Living with Environmental Change – Towards an Environmental History of Clydesdale

Richard Tipping

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Dr Richard Tipping is Senior Lecturer in Environmental Science at the School of Biological and Environmental Sciences, University of Stirling.

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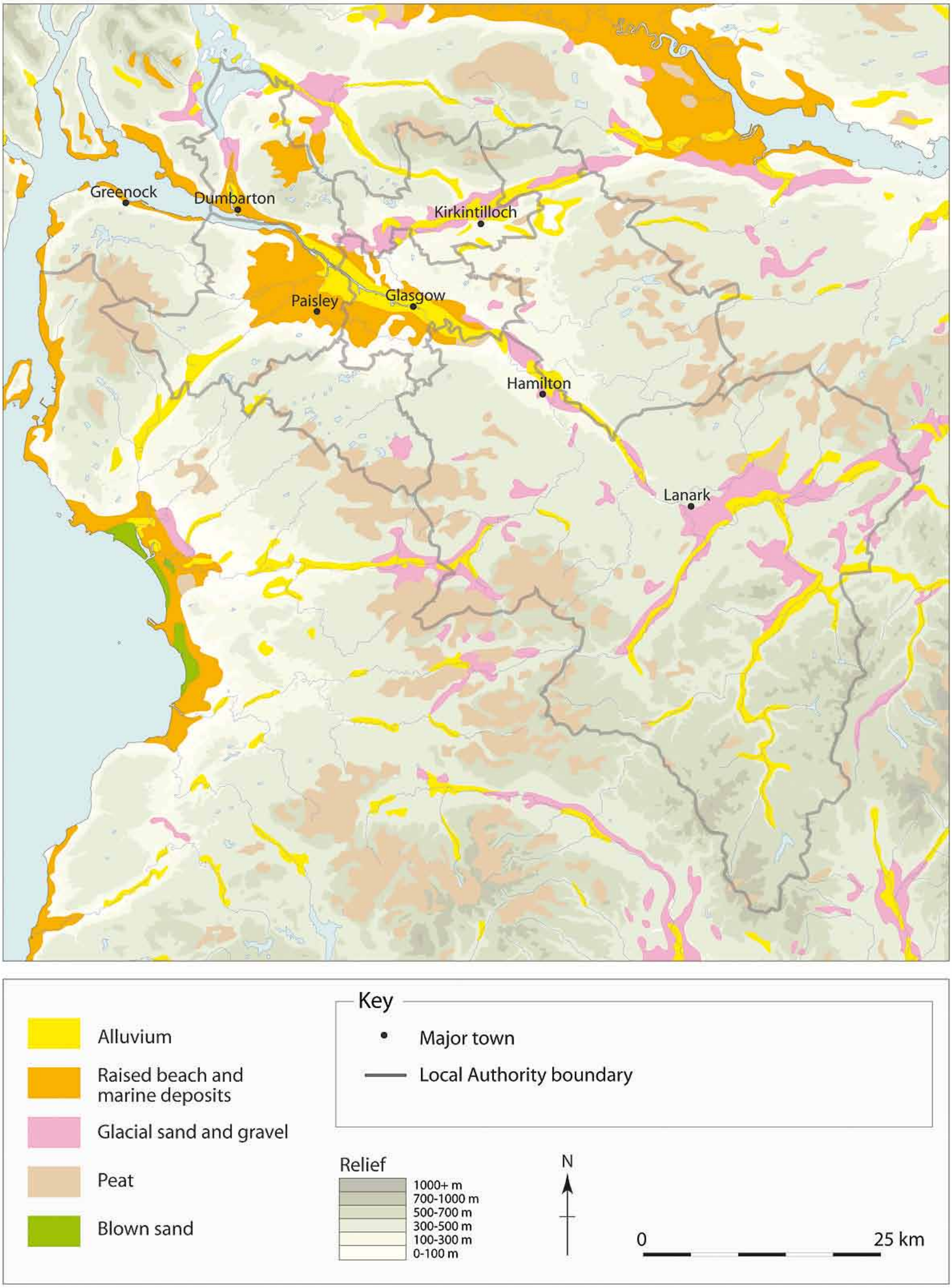

Figure 1. The topography and the major superficial deposits of Clydesdale, the latter after the Institute of Geological Sciences Quaternary Map of the United Kingdom (North) 1977. © CSG CIC Glasgow Museums and Libraries Collections. Produced by the former GUARD (Glasgow University Archaeological Research Division), created by Ingrid Shearer (Northlight Heritage), based on information supplied by the author.

Introduction

This review explores the landscapes and environments of Clydesdale – the shorthand used here for the region covered by the eight local authorities East Dunbartonshire, West Dunbartonshire, Glasgow, Inverclyde, North Lanarkshire, South Lanarkshire, Renfrewshire and East Renfrewshire – in the Holocene Epoch, in which we are still living and which has lasted so far for around 11,500 years: almost all the period that people have lived in Clydesdale since the last glaciation. 'Almost all' because at the very eastern edge of the region is the only substantive evidence for occupation before the Holocene, at Howburn near Biggar (Ballin, Saville, Tipping and Ward 2010; see also Finlay in this series). Even within the Holocene the region has Scotland's second-oldest archaeological site, high in the Southern Uplands around Daer Reservoir, dating to around 8300 BC (Ward 1998). There are only ambiguous hints in the archaeological record that people lived in Scotland before they camped at Daer (Ashmore 2004). (Note: Age estimates are all derived from radiocarbon assays; as radiocarbon years are not the same as calendar years, they have to be calibrated to turn them into calendar years – all dates in this review have been calibrated.)

There has been no full review for Clydesdale of environmental changes in this time period. Geologists have invariably found much more interesting the dramatic changes in landscape associated with the last glaciation, more than 12,000 years ago (George 1958; Jardine 1986; Gordon and Sutherland 1993; Gordon 1997; Evans 2003; McKirdy, Gordon and Crofts 2007). Because these have been reviewed recently the attention in this essay turns to the landscape left after the ice wasted away. By this time, 9500 BC, the physical landscape was largely as it is today (fig. 1). Around the coast the sea has risen and fallen significantly in our period, but inland any changes have affected only the surface features of the landscape.

There is a further reason why Holocene environmental changes have not been fully evaluated for Clydesdale – a paucity of data. In this, Clydesdale is not unique (Tipping 1994). Researchers always require more data, but highlighting deficiencies in what we know, compared with what we need to know, forms an important part of this essay, with the aim of defining what still needs to be done. The intention in this review is to evaluate the nature of the factors generating change in the landscape, what are called the driving forces or simply drivers of change, and to describe how the many different facets of the landscape have altered in the last 11,500 years. Figures 2, 3, 5 and 7 show the region under review and the locations of the analyses reviewed, grouped according to the information they provide. For clarity in the text, the sources of data are defined only in the captions to the maps. These are analyses known to the author after an extensive 'trawl' of the published literature: unpublished datasets have for the most part not been included. The density of dots on the maps might seem high for some forms of analysis, but this is deceiving. There are often concerns over data quality – most frequently related to the ability to measure with precision the timing of environmental change – that tend to undermine, with notable exceptions, the impression that data are abundant.

