Medieval Settlement Research **37** (2022), 22–39

WAR, PEACE AND POLLEN: EXAMINING THE LANDSCAPE OF LATER MEDIEVAL WALES

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Introduction

This paper presents the second part of a review of palynological studies covering the medieval period in Wales. The first part, covering the period *c*. AD 410–1050 (Davies 2019), has been published in Comeau and Seaman's edited review of medieval agriculture in Wales (2019); the current paper examines the period *c*. AD 1050–1500. Although some scholars have previously examined palynological trends in Wales through the earlier medieval period (e.g. Dark 2000; Rippon *et al.* 2013; 2015; Davies 2015; 2019; Rippon 2019), the later medieval period has been relatively neglected in regional reviews of palaeoenvironmental data. The greatest contribution has been provided by Astrid Caseldine (cf. Edwards 1997; Roberts 2006), who has demonstrated the potential of such research with her work on cores from Ynys Etws (Caseldine 2006), Llyn Morwynion (Caseldine *et al*. 2001) and several other sites. The current review builds on Caseldine's work, providing a comprehensive examination of published pollen studies and considering the potential cultural influences on Wales' pollen record.

Methodology

The methodology for the current work is consistent with the review of early medieval sampling sites noted above (Davies 2019). Relevant studies were identified through a review of published sources and unpublished 'grey' literature, with the majority of sampling sites being found in Astrid Caseldine's seminal *Environmental Archaeology in Wales* (Caseldine 1990), *Radiocarbon Dates from Great Britain and Ireland* (CBA 2000), *Wales and Borders Radiocarbon Database* (Burrow and Williams 2010) and a search of the *British Pollen Database* (BPOL – Grant pers. comm.).

All original radiocarbon dates were re-calibrated using the IntCal20 (Reimer *et al.* 2020) calibration curve with Clam 2.3.7 (Blaauw 2010). A viability assessment was then undertaken, comparing pollen sampling depths against the revised date models for data pertinent to the later medieval period. Sites without horizons directly dated to the late medieval period were not necessarily discounted out of hand, provided they contained scientific dating evidence either side of the medieval period and demonstrated constant accumulation rates. This discernment is often difficult, however, because there are challenges in establishing chronologies for the upper segments of palaeoenvironmental core samples. Although numerous pollen studies have been undertaken across Wales, few have been subject to rigorous scientific dating, as many studies pre-date the regular use of radiocarbon dates in palaeoenvironmental research.

There is also a lack of period-specific research into the environments of the first and second millennia in Wales, as well as some methodological constraints. Several sites have been affected by truncation, or have poorly dated upper sequences, which limit their use for chronological comparison. Sites with sequences that only partly cover the late medieval period have been included where it is possible to compare with earlier or later data. Scientific dating of the upper portion of a core also often proves difficult for a number of reasons. Despite advances in radiocarbon calibration (Reimer *et al.* 2020), the plateau in the radiocarbon calibration curve from *c*. 1700 onwards means that the calibrated date range of material dated between *c*. 50–300 BP is very wide, and samples with different ages BP can often produce almost identical calibrated date ranges. However, other scientific techniques are available to date more recent sediments. These include radio-isotopic dating of Lead-210 and Caesium-137 (Jaakkola *et al.* 1983), tephra dating (Dugmore *et al.* 1995) and establishing Spherical Carboniferous Particle (SCP) concentrations to compare with historical pollution levels (cf. Rose and Appleby 2005). The application of these techniques in Wales is limited. Lead-210, Caesium -137 and SCPs have been used in numerous studies of more recent environmental changes, but only rarely within longer-term studies (e.g. Llwyn Du: Mighall *et al.* 2010; Crew and Mighall 2013; Llyn Syfaddon: Jones *et al.* 1991). Tephra dating, which identifies the unique chemical signature of particles ejected from specific volcanic eruptions, has not been widely utilised. However, work undertaken by Watson *et al.* (2017) at Cors Fochno (or Borth Bog) has identified multiple tephra layers post-dating *c*. AD 1000, demonstrating the potential utility of this method for future palaeoenvironmental research.

The viability assessment also took into consideration pollen sampling frequencies, ensuring that they were sufficiently high to provide a detailed understanding of changes in the environment over time. Unfortunately, given the aforementioned paucity of research into period -specific issues in the medieval period, the sampling frequencies for pollen analysis are very low at several sites, limiting the potential for cross-site comparisons. Although such studies provide useful information relating to the environment surrounding a given site at a specific point in time, it is difficult to ascertain when the local environmental characteristics were established and how they relate to contemporary changes occurring

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elsewhere. These sites could not, therefore, be used in direct comparison with others. Where only parts of a core demonstrated dating evidence and pollen sampling of sufficient quality, the relevant segments have been included within the current review.

Results

A total of 56 relevant pollen sampling sites were identified by the literature review (Table 1; Fig. 1). These sites consist exclusively of cores taken from lake sediments and peat bogs which provide excellent preservation conditions for pollen, with chronologies largely based on the radiocarbon dating of organic material within sealed sequential deposits. Studies of pollen from archaeological sites were also reviewed (e.g. Hen Domen, Montgomeryshire: Moore 1971; Sycharth Castle, Montgomeryshire: Crampton 1966; Cefn Graeanog Farmstead, Caernarvonshire: Chambers 1982), but while these studies provide useful information about the landscape context of a given site, they offer limited information relating to changes within definitive timeframes.

The quality of the data available from these sampling sites is highly variable. Due to the general lack of period -specific research, pollen sampling frequency is sometimes restricted to two to three samples for the entire period. For the most part, the later medieval sequences are incidental to other research rather than the result of targeted projects, the only exception being the work at Llwyn Du, Merionethshire (Mighall *et al.* 2010; Crew and Mighall 2013), which aimed specifically to assess the environmental impact of later medieval ironworking activity. Here, examination of 29 sequential pollen samples dating to the later medieval period demonstrated that charcoal production for the bloomery involved the active management of woodland. However, since the chronological range of this core could not be verified beyond cal. AD 1300, it is not included in the comparative dataset of sites shown in Figures 3–6.

The majority of the sites identified in the review are located in north-west Wales, the southern Cambrian Mountains and the Brecon Beacons, where palaeoenvironmental research has tended to focus on peat deposits at higher altitudes. Lake cores provide a limited record of lowland environmental changes, but their pollen catchments are often regional and reflect a mixture of landscape contexts rather than their immediate lowland locale. Lowland sequences are especially underrepresented around the border between England and Wales (especially to the north), Anglesey (in earlier centuries), and south-east and south-west Wales. Pollen studies by a number of researchers have demonstrated that trends in arable activity are more acute within core lowland settlement zones, and that it is vital to study such areas to gain an appreciation of the variations in arable activity over time (Fyfe *et al.* 2003; 2004; Davies 2015; Seaman *et al.* forthcoming). It is therefore problematic that such areas have not been as extensively researched in Wales as elsewhere in Britain, where developer-funded projects have increased the availability of lowland pollen studies (cf. Rippon *et al.* 2015, 57). This issue is particularly problematic along the borderlands and south Wales, where the limited number of environmental sequences may also conceal changes in land use associated with early Norman settlement.

All pollen studies identified were re-examined, looking specifically at habitat types and indicators of land use based on the observations of Behre (1981), Turner (1964), Clapham *et al.* (1987), Grime *et al.* (2007) and Stace (2010). Changes in woodland cover, wetland, pastoral and arable indicators were noted, to provide an indication of changes in settlement patterns and farming intensity in relation to indicators of climate change. The pollen taxa indicative of these habitats are listed in Table 2. Two distinct periods have been recognised within the late medieval pollen record for Wales: the first *c*. AD 1050–1300, and the second *c*. AD 1300–1500. Coincidently, the latter broadly corresponds with the timing of major cultural and political changes in north and mid Wales following the conquest of Edward I, enabling a comparison of the environmental contexts of medieval Wales under native rulers and English control. The broad changes observed in these data are displayed as graphs in Figure 2 and cartographically in Figures 3–6. In these figures, the lack of arable indicators reflects an absence of either cereal-type pollen or other types of pollen that are associated with arable land use (see Table 2). Such absences sometimes reflect the fact that the studies have not differentiated between wild grass-type pollen and cereal-type pollen. However, the absence of arable weeds in association with cereal-type pollen should always be treated with caution as some wild grass pollen types (e.g. *Glyceria*, a wetland grass species: *cf.* Andersen 1979) have similar characteristics to those of cultivated cereals.

