), hence, it seems reasonable to assume that Late Glacial and early Holocene forest fires were predominantly natural in origin. The marked decrease in forest fires from the Atlantic onwards, as observed in the analysis of burnt ant nests (Crombé *et al.*, 2015; Crombé & Langohr, in press), corresponds with the expansion of deciduous tree species, which gradually replaced the coniferous species. It is commonly known that deciduous forests are less inflammable compared to coniferous forests, a notion propagated by, amongst others Clark (1952), Stewart (1956) and later Rackham (1980). Although full-grown deciduous trees are less susceptible to fire-damage than coniferous trees, they can still catch fire. The assumption that hunter-gatherers and particularly Mesolithic hunter-gatherers lacked the necessary technology to burn down deciduous trees is also prevalent. The felling of full-grown trees is a common practice with ethnographic groups though. Simple techniques can be used such as ring-barking or just starting large fires underneath individual trees (Anderson, 2005). The creation of open spaces in deciduous forest would be more labor-intensive than creating spaces in coniferous forests or grasslands, yet would still be feasible with limited technology. It must also be noted that creating open spaces did not need to have been a time consuming endeavor as already existing clearings could have been used and maintained through the use of fire, such as in North Gill in the North York Moors (Innis & Simmons, 2000). A combination of natural and anthropogenic factors could keep a clearing open for decades if not centuries (Brown, 1997; Bishop *et al.*, 2015).

3. Towards further archaeological research of fire disturbance phases

In areas were extensive ethnographic research has been conducted, more fire-ecological research on different ecosystems should be undertaken which could help create an ecological dimension to ethnographical research. This could help explain why certain techniques were used and what could have been the goal of a burning phase and further elaborate on the mean sizes of fires, the fire-return intervals and the most beneficial timing within particular ecosystems and vegetation types. This could be a valuable asset to fire-regime research in areas without ethnographical research or historical sources, or for time-periods preceding both such as the Mesolithic period in Northwestern Europe.

Fire-ecological research should also be performed in Northwestern Europe. Case studies on both Native American and Aboriginal groups have demonstrated that both the goals and the scale of fires is largely dependent and adapted to the particular ecosystems in which they are executed. As fire-ecology studies from North America and Australia do not cover the same vegetation and climate conditions as those in Europe, the studies do not provide a full picture.

The usage of disturbance phases in palynological data and current microcharcoal research to reconstruct local and short-lived prehistoric burning phases, the two most common methods, are starting to show their limits. Their main drawbacks being the resolution, both spatial and temporal (Scherjon *et al.*, 2015). Most fires lit by hunter-gatherer groups are constrained to the undergrowth and grassy areas, and mostly limited to small areas. The effects of a fire are mostly temporary, noticeable only for up to a decade (Zvelebil, 1994). Even after severe fires the effects last for less than half a century. A lot of fires therefore would not leave traces that can be detected, unless using fine-tuned analyses and robust dating techniques.

A major problem within the study of microcharcoal is the spatial resolution as the charcoal could originate from a large area, up to dozens of square kilometers or more. To mitigate this problem only large fragments, larger than 100 µm, should be used (Clark, 1988). Smaller fragments can be considered as background noise. Samples should therefore be taken with care in order not to fragment particles. The conventional method in Belgium and the Netherlands of preparing pollen samples involves the use of chemicals, such as hydrogen peroxide or hydrochloric acid, to remove certain particles and bleach plant material, and the use of a centrifuge. The sometimes violent chemical reactions and strong centrifugal force can further fragment the charcoal particles which make any size-distribution analyses useless. As there is no consensus on the optimal extraction of micro-charcoal from samples as of yet (Rhodes, 1998; Turner *et al.*, 2008) this must first be addressed before moving forward.

Equifinality should also be taken into consideration when studying burning phases. Different processes such as floods, herbivore trampling, natural forest fires, illnesses and anthropogenic fires can all lead to the same signals such as shifts in the AP/NAP ratios (Brown, 1997). These processes do not necessarily occur in isolation and combinations of different processes could have occurred. Only by combining both palynological data and microcharcoal research can a more accurate reconstruction of fire-regimes be reached.