Coastal Change

The relative rise and fall of sea levels around the coast in the Holocene is closely related to the impacts of the last glaciation. Ice sheets at their maximum 20,000 years ago weighed down the land, making the sea level relatively higher, whilst at the same time locking up enormous amounts of water that would otherwise have been in the oceans, making the sea level relatively lower. Interactions between these components during and after deglaciation were complex. As the weight of the ice sheets was released the land began to rise, making the relative sea level appear lower, but this rise was slower and has lasted longer than the flow of glacial melt water to the oceans, which also raised sea level. Because all the ice that could melt did so by around 5500 BC (global 'warming' apart: Rennie and Hansom 2011), and because Clydesdale is still rising, the region has had falling relative sea levels since this time.

On the Ayrshire coast (fig. 2) around 9500 BC the relative sea level was 2–3m above OD (Ordnance Datum: mean sea level at Newlyn in Cornwall) and in the Clyde Estuary was perhaps slightly higher (Shennan and Horton 2002). The sea flooded the Clyde Estuary, pushing into the large basin at Linwood between Paisley and Clydebank, drowning freshwater peat mosses from 9000 BC (Boyd 1986). By 7800 BC the effects of the rising relative sea level had been registered in the bays between Ardrossan and Girvan, pushing sea water into river mouths to form estuaries (Jardine 1975; Boyd 1982a, b) and creating complex geographies with high ecological diversity attractive to Mesolithic fisher-gatherer-hunters (Morrison 1982). By 5500 BC the sea had reached its maximum altitude in the region, around 12–14m above OD, meaning that it was high enough to penetrate the Vale of Leven. For the next 2000 years Loch Lomond was an arm of the sea, 4–5m higher than the lake is today (Dickson et al. 1978). From 4000 BC relative sea level fell. The Linwood basin became terrestrial peat once more around 1500 BC. The rate and pattern of sea level fall has not been analysed closely in the region (Jardine 1986), but in the Forth Valley a further rise in sea level may have affected the potential for later prehistoric settlement (Smith, Cullingford and Firth 2000). Ease of access along the shallows of the Clyde Estuary by log boat was a significant factor in crannog occupation in the late Iron Age (Sands and Hale 2001), and it must have been important for boats of shallow draught

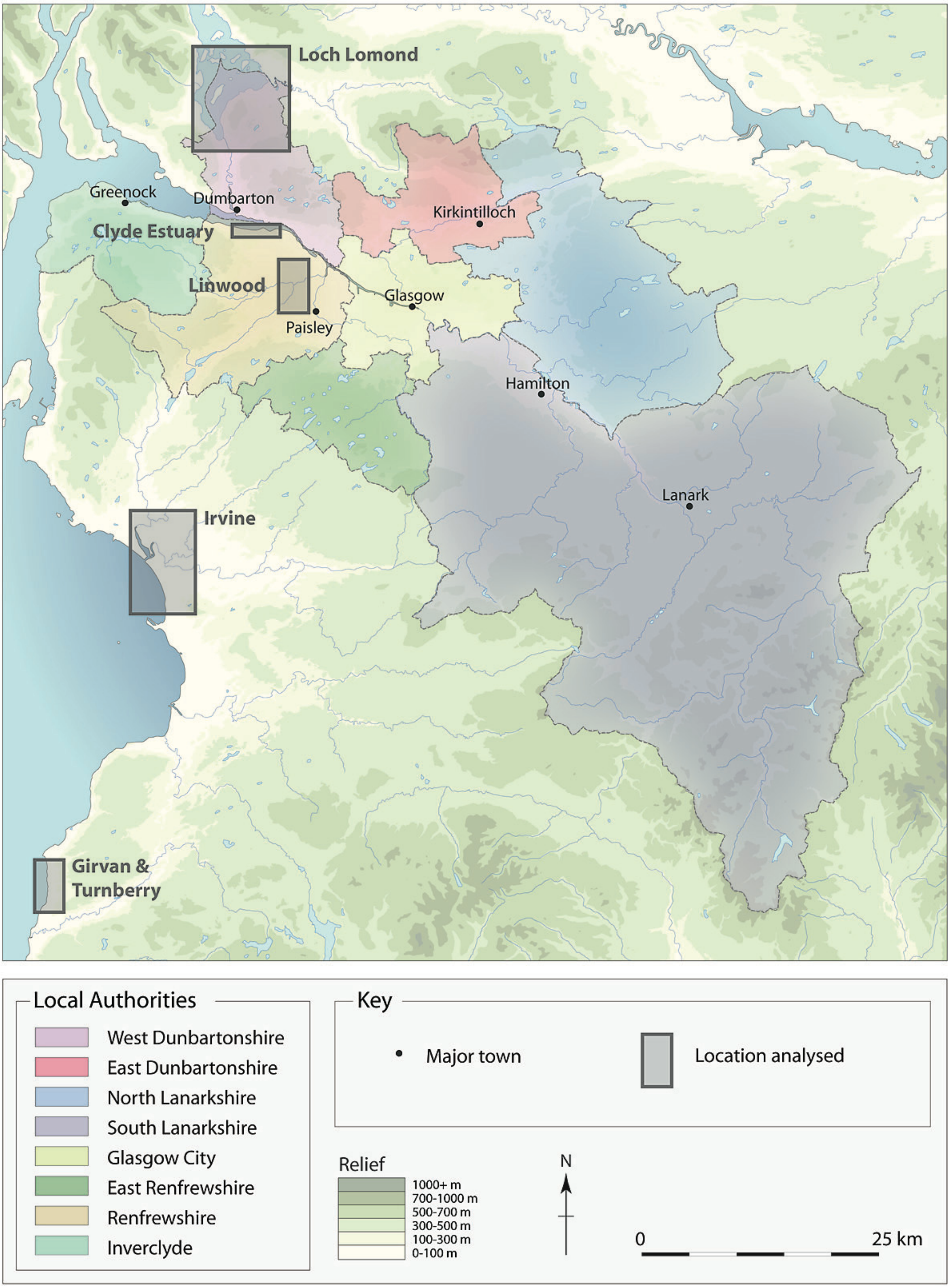

Figure 2. Locations of sites analysed in Clydesdale for Holocene coastal or sea-level change. The main sources are: Clyde Estuary: Jones and Sayeed (2000); Girvan/Turnberry: Jardine (1975); Irvine: Jardine (1975), Boyd 1982b; Linwood: Bishop and Coope (1977), Boyd (1982a, 1986); Loch Lomond: Dickson et al. (1978). © CSG CIC Glasgow Museums and Libraries Collections. Produced by the former GUARD (Glasgow University Archaeological Research Division), created by Ingrid Shearer (Northlight Heritage), based on information supplied by the author.

only slightly later in the Roman occupation (Tipping and Tisdall 2005). The deepening of the River Clyde in only the last few centuries has been skilfully analysed by Riddell (1979, 2000). Jones and Sayeed (2000) look to the future in evaluating how best to conserve the remaining areas of semi-natural coastal marsh in the face of near-future climate change.