A discussion of the environmental characteristics of these two phases is provided below. The reader should note that the dating of some environmental changes could be affected slightly by variations in the radiocarbon calibration curves. For example, some of the developments attributed to the late eleventh century may actually have occurred in the early eleventh or late tenth century. In most cases, however, only around one pollen sample at each site should be affected by any variance caused by radiocarbon calibration ranges. Given that this study assessed environmental conditions for each phase as a whole in comparison with the preceding centuries, the broad changes observed for each phase should provide an accurate assessment of the pollen record for that timeframe.

c. AD 1050–1300 – Continuity of conflict?

The pollen record for the later eleventh to thirteenth centuries shows a large degree of regional variability (Figures 3–4). This is consistent with what was observed in the latter centuries of the early medieval period (*c*. AD 800–1050), where no clear, uniform trend could be seen across Wales. In the period *c*. AD 1050–1300, woodland levels fluctuate from site to site, with both deforestation and woodland regeneration amply evidenced across the country. There are an equal number of studies that show both increased and decreased wetland indicators without any discernible overall geographical pattern. Overall, there is evidence for both pastoral and arable indicators at most sampling sites. Sites with both increased pastoral and arable indicators dominate, but a high number of studies show decreases or no changes in farming intensity. It should

Table 1 Pollen studies with later medieval environmental sequences in Wales (locations shown in Figure 1).

Map no.	Site	Reference
1	Aber Valley 8.1	Woodbridge *et al*. 2012
2	Aber Valley 9.2	Woodbridge *et al*. 2012
3	Aber Valley 10.1	Woodbridge *et al*. 2012
4	Afon Dwy	Davies 2015
5	Borth Bog	Mighall *et al*. 2010
6	Brecon Beacons	Chambers 1982
7	Bryn Mawr	Buckley 2000
8	Bryn y Castell	Mighall & Chambers 1995
9	Bryn y Castell 2	Mighall & Chambers 1995
10	Burbo Bank Pipeline Pit 21	Gregory *et al*. 2020
11	Carneddau 3	Walker 1983
12	Carneddau 5	Walker 1983
13	Cefn Gwernffrwd A	Chambers 1983
14	Cefn Gwernffrwd B	Chambers 1983
15	Cefn Hirgoed	Walker *et al*. 1997
16	Cefn Mawr	Lascelles 1995
17	Clarach Bay - BH1	Heyworth *et al*. 1985
18	Cleddon Bog	Jones 2011
19	Coed Bryn Bras 2	Davies 2015
20	Coed Ganllwyd	Edwards 1986
21	Cors Gyfelog central	Botterill 1988
22	Cors Gyfelog preripheral	Botterill 1988
23	Cors y Farl	Huggins 2008
24	Craig Y Dullfan 1	Caseldine 2013
25	Craig Y Dullfan 2	Caseldine 2013
26	Crymlyn Bog	Hughes *et al*. 2002
27	Dolaeron	Seymour 1985
28	Ffoston Ceglau	Rosen 1998
29	Figyn Blaen-Brefi	Buckley 2000
30	Hirwaun Common	Chambers *et al*. 2007
31	Llwyn Du	Mighall *et al*. 2010
32	Llyn Cororion	Watkins *et al*.2007
33	Llyn Geirionydd	Bloemendal 1982
34	Llyn Goddionduon	Bloemendal 1982
35	Llyn Morwynion	Caseldine *et al*. 2001
36	Llyn Padarn PA3	Elner *et al*.1980
37	Llyn Peris PE3	Elner *et al*.1980
38	Melynllyn	Walker 1976
39	Migneint 1	Blackford 1990
40	Migneint 2	Blackford 1990
41	Moel Llys y Coed	Grant 2009
42	Moel y Gerddi	Chambers & Price 1988
43	Mynydd Hiraethog	Grant 2007
44	Plynlimon	Mighall *et al*. 2013
45	Rhos Goch Common	Hughes *et al*. 2007
46	Tommy Jones' Pillar	Chambers & Legeard 1997
47	Tregaron	Turner 1964

Table 1 Continued.

Map no.	Site	Reference
48	Tregaron - Southeast bog	Morriss 2001
49	Tregaron - West Bog	Morriss 2001
50	Ty Cerrig 1	Davies 2015
51	Waun Fach South	Price & Moore 1984
52	Waun Llafair 2	Caseldine 2017
53	Waun Llafair 3	Caseldine 2017
54	Waun-Fignen-Felen (D7E)	Smith & Cloutman 1988
55	Waun-Fignen-Felen (E13N)	Smith & Cloutman 1988
56	Ynys Etws	Caseldine 2006

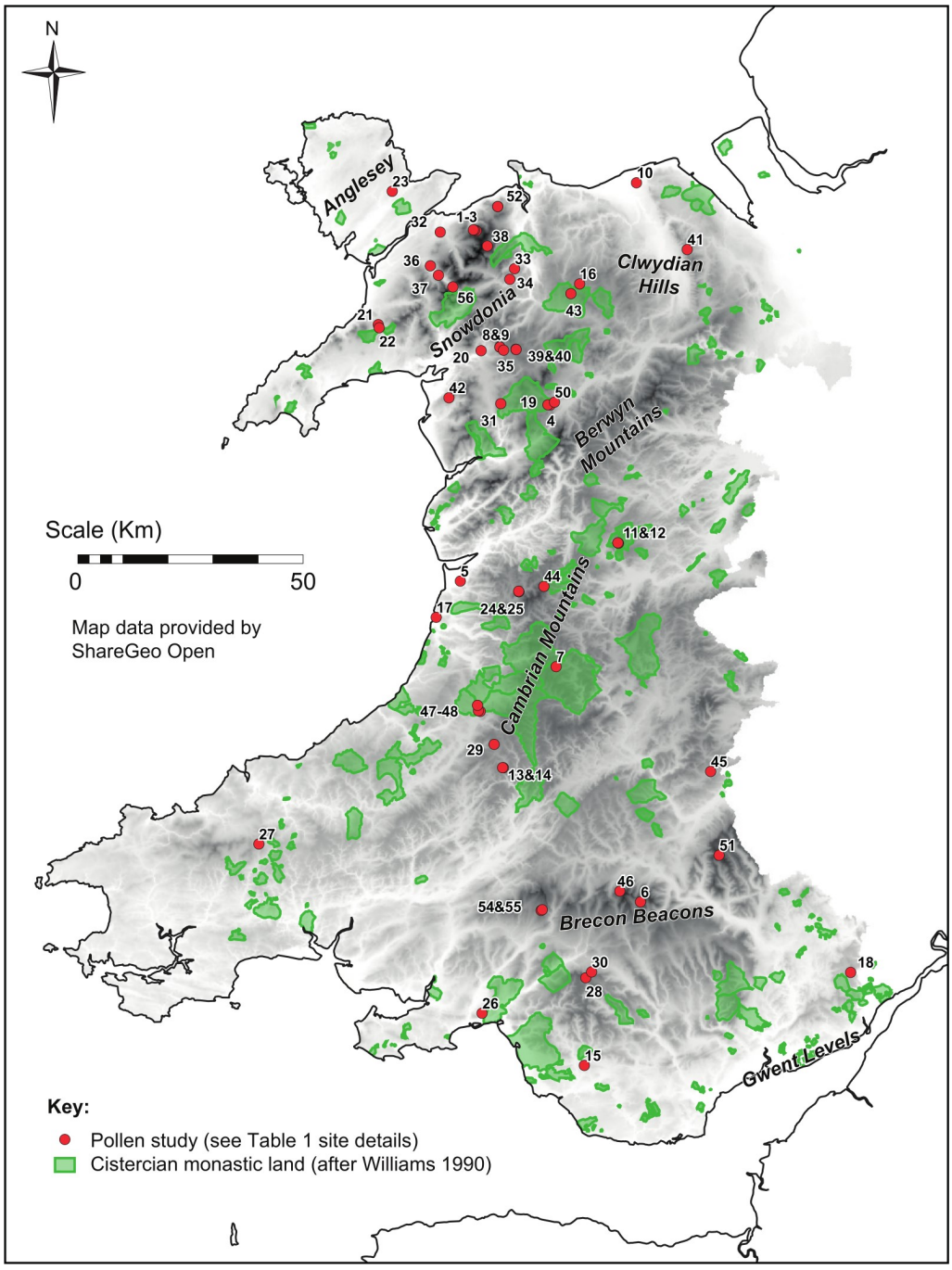

Figure 1 Distribution map for pollen studies with sequences dating to the later medieval period in Wales in comparison to Cistercian monastic granges (after Williams 1990).