Places where optimal preservation of pollen can be found, such as in low-lying wet areas, do not necessarily correspond with the places were human habitation occurred, such as high and dry sandy ridges (Crombé, 2016). It can therefore be difficult to link evidence of disturbance-phases or burning-phases with evidence of human activity, both in finding archaeological sites in the vicinity and in dating both.

4. Conclusion

In both modern and historic hunter-gatherer groups the use of fire during daily subsistence activities is a widespread, if not universal, practice. Through the controlled burning of vegetation they could promote the growth of early-stage plants, attract wildlife, improve mobility and more. These activities could also have been performed by pre-Neolithic groups in NW Europe, in particular during the Late Mesolithic (Atlantic) when deciduous trees covered the landscape. In periods of dominantly coniferous stands, such as the Late Glacial and Early Holocene, most forest fires were likely to be of natural origin.

Further research on this subject should further strive to incorporate ethnographic data which can provide a solid background on the use of fire in human niche construction in hunter-gatherer groups. Information that could be helpful in interpreting pre-Neolithic burning phases. Both microcharcoal and palynological data have disadvantages which should be addressed and taken into consideration. The study of burning phases is vital in understanding the potential impact of pre-Neolithic hunter-gatherers on their environment.

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Abstract

Hunter-gatherers and their impact on the environment has been debated since the second half of the 20th century. Due to the low-impact nature of their inferred activities, such as hunting, fishing and gathering, it is assumed that in Northwestern Europe humans only started asserting influence on their environment when farming was introduced in the Neolithic period. However, ethnographic research on (sub)modern Native American and Aboriginal groups has shown that hunter-gatherers can alter their environment, particularly through the regular use of controlled burning of vegetation. Archaeologists have been studying and debating for many decades the possible use of controlled forest fires by prehistoric hunter-gatherers, with a main focus on the Mesolithic. Most of these studies apply to Britain and Southern Scandinavia and are based on detailed palynological and microcharcoal analyses. Recently similar research has been applied in other areas of NW Europe, in particular in the sandy lowland of Belgium and the Netherlands. The first results seem to indicate that during the Late Glacial (mainly Allerød) and Early Holocene (Preboreal and Boreal) forest fires were predominantly of natural origin, while the role of hunter-gatherers in this process likely increased during the Atlantic, when coniferous forests were replaced by deciduous forests.

Keywords: Forest Fires, Ethnography, Pre-Neolithic, Microcharcoal, Palynological disturbance phases, Late Glacial, Early Holocene, Mesolithic.

Samenvatting

Over jager-verzamelaars en hun impact op de omgeving wordt al sinds de tweede helft van de 20ste eeuw gedebatteerd. Door de lage impact van de verwachte activiteiten, zoals jagen, vissen en verzamelen, wordt er verondersteld dat in Noordwest Europa de mens pas een invloed op zijn omgeving begon uit te oefenen vanaf de komst van de landbouw in het neolithicum. Etnografisch onderzoek op (sub)recente Indianen en Aboriginal groepen heeft echter aangetoond dat jager-verzamelaars hun omgeving wel kunnen aanpassen, voornamelijk door het regelmatig gecontroleerd afbranden van vegetatie. Het mogelijke gebruik van gecontroleerde bosbranden wordt al verschillende decennia bestudeerd door archeologen, voornamelijk gefocust op het mesolithicum. Het grootste deel van deze studies handelde over Groot-Brittannië en zuid Scandinavië en zijn gebaseerd op gedetailleerde palynologische en microhoutskool analyses. Recentelijk wordt gelijkaardig onderzoek toegepast op andere regio's in Noordwest Europa, in het bijzonder in de zandige laagvlaktes van België en Nederland. De eerste resultaten lijken aan te tonen dat gedurende het laat glaciaal (voornamelijk Allerød) en het vroeg holoceen (preboreaal en boreaal) bosbranden hoofdzakelijk natuurlijk van oorsprong waren, terwijl de rol van jager-verzamelaars waarschijnlijk groter werd tijdens het atlanticum, wanneer dennenwouden vervangen werden door loofbossen.

Trefwoorden: Bosbranden, Etnografie, Pre-neolithisch, Mircohoutskool, Palynologische verstoringsfases, Laat Glaciaal, Vroeg Holoceen, Mesolithicum.

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