Climate Change

Concern over future climate change has led in around the last 20 years to a comprehensive rethinking about how and why climate has varied within the Holocene (Alley 2000; Mayewski and White 2002; Flannery 2005). Major changes in climate, which were abrupt dislocations of the atmospheric circulation system, are now recognized (Mayewski et al. 2004). The ability of the oceans to redistribute heat around the planet may have fluctuated (Broecker 2000), perhaps triggered by variability in the delivery of heat to the Earth by the Sun (Bond et al. 2001). These shifts in climate have been on a sufficient scale to affect how people lived (Weiss 2000; Weiss and Bradley 2001; Berglund 2003; Fagan 2004). Some consensus has emerged that these globally significant phases of abrupt climate change happened within the periods 7000–6000, 4000–3000, 2200–1800 and 1500–500 BC and AD 800–1000 and 1400–1850, each spanning at most a few chaotic centuries.

These and lesser fluctuations had different impacts in different parts of the world. Clydesdale can be regarded as a single climatic region (Birse 1971), although as it ranges from sea level to more than 700m OD it will not have been affected uniformly by climatic change (Harrison 1997). On the Atlantic's eastern edge, the region is most affected by changes in the position, frequency and intensity of moisture-bearing westerly winds (Mayes 1991), which are determined by the strength of ocean currents (Hurrell et al. 2003). Temperatures today are benign only through warmth supplied by the 'Gulf Stream', but fluctuations in this are graphically shown by marine sediment cores which periodically contain rock fragments that were carried in icebergs as far south as Ireland (Bond et al. 1997).

Reconstruction of past climate within Clydesdale has concentrated on the record archived in peat bogs (Blackford 2000; Chambers and Charman 2004). There are different types of peat bog: blanket peat patchily cloaking upland soils, valley fens and raised mires. The last are broad domes of peat forming on waterlogged soils and are able to rise above the surrounding ground because layers of peat-forming plants like *Sphagnum* (bog moss) accumulate, but in the absence of oxygen decay only very slowly. Raised mires in particular are thought to be sensitive to climate change because their shapes prevent water from surrounding soils flowing into the mire (Barber 1981). As they grow vertically they retain information in peat stratigraphies on how wet or dry their surfaces were in the past.

Early work in and near the region at Blairbech, Cranley and Letham mosses (fig. 3) has been followed by more complex and better-dated analyses from four other raised mires in central Scotland: at Langlands and Killorn (for the last 4000 years), Shirgarton (for the last 2500 years) and towards Edinburgh at Temple Hill Moss (for the last 7500 years). Data were collected on (a) the changing abundances with depth, and so time, of peat-forming plants and microscopic animals (testate amoebae) that are known to flourish under different hydrological conditions, and (b) the extent of peat decay (humification), which increases when dry mire surfaces allow air and micro-organisms to digest peat faster. The records are inferred to represent relative changes in how dry or wet these mire surfaces were at any time. Figure 4 is Charman et al.'s (2006) synthesis for central Scotland for the last 4000 years using the testate amoebae records from these sites.

Early Holocene climates are not recorded in these mosses. The author (Tipping 2004) evaluated early climate changes from other types of record, emphasizing the effects on the landscape and possibly on hunter-gatherers of the largest Holocene climatic change around 6200–6000 BC. A major shift from a dry to a wet mire surface occurred at Temple Hill Moss around 4200 BC, towards the end of the Mesolithic period (see also Tipping and Tisdall 2004). Mires became alternately wetter and drier in the early to middle Bronze Age: they were very wet between 2000 and 1800 BC, drier by 1600 BC and wet again by 1400 BC. Mires seem then to have become drier throughout the later Bronze Age before becoming much wetter at around 500 BC near the Bronze Age–Iron Age boundary (van Geel, Buurmann and Waterbolk 1996; van Geel and Berglund 2000). They remained wet until AD 1000, with short pulses of deteriorating climate at around AD 300 and 800. In the medieval and early modern periods raised mires became increasingly dry, but this trend ended abruptly 400 years ago in a shift to very much wetter surfaces in what may be a signal of the 'little ice age', the most recent climatic excursion, between AD 1400 and 1850.

There are problems in interpreting individual sites. Some sites are more sensitive to change than others. Some mire surfaces appear to have been dry when others were wet. More significantly, it is uncertain what specific climatic factors induced the changes. Mires may, for example, have become drier because rainfall was reduced or because higher temperatures led to greater evapotranspiration. Also, we cannot yet define what these fluctuations meant in degrees Celsius or millimetres of rain (or any number of combinations of these). This is not to decry the extraordinary effort in securing these, our only palaeoclimatic records for the region. They record past periods when atmospheric circulation across central Scotland was perturbed sufficiently to disrupt plants and animals living on raised mires, and as such are very intriguing for what they might suggest about

Figure 3. Peat stratigraphies in the region from which palaeoclimatic records have been recovered. The main sources are: Blairbech Bog: Stoneman (1993); Cranley Moss: Stoneman (1993); Killorn Moss: Charman et al. (2006); Langlands Moss: Langdon and Barber (2004, 2005), Charman et al. (2006); Letham Moss: Stoneman (1993); Shirgarton Moss: Langdon and Barber (2004, 2005), Charman et al. (2006).

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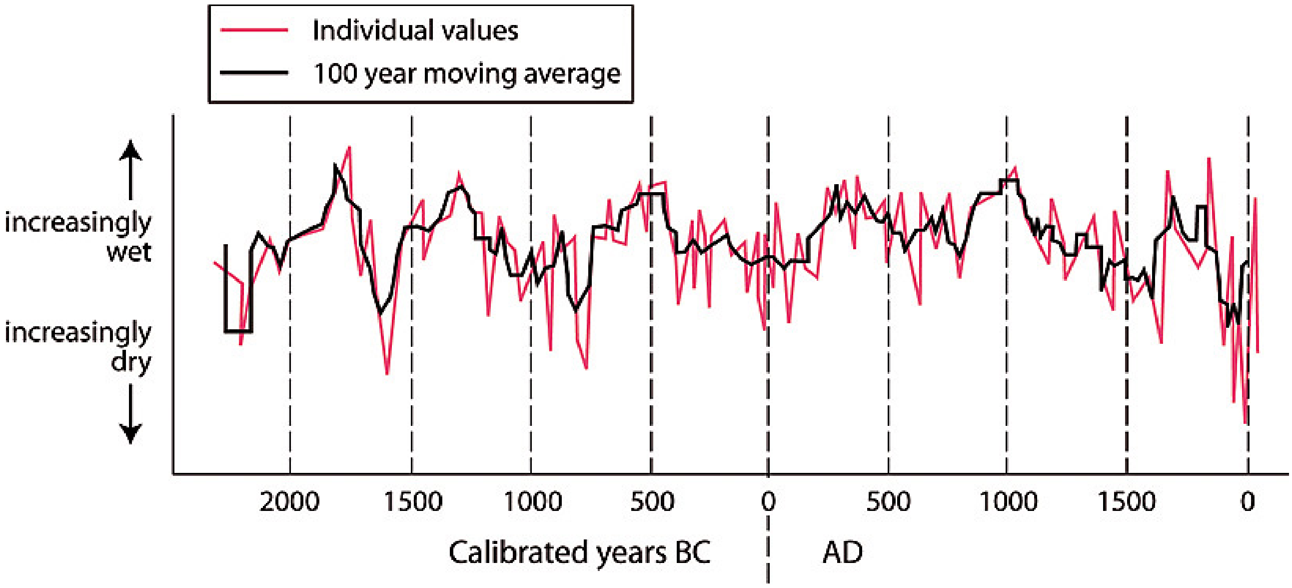