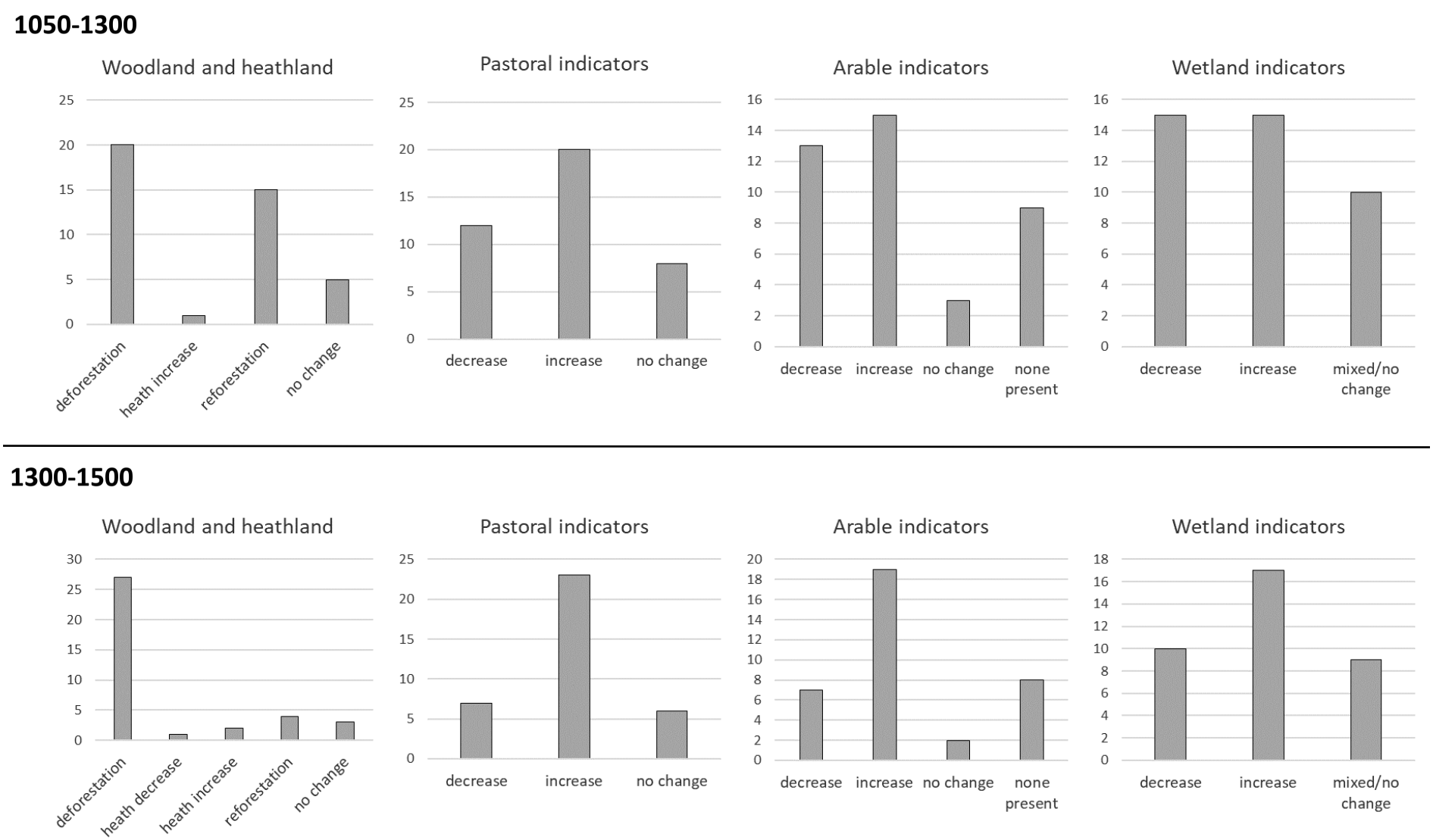

Figure 2 Graphs of palynological changes in Wales, c. AD 1050–1300 and 1300–1500 (the y-axis shows the number of sites in each category on the x-axis).

Table 2 Common pollen taxa by habitat type within the dataset. All pollen taxa nomenclature standardised to conform with Bennett (1991).

Habitat type	Pollen Taxa
Woodland	*Alnus glutinosa*, *Betula*, *Carpinus betulus*, *Corylus avellana*-type, *Fraxinus excelsior*, *Quercus*, *Salix*, *Ulmus*
Heathland	*Calluna vulgaris*, Ericaceae undiff., *Vaccinium*-type
Wetland	*Alnus glutinosa*, Cyperaceae undiff., *Filipendula*, *Sphagnum*, *Salix*
Pastoral	*Plantago lanceolata*, *Cichorium intybus*-type, *Cirsium*-type, Lactuceae, *Rumex acetosa*
Arable	Cereal-type, *Achillea*-type. Brassicaceae, Cannabaceae, Chenopodiaceae (at non-coastal sites), *Plantago major/media*

be noted that the increase in arable indicators at some sites is relatively limited, consisting of additional rare arable weeds or cereal-type pollen. There are also a high number of cores that lack arable indicators for this period, including sites that contain arable indicators in later or earlier levels (Bryn Mawr, Radnorshire: Buckley 2000; Hirwaun Common, Glamorganshire: Chambers *et al*. 2007; Tregaron, Cardiganshire: Turner 1964). Despite the apparent growth in arable land use, therefore, the intensity of arable farming may still be relatively low at this time. Unfortunately Anglesey, an area described by Gerald of Wales in 1188 as producing far more grain than any other part of Wales (Thorpe 1978, 187), has only one study (Cors y Farl) with any pollen for this phase, and cereal-type pollen is entirely absent. It is difficult to understand how representative this is of Anglesey as a whole, but the level of arable indicators in this core contrasts starkly with Gerald's comments.

A better picture is available at Penllyn (Merionethshire), where evidence for spatial variation in farming practices is present at multiple coring sites from the upland to lowland zone (Davies 2015). The upland sampling sites had far more pastoral indicators than cereal-type pollen and other arable indicators, while sites in lowland contexts showed higher proportions of arable indicators. This variation is consistent with the pollen signature expected from transhumant farming practices described in the Welsh law texts, whereby pastoral activities shifted to upland pastures in the summer months away from crop-growing areas in the lowlands (cf. Jenkins 1986; Comeau 2019, Table 8.1; Hooke 2019; Roberts 2019, 85–88). While other studies have sampled sites in comparable proximity to one another (e.g. Woodbridge *et al.* 2012), they have not crossed landscape zones to enable a similar comparison of spatial variations in farming practices.

Evidence for the cultivation of non-cereal crops can also be found during this phase, with low levels of Cannabaceae pollen at both Llyn Cororion, Caernarvonshire (Watkins *et al.* 2007), and Llyn Goddionduon, Caernarvonshire (Bloemendal 1982). Cannabaceae pollen can represent either *Cannabis sativa* (cannabis), which can be grown for hemp or used as a narcotic, or *Humulus lupulus* (hops), used in brewing. It is difficult to assess the extent to which other non-cereal crops were grown as they are often under-represented because of poor pollen dispersal mechanisms (i.e. being insect-pollinated rather than wind-pollinated), and in some instances cannot be differentiated from wild species of similar appearance that fall into the same taxonomic group (cf. Bennett 1994). Some evidence is available from the macrofossil evidence of seeds and grains. Although the archaeobotanical record for later medieval Wales is scarce (van der Veen *et al*. 2013), oat (*Avena*) is often the predominant food crop identified from archaeological excavation (Comeau and Burrow 2021). This is consistent with the late twelfth-century observation by Gerald of Wales that in Wales 'the whole population lives almost entirely on oats and the produce of their herds, milk, cheese and butter' (Thorpe 1978, 233). However, archaeobotanical evidence shows some increased diversity in the medieval diet, with other food types including legume remains (e.g. peas: *Pisum sativum*, and beans: *Vicia faba*) found in urban, military and rural contexts at sites such as Rhuddlan, Flintshire (Holden *et al.* 1994), Dryslwyn Castle, Carmarthenshire (Caple 2017) and Cefn Graeanog Farmstead, Caernarvonshire (Kelly 1998).

Settlement shift?