Figure 4. A synthesis of phases of mire surface wetness in central Scotland from 2000 BC to the present (from Charman et al. 2006).

ecosystem responses in other parts of the landscape, and particularly what they meant for human beings.

Vegetation and Land Use Change

Changes through time in plant communities are best described at the regional scale by pollen analyses (Tipping 1994), complemented locally by analyses of charred plant remains (Dickson and Dickson 2000). Pollen grains blown on the wind drift to peat and lake surfaces and are preserved as sediments accumulate. Within this simple description are also two of the major problems in the technique. Firstly, plants which do not disperse pollen by the wind are by and large not recorded. Secondly, where and how large past plant communities were cannot confidently be mapped because wind-blown pollen grains are transported over sometimes large distances: large lakes in Scotland receive pollen from trees growing in North America (Tyldesley 1973). Two other major problems exist. Pollen analysts are able to identify a specimen to the species level far less often than botanists or palaeobotanists working on charred fragments, and specific to Clydesdale is the problem that the past has been visited by pollen analysts in their particular 'time machine' rather infrequently, often only every few centuries when it would be nice to visit every human generation.

The region was included in the author's review of Scottish woodland history (Tipping 1994), and was the focus for Ramsay and Dickson's (1997) review. Tipping and Tisdall (2005) reviewed the data for the period spanning the occupation of the Antonine Wall between AD 140 and 160. The distribution of pollen sites in Clydesdale known to the author is strongly skewed to the midland valley and its raised mosses (fig. 5). Such sites, because they receive pollen from large distances around them, are not best suited to understanding the delicacy of human activities (Tipping and Tisdall 2005), and as a consequence our current reconstructions of land use can be clumsy: we are in effect trying to create a Constable landscape with a paint roller. Pollen analysts can make their reconstructions more detailed, for example by sampling small ponds and small peat basins, because these receive pollen from smaller areas than large lakes or raised mires, but we have yet to adjust our site selection strategies in the region to understand the fine detail of how people lived. We must 'visit the past' more often than we have, and we must be able know more precisely the dates of our 'visits'. Figure 7 shows the time spans covered by the analyses known to the author, and indicates which have been radiocarbon dated as well as how many (or few) radiocarbon dates were obtained.

One effect of the glacial climate before 11,500 years ago was to eliminate the tree cover from most of northern Britain, leaving only species-poor tundra with grasses and sedges. The woodland had to be built anew in the early to middle Holocene. Individual tree species immigrated at different speeds, governed by chance and by different ecological tolerances (Birks 1989). Juniper and willow were ousted by birch 9000–8600 BC, and hazel joined birch around 8200 BC. Elm colonized more rapidly than oak, although oak appears to have been more abundant in the region, and the two formed closed deciduous woodland that suppressed the growth of birch and hazel after 7500 BC. This pattern can be found at all sites spanning this period as each competitively superior tree colonized, producing what appears from our analyses to have been a uniform vegetation cover over most of the lowland, although woodland was in detail always dynamic, always adjusting to local soil

Figure 5. Locations of Holocene pollen records, archaeological sites and other places in the region containing information on vegetation and land-use change. The main sources are: Auld Wives' Lifts: Dickson (1981); Bar Hill: Boyd (1984, 1985); Bearsden: Knights et al. (1983); Biggar Common: Tipping, Carter and Johnston (1994); Blackshouse Burn: Ramsay in Lelong and Pollard (1998); Blairbech Bog: Dumayne-Peaty (1998b, 1999); Bloak/Kennox mosses: Turner (1965, 1970, 1975); Bodsberry: Terry (1993); Buiston Loch: Crone (2000); Cadzow: Dickson (1993); Campsie Fells: Eydt (1958); Carnwath Moss: Fraser and Godwin (1955); Craigbarnet Muir: Stewart (1983); Cranley Moss: Dumayne-Peaty (1999); Drumbow Moss: Dickson (1988); Drymen: Donner (1957), Vasari and Vasari (1968); Dubh Lochan: Stewart, Walker and Dickson (1984); Dumbuck: Sands and Hale (2001); Garscadden: Dickson (1993); Gartlea: Ramsay (1995); Gartmore: Donner (1957); Girvan: Jardine (1975), Boyd (1982a, b); Glasgow Bridge: Dunwell and Coles (1998); Greenhead Moss: Davies and Tipping (2004);

or environmental changes. Climatic fluctuations, for example, are increasingly recognized as major factors in forcing change in woodland structure in the early to middle Holocene (Tipping 2004). There is, however, no clear evidence that this woodland was the natural patchwork of glades and grass evoked by Vera (2000: see Mitchell 2005). At altitudes above 250–350m OD the woodland may have remained predominantly of hazel and birch with ash. Even on hills higher than 600m OD open canopy birch-hazel-ash woodland grew (Tipping 1994, 1999).

Alder colonized after oak and elm, between 6000 and 5500 BC (Ramsay and Dickson 1997), and yet is competitively inferior to these trees, leading to suggestions that existing woodland had to be disturbed through climatic, soil or human impacts to facilitate its establishment (Bennett and Birks 1990). The repercussions of abrupt climatic change around 6200 BC may have been one such stress (Tipping 2004). Waterlogging of soils might have created habitats where alder could compete, such as around the lowland mires at Linwood or Greenhead. Blanket peat formed on the highest parts of the Southern Uplands very early in the Holocene (Tipping 1999), but it spread later to lower altitudes and on drier slopes, as at Craigbarnet Muir on the Campsie Fells between 5000 and 4500 BC and at Auld Wives' Lifts on Craigmaddie Muir where a fen became a small valley bog by 4500 BC. The raised mires of Bloak and Kennox mosses nestled between glacial drumlins near Kilwinning formed between 4500 and 4000 BC, and in a similar setting at Springburn in Glasgow wet hollows between drumlins had started to fill with peat by 4500 BC (fig. 5).