The high frequency of instances of deforestation and reforestation seen during this phase shows no obvious pattern (Figure 3). Sites showing evidence for heath regeneration and reforestation that may be indicative of the abandonment of land occur in almost as many instances as deforestation suggestive of colonisation. It is possible, therefore, that a shift in the locations of both settlement and farming activity occurred at this time. There is certainly an increased number of settlement sites that have been identified in this period that could account for some instances of deforestation, but establishing a chronology for such sites is problematic given the limited extent of excavation and radiocarbon dating (Comeau and Silvester 2021). The higher number of later medieval settlement sites is partly the result of more reliable documentary evidence which enables the identification of known settlement sites, but there is also a better understanding of site typologies for the later medieval period. Both north and south Wales were subject to incursion from England from the late eleventh century, with settlements of Anglo-Norman and Flemish colonists being established in the south. New monument types – earthworks and stone castles – appear in strategic locations. Norman castles were established in areas of greatest agricultural potential, together with nucleated villages and large common fields with rotations which were 'alien to the Welsh' (Rippon 1997, 23). Several monasteries of orders popular in mainland

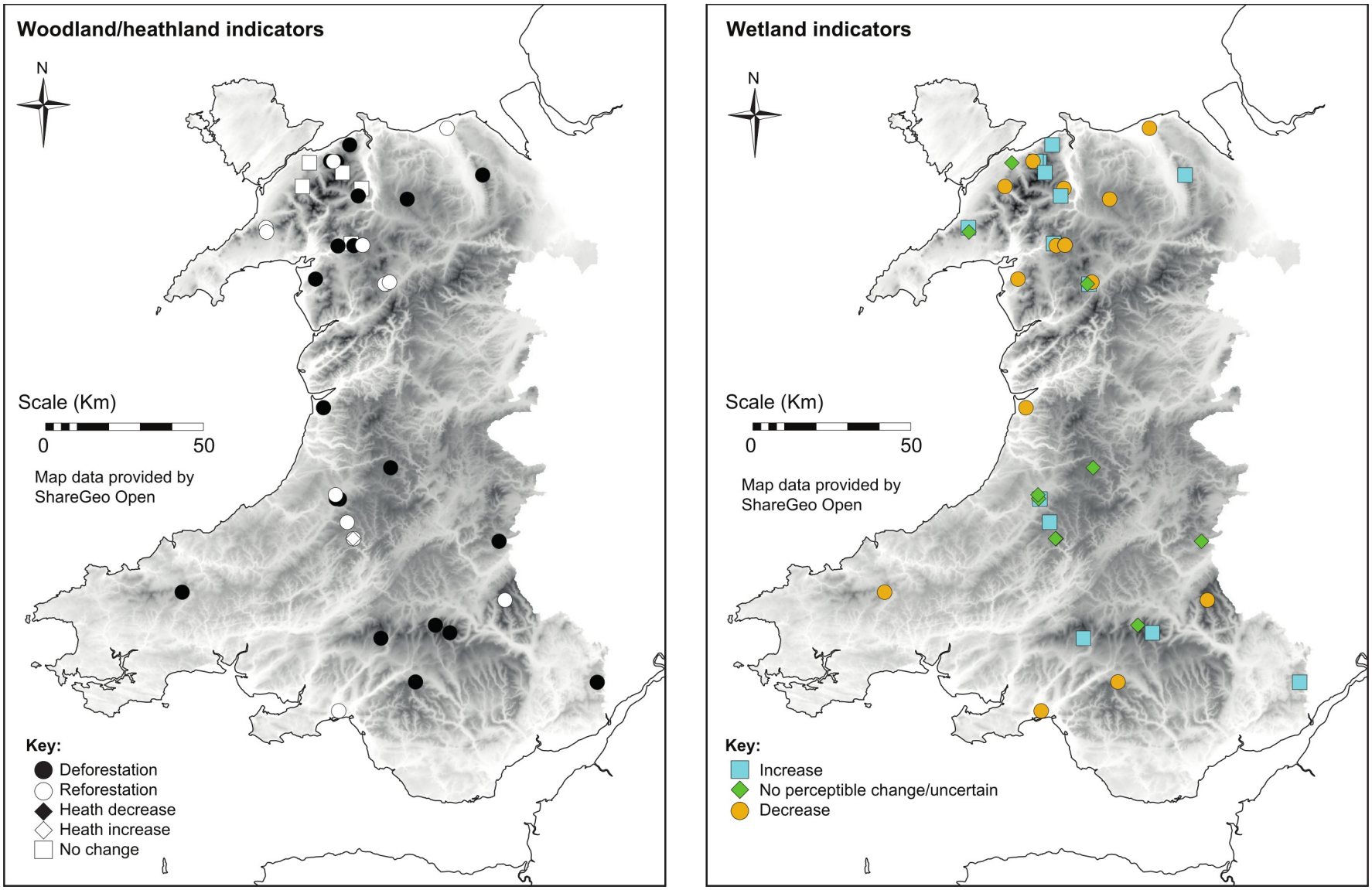

Figure 3 Palynological changes in Wales, c. AD 1050–1300: Woodland and heath and Wetland indicators.

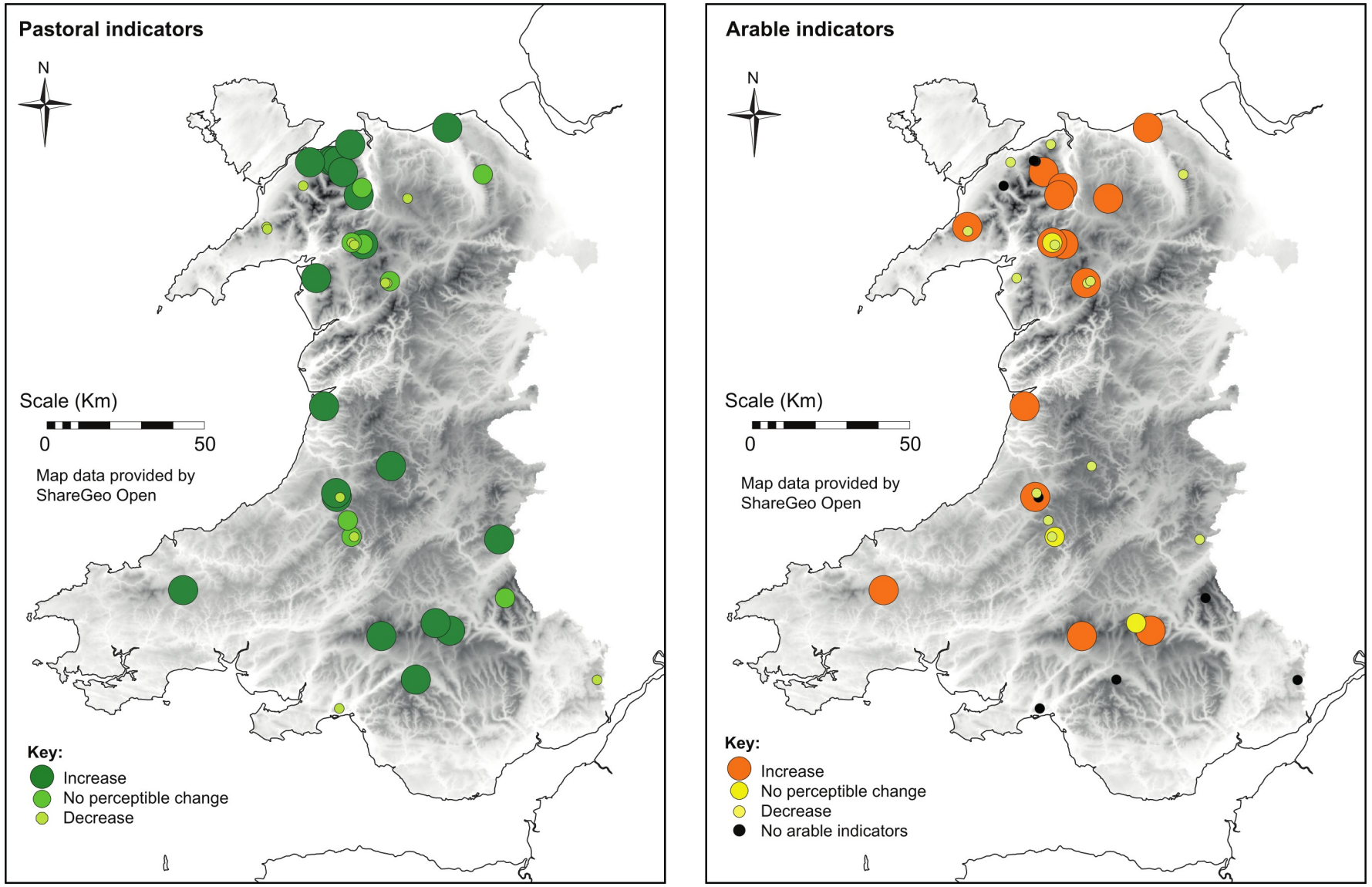

Figure 4 Palynological changes in Wales, c. AD 1050–1300: Pastoral and Arable indicators.