Hunter-gatherer impacts on vegetation in the region have been suggested at Blackshouse Burn around 5500 BC, although the data remain unpublished, and possibly around Greenhead Moss between 5100 and 4700 BC (fig. 7). The absence of evidence at other sites may well be because of the low temporal resolution of most analyses. The deliberate use of fire to alter woodland, measured by the amounts of microscopic charcoal on pollen slides, is most commonly assumed to indicate hunter-gatherer impacts (Davies and Tipping 2004; Tipping 2004). Elsewhere in southern Scotland the frequency or severity of fires was high between 5500 and 4000 BC, in the later Mesolithic period, but this may have been because the climate created dry soils and tinder-dry plants (Tipping and Milburn 2000).


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Figure 6. A recreation of how a hunter-gatherer may have looked using a bow very much like that found at Rotten Bottom, high in the hills of the Southern Uplands. Some researchers have suggested that woodland was deliberately burned to create openings in the tree canopy, encouraging grass growth and in turn attracting herbivores like deer, making them easier to hunt.

Pine trees may have penetrated south into the region on several occasions, but they probably grew only on the surfaces of nutrient-poor raised mosses where few other trees provided competition and when they were exceptionally dry (fig. 4). Four stumps have been radiocarbon dated (Ramsay and Dickson 1997): in Lochend Loch Bog, to around 4060 and 3760 BC; Walls Hill Bog, to around 2760 BC; and at Drumbow, to around 1100 BC (fig. 5). Western Scotland was always too cold and too damp, and soils too acidic, to allow lime trees to spread north from Cumbria.

The period between 5500 and 4000 BC is sometimes described as the climatic optimum, although the woodland did not approach the idealized stability of a 'climax' community. But it was a period when all major trees had become established, all grew well at the regional scale, some probably grew at higher altitudes than before or after, and the tree canopy was nearly complete. We do not readily know what it was like for people to walk through this woodland but in different ways Edmonds (1998), Austin (2000) and Tipping (2003) have tried to imagine this.

A decline in the population of elm trees around 3800 BC (Parker et al. 2001) throughout north-west Europe is significant for palaeoecologists because it was the first time in the Holocene that a major component of the deciduous woodland suffered a setback. It has ceased to mark the start of the Neolithic period because the elm decline occurred at least 400 years after farming was introduced to Britain. Because of this the elm decline is now less strongly linked to human impacts, such as

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Jock's Gill, Carluke: Sansum, Stewart and Watson (2005); Kirkintilloch: Boardman, Dickson in Keppie et al. (1995a); Lenzie Moss: Ramsay (1995); Letham Moss: Dumayne-Peaty (1998b, 1999); Lintshie Gutter: Terry (1995); Linwood Moss Wood: Boyd (1986); Lochend Loch: Ramsay (1995); Loch Lomond: Dickson et al. (1978); Mollins: Boyd (1984, 1985); Moss Cottage: Boyd (1986); Mugdock: Dickson (1993); Nethan Valley: Sansum, Stewart and Watson (2005); Shewalton Moss: Boyd (1982a, b); Shiels: Robinson (1983), Scott (1996); Springburn: Dickson, Jardine and Price (1976); Walls Hill: Ramsay (1995); Westerwood: Tipping in Keppie et al. (1995b); Wilderness Plantation: Newell in Hanson and Maxwell (1983). © CSG CIC Glasgow Museums and Libraries Collections. Produced by the former GUARD (Glasgow University Archaeological Research Division), created by Ingrid Shearer (Northlight Heritage), based on information supplied by the author.

the selective feeding of elm leaves to cattle newly acquired by the first farmers (Garbett 1981), and in Clydesdale there are no indications that the decline was anthropogenic in origin. A link to climatic stress has been proposed for the decline in southern Scotland (Cayless and Tipping 2002).

The Neolithic period in Clydesdale (4200–2200 BC) is very poorly understood from pollen records – it receives no consideration in Ramsay and Dickson's (1997) review – because records are few (fig. 7): they have low temporal resolutions and are from sites receiving pollen from very large surrounding areas. We have not looked hard enough or in the right places in Clydesdale to define with any satisfaction the Neolithic landscape. We can expect human impacts to have been small in extent (Tipping 1994), and around Bloak and Kennox mosses (fig. 5) they were very slight. At Greenhead Moss near Wishaw the earliest farmers are identified after 3500 BC by their creating small clearings in the woodland, principally for pasture.

Pollen records from the Bronze Age and early Iron Age (2200–500 BC) are more numerous (fig. 7), though most have low temporal resolutions. The landscape continued to be well wooded. Burgess's (1985) and Terry's (1995) suggestions of a highly populated agrarian landscape do not fit easily with the description of extensive woodland, but recognizing how frequently houses had to be rebuilt (Halliday 2007) may resolve these conflicts. Analyses of wood charcoal by Camilla Dickson at Lintshie Gutter (fig. 8) and Stoneyburn in upper Clydesdale (fig. 5) suggest, if representative of natural woodland, either that woodland higher than 250m OD had little oak, or that by the early Bronze Age oak had been lost, or perhaps that by this time woodland was being managed (Dickson and Dickson 2000). Wood charcoal provides evidence of a much richer range of tree and shrub species, adding much local colour to pollen records, and in upper Clydesdale, Bronze Age people collected wood for fuel from birch, hazel, cherry, rowan, alder, willow and blackthorn.

In what is still an outstanding analysis, Judith Turner (1965, 1970, 1975) identified from pollen analyses around Bloak and Kennox mosses (fig. 5) a series of 'small temporary clearances' beginning, it is estimated here, at around 1400 BC. These were limited in size, though probably much larger than Turner's (1975, 95) estimate of 'a few hundred metres in diameter at the very most', short in duration (between 50 and 100 years), and were each followed for around 150 years by woodland closure. Similar episodes have been found elsewhere in the region, from the early Bronze Age at Walls Hill Bog, within the Bronze Age at Fannyside Muir and Letham Moss and throughout upland northern Britain (Tinsley 1981; Tipping 1994). Extensive early Bronze Age clearance at Moss Cottage (fig. 5) is not supported by the data. The uniformity of short-lived intakes of land across the region might suggest that contrasts between lowland and upland were not significant then, and it is not possible from the current dataset to recognize core areas and their corollary peripheries (Tipping 2002). It has been argued that it is only around Greenhead Moss (Davies and Tipping 2004) that Bronze Age woodland clearance from 2150 BC expanded or intensified into the Iron Age, to 300 BC, without woodland regeneration.

Pastoralism was stressed as the major agricultural activity by Turner (1975) because cereal-type pollen

Figure 7. The time spans covered by pollen records in the region known to the author (see fig. 5), indicating by dots the numbers and temporal positions of radiocarbon dates when obtained.

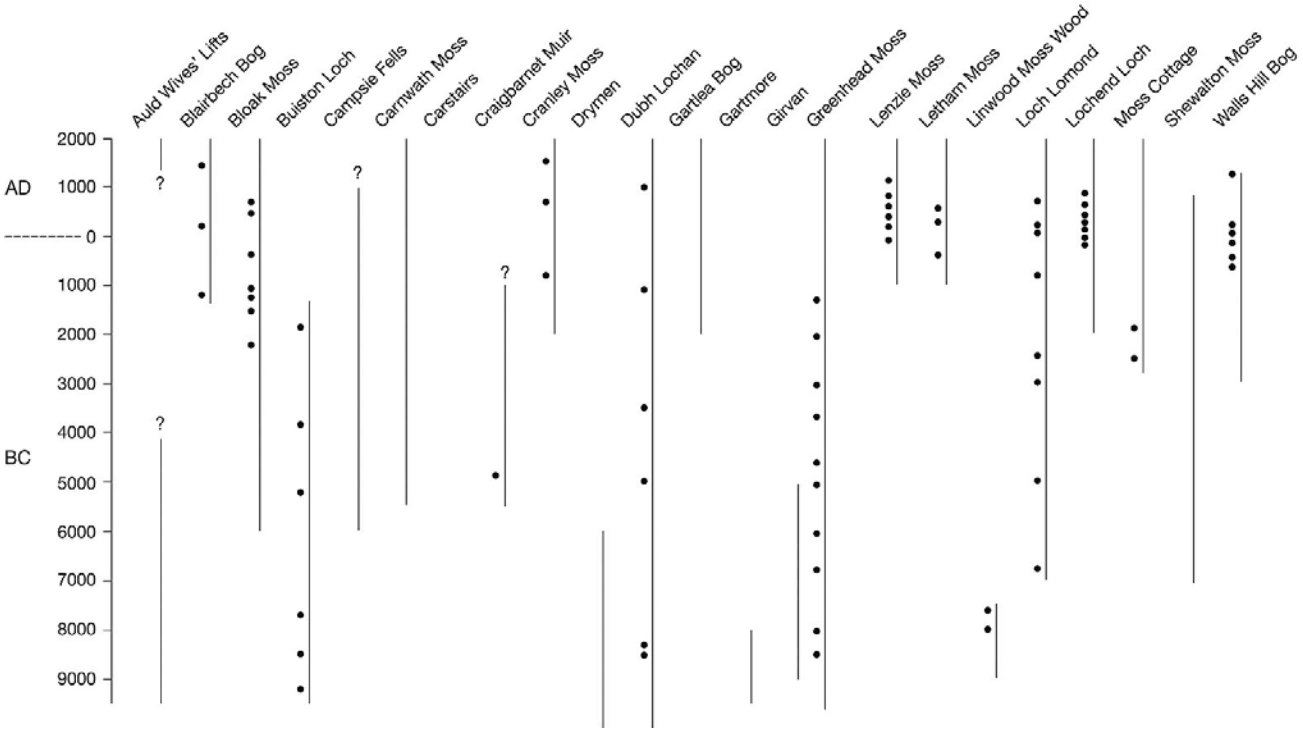

Figure 8. The excavation of the Bronze Age Lintshie Gutter unenclosed platform settlement in upper Clydesdale, from which Camilla Dickson retrieved evidence of species-rich woodland nearby.

was not recorded, but all the pollen sites recording clearance may have been too far from the nearest farmland to receive pollen from crops. Landscapes dominated by bog might also have been of only marginal interest to farmers. Barley grain, probably locally grown, was recovered at the Lintshie Gutter unenclosed platform settlement and some crops were grown amidst pasture on Biggar Common and around Greenhead Moss. The functions of small field systems such as at Bodsberry Hill remain unclear: soil pollen analyses there were not interpretable. South of Clydesdale at Stanshiel Rig (RCAHMS 1997), pollen analyses by Cayless (2000) suggest that cairns and fields were developed beneath a woodland canopy. Toolis's (2005) speculations on transhumant exploitation on the flanks of the River Clyde cannot be tested from existing evidence. Why later prehistoric farmers moved around the landscape at longer, centurial timescales is not at all clear, assuming these clearances do represent single phases of farming (Turner 1970; Tipping and Tisdall 2005). These were quite large areas being cleared, abandoned after four to five human generations, and reclaimed after a further six to seven generations – on a larger spatial scale and relating to longer timescales than those in house rebuilding suggested by Barber and Crone (2001) and Halliday (2007). Clearings seem to have been maintained for far longer than required by, for instance, slash-and-burn models of land use, even if these were appropriate to upland Britain (Rowley-Conwy 1981), and, in any case, farmers had by the Bronze Age understood how to maintain soil nutrients by manuring (Bakels 1997). Woodland regeneration may have represented only a single generation of trees, but 100 to 150 years is too long a duration to think the patterns of felling and regeneration were related to woodland management.

After the middle of the Iron Age, between 500 BC and the BC/AD boundary, the landscape of the region changed entirely. What had been woodland became farmland. Small temporary clearings in the woodland, tentative attempts by farming families to find a place in the natural world, were utterly transformed into deliberate, probably planned assaults on nature (fig. 9). This transformation has been explored in the region by Susan Ramsay (1995; Ramsay and Dickson 1997) and by Lisa Dumayne-Peaty (Dumayne 1992, 1993a, b, Dumayne-Peaty 1998a, b, 1999), reviewed in detail by Tipping and Tisdall (2005) and placed in a wider context by Tipping (1997c) and Huntley (2000). Though initially argued by Dumayne-Peaty (Dumayne1993a, b) to be of Roman origin, these earliest extensive or large-scale woodland clearances are now seen to have been made by the native population before Roman influence. Even on what must have been at least seasonally wet ground by the River Clyde, the enclosure at Shiels was constructed in open ground. We do not know why, but throughout northern Britain from the Mersey–Humber to the Forth–Clyde, at different times communities cleared most of the woodland and created a landscape as treeless as that of today. The rapidity, extent and totality of individual woodland clearances, and the establishment of what appears to have been a fully integrated agrarian landscape might imply that decisions were made by 'tribal' elites that could draw on large workforces to mould regional scale rural economies based on both livestock and cereal crops (Tipping 1997c; Tipping and Tisdall 2005), a view of a centralized hierarchy that differs from Wilson's (1997) interpretation of the archaeological record.

There is little doubt that Roman forces moved to the Antonine Wall through farmed land readily capable of supplying the troops, and at most places agriculture was maintained during occupation. It is probable that this new market led to a concentration in the region on livestock and a decline in crop production (Ramsay and Dickson 1997; Tipping and Tisdall 2005). Some places did not thrive, however, as around Cranley, Greenhead, Walls Hill and Bloak mosses, perhaps too distant from the Wall, or Blairbech Bog and Dubh Lochan, north of and on the wrong side of the Wall (fig. 5). Roman withdrawal to Hadrian's Wall did not lead to immediate economic decline. Around AD 300, however, several localities in the midland valley saw partial woodland regeneration, although such phases described from raised mosses may be only of trees colonizing their edges. Reforestation was not 'almost complete' (Ramsay and Dickson 1997, 146), and it by no means signifies societal collapse or land abandonment (Dumayne-Peaty 1999) but simply a scaling down of agricultural activity as the market contracted.