Europe were also founded during this period, some on sites previously established as religious communities.

Within lowland contexts, open field systems of English type have been identified in the areas subject to early incursions and more purposeful English settlement (Sylvester 1969; Silvester 2019). Although most of these field systems are undated, and some may pre-date the English conquest of Wales (e.g., Caerwys, Flintshire: cf. Silvester 2019, 97–8), but their association with the locations of early Norman activity is suggestive of Anglo-Norman influence. Rippon indicates that the medieval phase of wetland reclamation in the Gwent levels may likewise reflect Anglo-Norman influence, though he acknowledges the possibility of multiple influences and creators (Rippon 1997, 24). One would expect this Anglo-Norman activity to produce a pollen signature indicative of woodland clearances and increased arable intensity in the borderlands and south Wales. However, as previously noted, detailed pollen sequences are few in these areas, which impedes detailed assessment of the environmental impact of Anglo-Norman settlement. Such studies as currently exist provide a highly variable palaeoenvironmental narrative, with evidence for both deforestation and reforestation, increases and decreases in pastoral activity, and reduced or very low numbers of arable taxa.

Urban or nucleated settlement is absent from Wales prior to the high medieval period (*c*. AD 1000–1300). Towns were established in Anglo-Norman areas in Wales during the eleventh and twelfth centuries (cf. Soulsby 1983, 7–11). In native-held areas of north Wales there is evidence for coinage in circulation during the reign of Llywelyn ap Iorwerth (1195–1240), and several semi-urban trading settlements appear during the thirteenth century, partly through a deliberate stimulation of a monetary economy by the Princes of Gwynedd (Davies 1990, 148; Carr 1995, 70–71; Stevens 2019, 58). It is possible that such settlements grew around the earthwork castles of north Wales, which David Longley (1997) notes are often associated with royal *maerdrefi* (settlements of bondmen at estate centres). However, as the excavation of the historic cores of documented early settlements in Wales has been very limited, their evolution is poorly understood.

Lower status rural settlement sites have been found in large numbers across Wales, surviving as earthworks with rectangular building platforms, sometimes in association with field systems. It should be noted, however, that there is a clear upland bias towards the preservation of these sites, few have been subject to rigorous investigation through excavation, and most are dated by typology (Roberts 2006; Comeau and Silvester 2021). The uncertainty of the dates of these structures is exemplified by recent excavations at Rhuddgaer on the coastal lowlands of Anglesey, where rectangular stone-built structures and a field system, originally believed to be later medieval in origin, have been dated to the seventh or eighth century (Hopewell and Edwards 2017). This evidence indicates that this building tradition of rectilinear earth and stone dwellings had much earlier origins than previously thought, and questions the later medieval date assigned to most abandoned rural settlements. It is therefore difficult to ascertain how the apparent increased visibility of upland settlement in the later medieval period truly relates to changes in upland settlement practices, or changes in the pollen record at this time.

The 'Medieval Warm Period'

Traditional interpretations of the patterns of upland settlement in Wales broadly conform with narratives presented across Britain as a whole. It has often been argued that an increase in the exploitation of higher altitudes occurred in response to the warmer climate experienced during the 'Medieval Warm Period' or 'Medieval Climate Anomaly' (Lamb 1995; Parry 1985; Ward 1997; Davidson *et al.* 2017). In Britain, the documentary evidence for climatic conditions (cf. Lamb 1995, 84–86) supports scientific data in central Europe that suggest a stable climate during the period *c*. AD 1000–1200, with wetter summers occurring from the thirteenth and fourteenth centuries, and a change to colder temperatures starting around AD 1300 (Büntgen *et al.* 2011, 580). Considering the fact that the pollen studies in Wales show an equal number of sites with increased and decreased wetland habitats (Figures 2–3), the effects of the medieval warm period do not appear to have had a significant effect in the period *c*. AD 1100–1300. It should also be noted that variations in wetland-species pollen may not always a good proxy for climate change, since human activities can also affect the percentages of wetland species – for example, by cutting drainage ditches or ceasing to maintain a drainage system, and possibly abandoning land formerly cultivated or grazed.

Human responses to climate change do not, however, explain the differences seen in pollen indicators of farming intensity across Wales during this phase. With increased temperatures and length of growing season, increases in both arable and pastoral indicators in the pollen record might be expected, especially since the upland bias of the sampling sites would coincide with the supposed location of increased exploitation during the 'medieval warm period'. Although there are sites where such an increase is observed, it occurs without any distinct pattern across the country or within any specific region (Fig. 4).

Changes in pollen catchments may account for some of the variations seen in farming indicator levels. Woodland clearances are likely to have increased the pollen catchment area of sampling sites and additionally removed barriers to the dispersal of herb taxa. At the Aber Valley, Caernarvonshire (Woodbridge *et al.* 2012), sampling sites show a mixture of evidence for both woodland clearance and reforestation at this time, yet all show increased pastoral indicator levels, suggesting that the evidence for increased pastoral activity alongside woodland clearance is genuine. Similar instances are seen for increased arable indicators alongside reforestation, and reduced farming indicators alongside woodland clearance. The changes in the intensity of farming activity cannot simply be explained by variations in woodland or heathland levels, nor indeed by changes in climate. We must therefore consider cultural reasons for these variations.

Monastic influences

A number of studies of twelfth- and thirteenth-century farming practices have attributed increased farming indicators to the influence of monastic institutions. Turner (1964) suggested that the increased pastoral

levels observed at Cors Caron (or Tregaron Bog), Cardiganshire, could be related to the influence of the Cistercian monastery of Strata Florida, established in 1165. This view is echoed by Morriss' (2001) work, also at Cors Caron, where increased arable and pastoral activity alongside reduced woodland levels is noted at Tregaron South East (TSE) at around the time that Strata Florida was founded. However, it should also be noted that contemporary deposits to the northwest of this site, at 'Tregaron west' (TW), show evidence for reforestation, increased pastoral indicators and reduced arable indicators. It is possible that these differences in the pollen record relate to a slightly closer proximity of TSE to lower lying ground to the west, where '*loci excellentiores*' (more excellent places) are described in the monastery's 1184 charter (Austin 2019, 124). It is arguably more likely, however, that the increase in arable indicators at TSE is related to its closer proximity to better-draining soils at Tregaron to the south. The higher suitability of this area for growing crops is demonstrated by a large area of arable land shown on the Land Utilisation Survey (1932–33) map, when arable land elsewhere in the area appeared scarce. If this interpretation is correct, it suggests that any increase in arable activity was undertaken beyond the grounds of the monastery by the local lay population rather than the monastic community. However, it is also possible that farmers living outside the abbey grounds increased their focus on arable activities to supply the monastery with food. Cowley notes that some of the lands received by the abbey on its foundation included lands that had 'never previously been exploited or had been exploited in the past and gone out of cultivation' (1977, 71). It is likely that some of the woodland clearances seen in the pollen record by both Turner (1964) and Morriss (2001) are indeed related to monastic activities, but since the increase in cultivation possibly occurred outside the monastic estate, it is equally possible that deforestation also occurred outside its boundaries.

The attribution of increased agricultural productivity to monastic influence in Wales is in fact a problematic interpretation for the current dataset. Besides Cors Caron, eight of the remaining sampling sites reviewed are located either inside or within 1km of Cistercian monastic landholdings (cf. Williams 1990 and Figure 1). Despite this, evidence of increased pollen indicative of agricultural activities are only present at three of these sites during *c*. AD 1050–1300. Evidence of increased arable activity is observed at Cors Gyfelog central, Caernarvonshire (Botteril 1988), and Cefn Mawr, Denbighshire (Lascelles 1995), but only at extremely low values. Increased pastoral indicators are also noted at Bryn Mawr, Radnorshire (Buckley 2000), but this is the only site beyond Cors Caron where evidence for increased pastoral activity could potentially be attributed to Cistercian influence. It is also worth noting that despite the increased pastoral indicators noted by Morriss (2001) and at Cors Caron during this phase, the increase did not reach the higher levels observed between the late Roman period and the late ninth century. This suggests that any increase in the exploitation of the landscape initiated by the Cistercians at Strata Florida was not as intensive as grazing practices seen in the past. Given the lack of any positive effect on farming indicators at other sampling sites near or within monastic lands, the Cistercian reputation for innovation and efficiency in farming (cf. Williams 1990, 16) is perhaps questionable in view of the pollen evidence. It is acknowledged, however, that the pollen evidence noted above is based on studies that are incidental in their proximity to monastic lands. Targeted research into the environments of monastic lands, with higher pollen sampling frequencies and increased dating resolution, may provide a more nuanced appreciation of the environmental impact of monasteries in Wales.