Because late Iron Age and Roman impacts have been central to many studies the temporal resolutions of all pollen analyses in the region are lower, detailed descriptions fewer and dating controls mostly poorer in sediments formed after around AD 550 (fig 7). Ramsay and Dickson (1997) placed emphasis on population decline in the early historic period, but this perhaps contrasts with archaeological data for a vibrant economy at Buiston (Crone 2000). Woodland clearance resumed with some vigour between AD 400 and 600 at Letham and Cranley mosses and Blairbech Bog, after AD 800–900 at Fannyside Muir, Walls Hill, and Lenzie and Greenhead mosses, and as late as AD 1150 around Bloak Moss (fig. 5). Nearly all diagrams show that a fully agricultural landscape developed once more in and after the high medieval period. The exception is along the east side of Loch Lomond at Dubh Lochan where oak woodland remained uncleared, though heavily altered in structure as the woods subsequently became a source for the charcoal industry (Lindsay 1975). By the early modern period woodland must have been rare throughout the region, but survived when managed in some unlikely places: in Bearsden (Garscadden Wood), just outside Milngavie (Mugdock Wood), close to Hamilton at Cadzow, and along the gorges of the Clyde's middle reaches (Sansum, Stewart and Watson 2005).

Figure 9. The Kelvin Valley from Dullatur fort on the Antonine Wall: it is very likely that this landscape was as treeless in the second century AD, and as carefully organized as it is now.

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Geomorphological Change

We return finally to the physical appearance of the region, to the valleys of the interior rather than the coast. The floors of the major valleys are filled with alluvium (fig. 1), the most easily measured indicator of times in the past when slopes and rivers became unstable, and when there was accelerated landscape change. This type of landscape change is intimately bound up with archaeology because rivers may have eroded archaeological sites and alluvium may have buried them (Howard and Macklin 1999), and because alluvium can be a product of human actions, deliberate and unintentional (Brown 1997).

Alluvium can be derived from glacial melt water (principally gravel, marked as 'glaciofluvial deposits' on most up-to-date British Geological Survey Drift Geology maps), but in the Holocene sandy alluvium has been derived either by rivers reworking glaciofluvial gravel or by erosion of soils, sediments and bedrock from slopes above the valley floor. Alluvial fans act as connections between slopes and valley floors. Sediment supply to rivers has not been constant in the Holocene. It has occurred as quite discrete pulses (Johnstone, Macklin and Lewin 2006). These pulses of sediment accumulate in lakes and can form stratified 'layer cake' sediment sequences under floodplains, as along much of the River Kelvin (Tipping et al. 2008). More commonly in the region they form staircases of river terraces. Sediment is deposited on the valley floor as a floodplain, a process called 'aggradation', but before the next pulse of sediment the river cuts down or incises into its valley floor, leaving the floodplain high and dry as a terrace. In upper Clydesdale there can be three or more terraces preserved above the floodplains of several rivers. Through Glasgow terraces are poorly preserved, as much because of the narrow width of the Clyde Valley between glacial deposits (Menzies 1981) as through building disturbance. River terraces become estuarine mud west of Glasgow.

There is much debate as to what environmental factors triggered these pulses of slope and river instability. Probably the most important factor influencing erosion from slopes is the vegetation cover: whether wooded or open, whether extensively cleared or in small patches (which affects the length of slope able to be eroded), and whether the slope is grassed over or ploughed. Other major factors are climate change in determining, for example, the long-term frequency and intensity of precipitation (Macklin, Johnstone and Lewin 2005) or stresses placed on particular plant communities, and human beings in altering the vegetation cover and the responsiveness of slopes and soils to erosion (Foulds and Macklin 2006). Time may also be a factor because a slope can run out of sediment and soil to erode.

Slopes higher than 600m OD on hills ringing upper Clydesdale, and on Tinto in mid-Clydesdale, are mantled in stratified angular stones (Ragg and Bibby 1966), which can be moulded into 'terracettes', lobes of material that have slid down slope (Tivy 1962) and surficial stripes (Ballantyne 1993). These have formed at these high altitudes by frost action and probably also by flowing water. Ballantyne showed that stripes form at the present day, over single winters, but larger features may not form under present conditions. These coarse deposits can lead to stratified stony silts and sands on lower slopes, creating the smooth concave shapes of these hills. Elsewhere in southern Scotland these slope deposits are assumed to relate to the last glaciation (Harrison 1993) but they are undated. Excavations of Bronze Age unenclosed platform settlements dug into quite steep hillsides (Terry 1993, 1995) have shown hill wash to be common in and after the Bronze Age.

Sediment pulses can be defined by radiocarbon dating. The most recent review of data for Great Britain (Macklin et al. 2005) defined 16 such episodes, around 9200, 3800, 2900, 2500, 1600, 800, 600 and 300 BC, at the BC/AD boundary and AD 650, 1300 and 1400. The earliest episode in the region may have resulted in river incision (Tipping et al. 2008), creating the valleyside cliffs that also characterize the region (fig. 11). Macklin et al. (2005) argued that climatic changes have driven these pulses but all bar the earliest occurred after people became farmers. No river in Clydesdale provided data for the review of Macklin et al. and in general this burgeoning area of research has been largely neglected in Clydesdale despite its archaeological relevance and the responsiveness of the region's rivers to current climatic change (Black and Burns 2002). New data are emerging, however, and some old data can be re-examined (fig. 10), though patterns are currently hard to see.

The floodplain of the River Kelvin between Kilsyth and Kirkintilloch is underlain by 3–4m of Holocene alluvium, but none of it was deposited in any of the episodes defined for Great Britain as a whole by Macklin et al. (2005). The floodplain was formed between 9000 and 1000 BC, mostly before 4000 BC and before any major disturbance to the natural woodland. There is little evidence that periods of farming created slope or channel instability, even during Roman occupation when farming was very extensive. This is perplexing, because elsewhere in southern Scotland the late Iron Age and Roman Iron Age were periods of heightened geomorphic change (Tipping 1992; Tipping, Milburn and Halliday 1999), and because there is evidence from the sediments of Loch Lomond for large-scale sediment erosion around AD 150, near the peak in Romano-British agriculture. By this time Loch Lomond was a freshwater lake, its sediment coming from rivers like the Endrick.