Conflict and instability

The diversity of changes in the pollen record at this time is similar to those seen in previous centuries from *c*. AD 800–1050, where no clear pattern is apparent (Davies 2015; 2019). In this earlier period, a possible focus on arable activities in the core area of Gwynedd alongside increased pastoral indicators have been interpreted as possible strategic interventions by the rulers of the kingdom in response to the documented increase in conflict, both between the Welsh kingdoms and with the Anglo-Saxons and Vikings (cf. W. Davies 2002, 163; J. Davies 1990, 45, 85). The deforestation seen in some upland contexts in combination with increased pastoral activity has also been interpreted as a possible effect of the creation of specialist upland pastures in consequence of increased demand for livestock tributes to Anglo-Saxon kingdoms (Davies 2019, 189–193). During the late eleventh, twelfth and thirteenth centuries, no similar pattern of arable activity in Gwynedd is evident (Figure 4). However, the continuation or expansion of pastoral activity linked to tribute payments to the Norman/ English crown may be reflected in the pollen record from *c*. AD 1050–1300, in instances where pastoral and woodland taxa remain stable or where deforestation and increased pastoral indicators are noted. Indeed, documentary evidence records the creation of vaccaries in Snowdonia to supply cattle to Llywelyn ap Gruffudd in the thirteenth century, which Beverley Smith suggests served as both a food source during times of conflict and a source of income for the prince (Beverly Smith 2014, 231). The creation of these vaccaries may well be partly responsible for the changes observed in the pollen record for north Wales at this time.

Political turbulence and frequent incursions by the English Crown and by Anglo-Norman Marcher lords characterise much of the period *c*. AD 800–1300 (Davies 1982, 102–112; Davies 1987, 56–81). Under such conditions, it is perhaps unsurprising that the intensity of the farming economy is highly variable across the country. It is likewise understandable that woodland and heath pollen levels suggest numerous instances where the abandonment of farmland and settlements is apparent alongside possible shifts in settlement locations. The generally low percentages of arable indicators in comparison to pastoral indicators may also be linked to this turbulence, possibly relating to the risk of crops being destroyed by enemy forces, as indeed happened on Anglesey during Henry III's campaign in north Wales in 1245 (cf. Beverly Smith 2014, 53–4). It is also possible that the low levels of arable indicators reflect the undeveloped market economy of Wales at this time, which may have stifled demand for arable produce (Stevens 2019, 24).

c. AD 1300–1500 – Intensification and 'peace'

In contrast to the previous phase, the majority of sampling sites across Wales dated *c*. AD 1300–1500 show more uniform changes within their pollen record, with most presenting evidence for deforestation and increased arable and pastoral indicators (Figs 2, 5–6). There is also a greater number of sites with increased wetland species, most of them located in north Wales, though sites showing decreased or no change in wetland taxa also occur in relatively high numbers.

Climate deterioration

This phase coincides with the beginning of the Little Ice Age, a time when evidence for wetter conditions and lower temperatures is observed on a global scale (cf. Lamb 1977, 1995; van Loon and Rogers 1978; Buntgen *et al.* 2011). These climatic changes likely account for the increase in wetland taxa observed from *c*. AD 1300–1500 (Figure 5). The higher number of sites showing increased wetland in the north may relate to an increased susceptibility to temperature and precipitation variation at higher latitudes. This deterioration in climate has often been associated with poor harvests and a contributory factor to population decline and settlement abandonment in the fourteenth century (Silvester 2000, 57). However, the pollen evidence in Wales for this period shows high levels of woodland clearance and an increase in both arable and pastoral indicators, which may reflect colonisation of woodland areas and an intensification of farming practices.

The Edwardian conquest

Documented woodland clearances ordered by Edward I have previously been suggested as the cause of woodland decline seen in samples from west-central Wales (Moore and Chater 1969), though this interpretation is based on palynological-historical correlation rather than scientific dating. Similar interpretations have been applied to woodland declines evident at Cwm Lliw, Merionethshire, and (using a more robust chronological framework based on radiocarbon dates) at Afon Dwy, Coed Bryn Bras 2 and Tŷ Cerrig (Davies 2015). Here, all three sampling sites show a sharp decline in woodland at around cal. AD 1300, coinciding roughly with the final conquest of Wales in 1282–3. The majority of other sampling sites examined across Wales also indicate woodland clearances straddling *c*. AD 1300, but in the majority of cases the pollen sampling frequency is not detailed enough to definitively place this clearance within the context of the Edwardian conquest. Where greater chronological detail is possible, it is evident that some sites show a more gradual woodland decline over the period as a whole (e.g., Crymlyn Bog, Glamorganshire: Hughes and Dumayne Peaty 2002; Cleddon Bog, Monmouthshire: Jones 2011; Cors Gyfelog Peripheral, Caernarvonshire: Botterill 1988; Tregaron, Cardiganshire: Turner 1964). Sharper declines dating to *c*. AD 1300 are, however, apparent at Borth Bog, Cardiganshire (Mighall *et al*. 2010, Bryn y Castell 2, Merionethshire (Mighall and Chambers 1995), Dolaeron, Pembrokeshire (Seymour 1985) and Llyn Cororion, Caernarvonshire (Watkins *et al.* 2007). A sharp decline in woodland levels is also observed at Mynydd Hiraethog, Denbighshire (Grant 2007), although the overall proportions of woodland taxa for the whole period *c*. AD 1300–1500 remain similar to those seen in previous centuries. Despite this ambiguity, in a number of instances there does appear to be a similar signature consisting of a sharp and at times extensive woodland decline dating to *c*. AD 1300 that could well relate to the decrees of Edward I during his final conquest of Wales.

Edward I's justification for these woodland clearances was to prevent 'robberies, homicides and other enormities against the King's peace' (Williams 1889), though there may also have been other motives behind this order. The loss of woodland would have had a significant impact on the native population. As well as providing fuel, building material and foraged foods, woodland would have offered seasonal grazing for pigs and hunting grounds for the Welsh lords (cf. Jenkins 1986; Roberts 2019). Hunting represented an important demonstration of authority for Welsh nobility, as indeed did the consequent feasting activities. Woodland was also an important resource for the production of charcoal for metalworking in medieval Wales (cf. Steane 2014, 458). In the post-conquest period, the Crown asserted control over woodland and wastes, and restricted access to their resources, to the extent that the Bishop of Bangor during Edward I's reign complained about his tenants' losses (Given 1989, 41). A severe reduction in the capacity of the Welsh nobility to demonstrate their authority and produce arms for warfare can also be presumed.

It is also useful to consider what may have happened to the wood collected from this apparently widespread woodland clearance. It is unlikely that this resource would simply have been burned and wasted. Timber was used in Edward I's construction projects of towns and castles as part of the consolidation of his rule, and likely also sold to cover the costs of his military expansion. Cargoes of Welsh timber are noted in the medieval port records of Cardiff, as is its transport by barge along the coast and by river from the inland districts of North Wales (Lewis 1903, 139–140). The woodland clearances noted in the documentary and pollen records are therefore likely to have benefited the coffers of the English Crown, as well as its military objectives.

Upland abandonment

Irrespective of Edward I's motives for deforestation, the pollen record suggests significant landscape changes as a consequence. This is especially clear for Cwm Lliw in Penllyn, Merionethshire. Here, alongside evidence for localised deforestation, increased arable and pastoral indicators in the lowland zone coincide with heath regeneration and diminished microcharcoal concentrations in upland contexts (Davies 2015). At the upland sampling site of Coed Bryn Bras 2 (CBB2), high microcharcoal concentrations are present from around 2000 BC and may represent the control of heathland through burning, which is a practice noted in the Welsh Law texts (Jenkins 1986, 170; Richards 1954,106; Wade -Evans 1909, 274), possibly as a means of improving pasture (cf. Dixon 2018, 67). Their cessation at CBB2, alongside an increase in heathland, suggests a degree of abandonment of upland pasture and interruption of upland management practices. The coincidence of this with lowland woodland clearances and increased farming indicators possibly indicates a shift in the

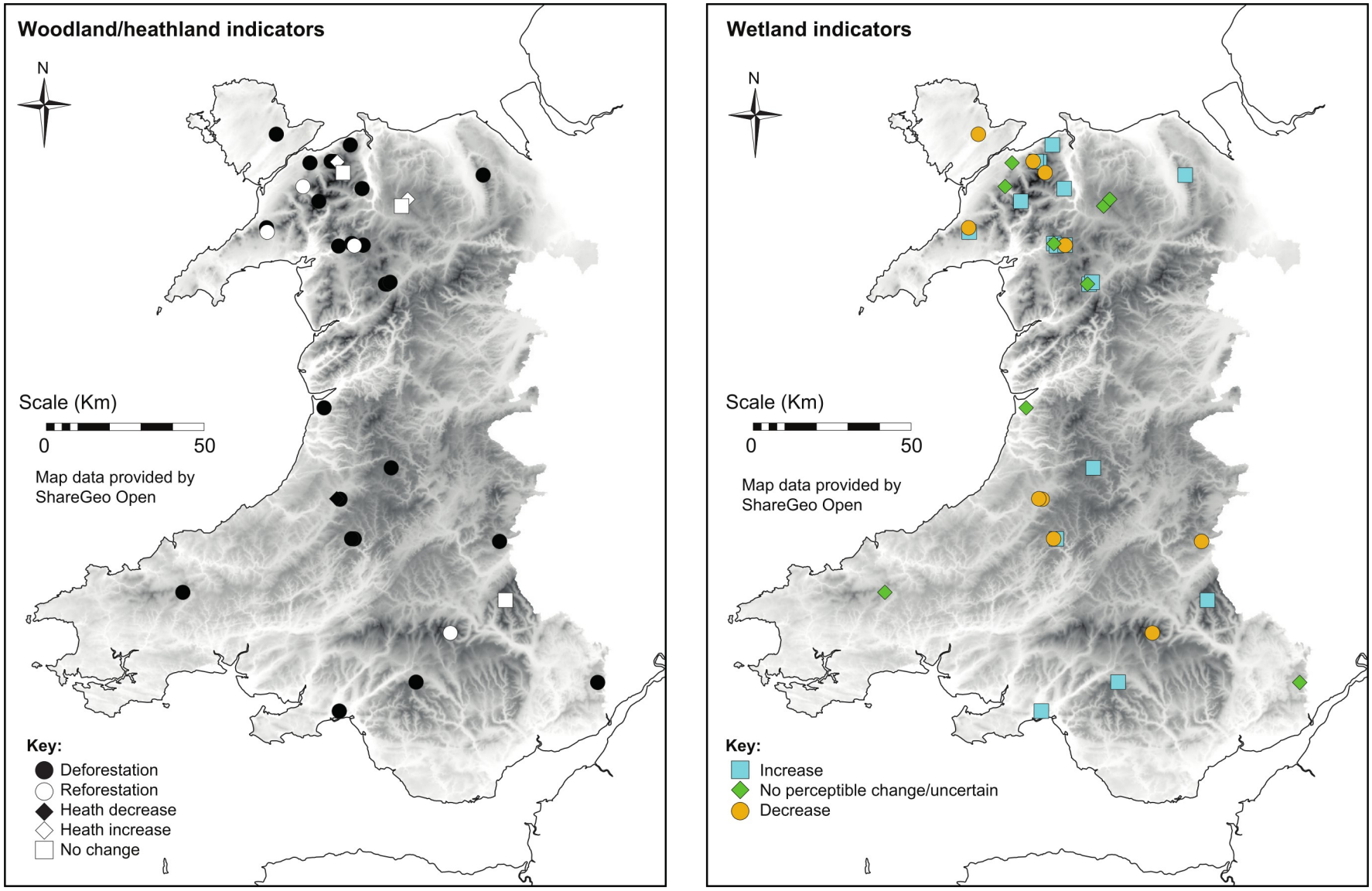

Figure 5 Palynological changes in Wales, c. AD 1300–1500: Woodland and heath and Wetland indicators.

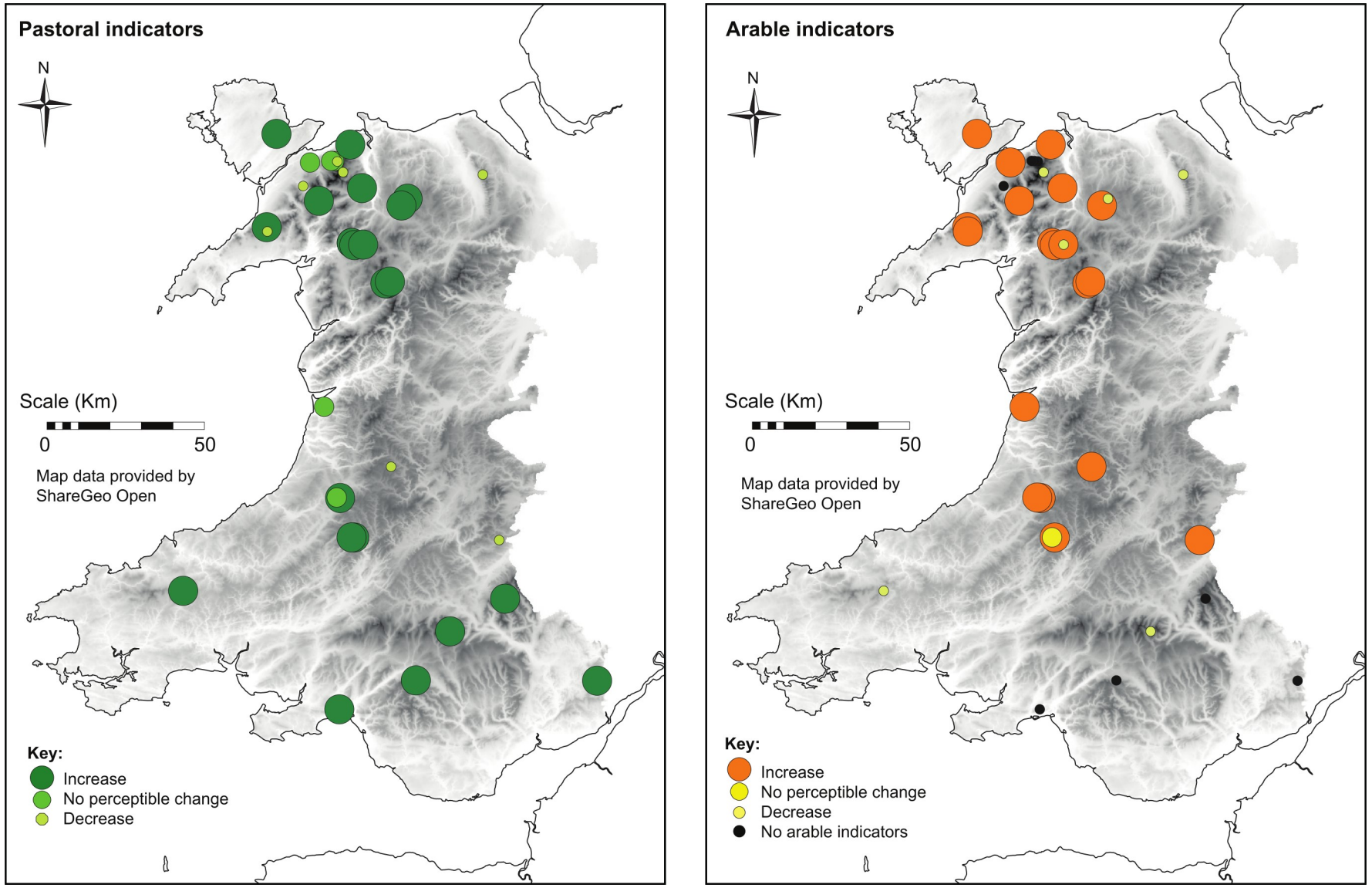

Figure 6 Palynological changes in Wales, c. AD 1300–1500: Pastoral and Arable indicators.

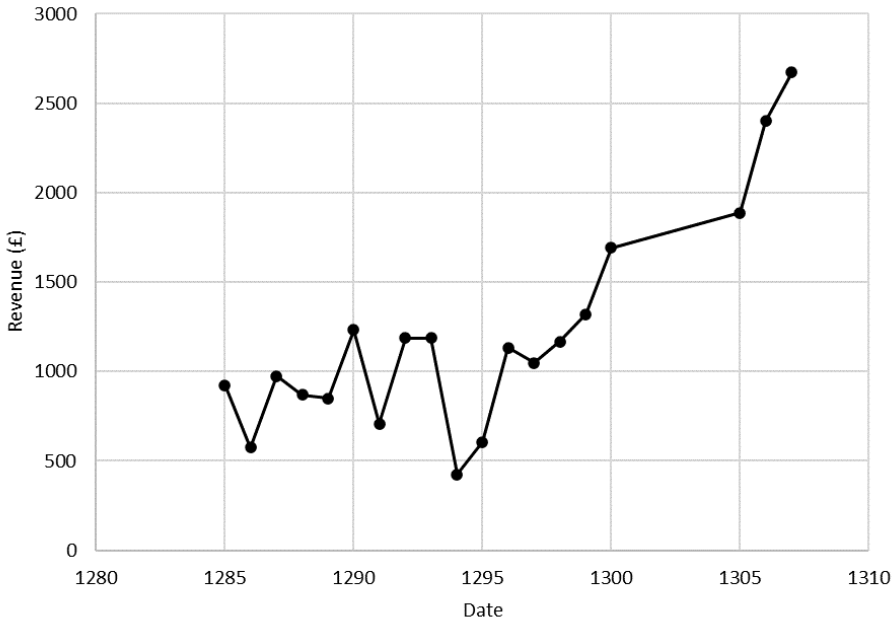

Figure 7 Royal Revenue from the Principality of North Wales 1285–1307 (data from Given 1989, Table 3).

locations of settlement and farming practices (Davies 2015). These environmental changes may also coincide with, or relate to, the development of medieval sheep farming, which increased significantly after the Edwardian conquest (Stevens 2019, 59). The lack of woodland regeneration following the heathland increase at CBB2 does suggest continued grazing, whilst the specific increase in heathland could represent selective grazing by sheep (cf. Limbrey 1975, 154). It should be noted, however, that cattle rather than sheep dominate at a household level in the local post-conquest Subsidy roll of Penllyn from 1310 or 1318 (cf. Williams-Jones 1976).

One factor that may relate to this possible settlement shift is the aforementioned appropriation of common pasture in this area (Gwynedd) which – in combination with additional taxes and charges for grazing rights – is said to have led to 'a steady outflow of Welshmen into England seeking service in the royal armies or employment as laborers' (Given 1989, 41). This evidence provides an alternative to existing models for the desertion of medieval upland settlements in Wales. In this instance, the pollen and documentary records suggest that medieval settlement abandonment was not necessarily the result of depopulation, previously attributed to conflict or disease (as discussed further below), nor was it necessarily due to a loss of productivity on upland farmlands consequent on climate change (cf. Silvester 2006, 27). Woodland clearances in lowland contexts may also have driven some of the changes in settlement patterns inferred from the pollen record. In Penllyn, the woodland clearances that were probably stipulated by Edward I appear to have provided high quality farming land in closer proximity to the existing core zone of lowland settlement. In combination with the restrictions placed on upland wastes, this may have stimulated the abandonment of some transhumance settlements and brought an end to traditional burning practices used to control heath levels (Davies 2015, 202, 215–216). The widespread evidence for woodland clearance and increased farming indicators in the pollen record across Wales at this time suggest that this possible shift in settlement and agriculture may have occurred on a relatively large scale. It is also possible that the increase in farming indicators in the pollen record reflects a general increase in agricultural output encouraged by the relative peace and stability brought about by the final conquest of Wales, or in response to increased tax pressures. This is possibly supported by records of royal revenue from land within the Principality of North Wales, which show a marked increase in revenue after *c*. AD 1300 (Fig. 7). Interestingly, a fall in this revenue corresponds with the revolt of Madog ap Llywelyn in 1294–5 (Given 1989, 31), demonstrating the potential impact of political instability on economic productivity.

Revolt, plague and famine

Previous pollen studies have also suggested that the Black Death (1348–9) and Owain Glyndŵr's revolt (1400–1415) may have affected the pollen record, resulting in episodes of woodland regeneration and decreased farming indicators reflecting the possible abandonment of landholdings and reduced farming activity (Moore and Chater 1969; Grant 2007). The Great Famine of 1315–22 may also have had a similar impact. Pollen evidence for this suggestion is restricted because in the majority of pollen studies in Wales, the pollen sampling frequency within the core is too low to detect any potential variation caused by these specific events. However, many of the studies with suitable frequency of pollen samples do show episodes of woodland regeneration and declines in pastoral and arable activity associated with one, two or all three events (Borth Bog, Cardiganshire: Mighall *et al*. 2010; Bryn y Castell 2, Merionethshire: Mighall and Chambers 1995; Cleddon Bog, Monmouthshire: Jones 2011; Cors Gyfelog Peripheral, Caernarvonshire:

Botterill 1988; Dolaeron, Pembrokeshire: Seymour 1985; Tregaron, Cardiganshire: Turner 1964; and Tregaron SE, Cardiganshire: Morriss 2001). Given the close date intervals between these three events, it is at times difficult to establish which one(s) may have affected the pollen record. Although they do appear to have a genuine impact on the environment, their effects appear to have been relatively short-lived and do not affect the overall trend for *c*. AD 1300–1500 of increased percentages of farming indicators and reductions in woodland taxa. In essence, although these events are thought to have probably caused the death of more than a third of the population of Wales (Stevens 2019, 110), their long-term effects appear relatively negligible in the pollen record; and despite their genuinely devastating impact on the medieval population of Wales, there may not have been as severe and permanent a disruption to the farming economy as previously believed (e.g. Silvester 2006; Grant 2007; Stevens 2019). There is no comparable pollen study from elsewhere in Britain to compare the impact of the Great Famine or the Black Death on the farming economy, although documentary records in England show that population decline related to the Black Death led to a marked reduction in the total area of arable and the output of the principal bread cereals, wheat and rye (Aposolides *et al.* 2008, 13–19). These records indicate a slower arable recovery than the pollen evidence in Wales would suggest prior to the early fifteenth century, but by the end of the sixteenth century arable output of the major cereals in England had returned to pre-plague levels (cf. Aposolides *et al.* 2008, 26–27, 36–38).

Given this apparent increase in agricultural output indicated in the pollen and documentary records, one might easily conclude that there was an improvement in the farming economy after the Edwardian conquest of Wales. James Given's (1989) examination of the economy of Gwynedd in the post-conquest period has demonstrated, however, that the native Welsh population suffered great hardship from increased taxation and other economic restrictions. Although there may have been a greater degree of landscape exploitation and agricultural productivity, this would not necessarily have conferred wider benefits on all sectors of Welsh society.

Conclusions

The dataset examined for this review of pollen studies provides a broad understanding of two distinct phases of development of the later medieval landscape in Wales. Although there are geographical gaps in the distribution of sampling sites across the country, some spatial trends can be observed alongside chronological patterns of environmental change. These patterns broadly align with changes in political dynamics, corresponding with the conquest of Wales in the late thirteenth century. The instability of medieval Welsh dynasties in the pre-conquest period are possibly reflected in the pollen record by the fluctuations in woodland levels and farming indicators observed across the country. It is possible that instances of increased pastoral intensity may signify the influence of monastic foundations, but this is by no means universal and may in part be driven by increased demand for farming produce from the local lay community to supply monasteries, rather than by the direct actions of any given monastery. The development of specialised upland pastures to support the economy of Welsh rulers may also have driven the increase in pastoral indicators, but contemporary trends in the arable economy of Wales are difficult to discern. The geographical variations observed in the pre-conquest period stand in contrast to the clear patterns of widespread woodland clearances and increased farming output in the fourteenth and fifteenth centuries. The timing and pace of these deforestation events at some sites appear to correlate with the documented edicts of Edward I to clear woodland that might conceal Welsh 'rebels'. Upland heathland development alongside changes in the levels of woodland and farming indicators in north Wales suggest a settlement shift and possible abandonment of upland pastures connected with documented restrictions on traditional grazing rights. A subsequent increase in pastoral and arable indicators suggests the stabilisation of the Welsh economy and increased agricultural surpluses. There is evidence at some sampling sites for declining farming output and woodland expansion associated with the Black Death, Great Famine and Owain Glyndŵr's rebellion, but these events do not appear to have had long-lasting impacts on the Welsh farming economy.

The pollen evidence from Wales provides an important record of the interrelationship between the environment and cultural changes in the past. It should be stressed, however, that the conclusions drawn from the examination of these data have their limitations and should be subject to revision as future studies of palynological data are undertaken.

Acknowledgements

I would like to thank Dr Michael Grant for a search of the BPOL database for relevant sites for this study; Dr Alice Forward for useful discussions relating to medieval trade; the two anonymous referees for their constructive feedback; and Rhiannon Comeau for much valued comments on a draft of this article. All errors or omissions within this work remain my own.

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