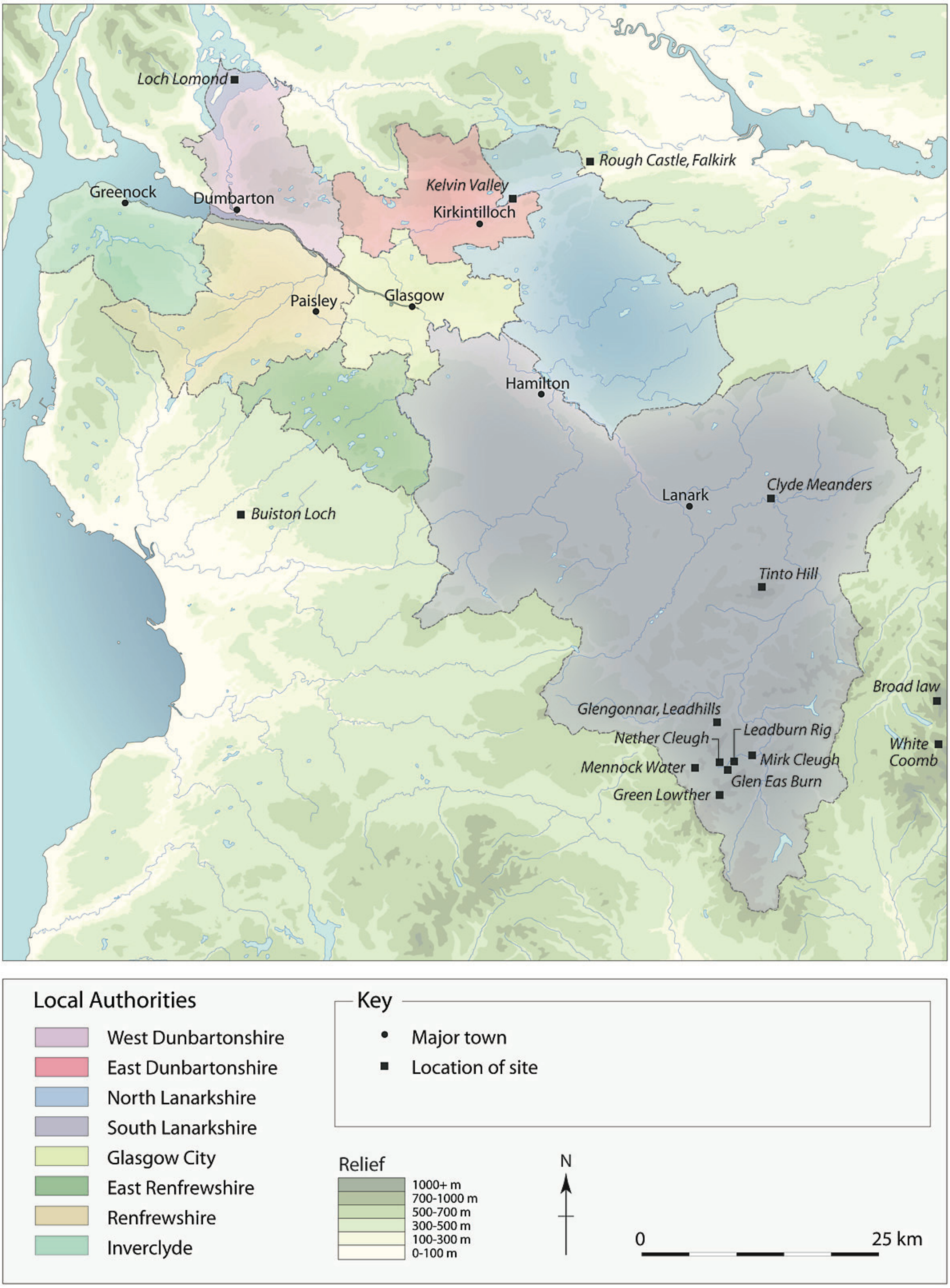

Figure 10. Localities in the region from which Holocene geomorphic change has been identified. The main data sources are: Broad Law: Ragg and Bibby (1966); Buiston Loch: Crone (2000); Clyde Meanders: Rowan, Black and Schell (1999), Rowan and Franks (2002); Glen Eas Burn: Chiverrell et al. (2007); Glengonnar, Leadhills: Rowan et al. (1995), Rowan and Franks (2002); Green Lowther: Ragg and Bibby (1966), Tivy (1962); Kelvin Valley: Tipping et al. (2008); Leadburn Rig: Chiverrell et al. (2007); Loch Lomond: Dickson et al. (1978); Mennock Water: Chapman and Leake (2005); Mirk Cleugh: Chiverrell et al. (2007); Nether Cleugh: Chiverrell et al. (2007); Rough Castle, Falkirk: Hamilton et al. (2002); Tinto Hill: Ragg and Bibby (1966), Ballantyne (1993); White Coomb: Ragg and Bibby (1966). © CSG CIC Glasgow Museums and Libraries Collections. Produced by the former GUARD (Glasgow University Archaeological Research Division), created by Ingrid Shearer (Northlight Heritage), based on information supplied by the author.

Radiocarbon-dated sediments formed less than 1800 years ago appear to be older because old organic matter in soils was flushed into the lake from this time (Edwards and Whittington 2001).

The lake sediments in the former Buiston Loch were similarly affected by this problem but here the in-washed organic matter occurred from 1300 BC (Tipping in Crone 2000). Substantial soil erosion within the Bronze Age has clear significance for how we view the 'small temporary' woodland clearances of this period: Bloak and Kennox mosses are only 8km from Buiston Loch (fig. 10).

Recent work in the Elvan Water (Chiverrell, Harvey and Foster 2007) has identified that several alluvial fans feeding sediment from slopes to rivers (fig. 10) have been active since later prehistory. Most are undated but one at Mirk Cleugh, close to Elvanfoot, was analysed by the author with Richard Chiverrell in preparation for this essay. The Elvan Water was most active in later prehistory, after 250 BC, and until AD 500, but the alluvial fan that has covered the riverine sediment probably formed in the medieval period from lead mining. In large part the Mirk Cleugh sequence fits the regional pattern with pulses of activity around 500–200 BC, within the mid to late Iron Age, AD 700–1200 and after 1500, which are also seen to be primarily caused by anthropogenic pressures.

Not all floodplains in the region are as old as that of the River Kelvin. The Glengonnar Water in the Lowther Hills (fig. 10) is downstream from the major lead- and gold-mining centres of Leadhills and Wanlockhead. John Rowan has shown that this upland floodplain cannot be more than a few centuries old because sediments stored in the floodplain are highly contaminated by lead (Rowan et al. 1995; Rowan and Franks 2002). The river seems to have flushed older sediments downstream. Chapman and Leake (2005) found comparable fluvial instability from past alluvial gold panning in the Mennock Water. Rowan, Black and Schell (1999; Rowan and Franks 2002) traced the geochemical signature of lead mining down the River Clyde to sediments in abandoned channels of the actively migrating Clyde meanders (Brazier, Kirkbride and Werritty 1993) but found the downstream impact of mining was minimal. Most sediment in the last 500 years seems to have been generated by intensive agriculture or through climatic change. Foster et al. (2008), working on lake sediments in Moffatdale, just south of Clydesdale, found that the period between AD 1600 and 1870 was one of increased sediment supply from higher numbers of floods in the 'little ice age', but in the last 130 or so years there have been more stable slopes and valley floors, in support of work on the River Tweed by Walling et al. (2003).

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Figure 11. Mirk Cleugh near Elvanfoot, an alluvial fan truncated by the current Elvan Water flowing at its foot, which has exposed a stratified sequence of old river sediments buried by gravels and sands that cascaded down Mirk Cleugh.

Integration

We cannot yet write an environmental history of Clydesdale. We cannot describe in their entirety, and in some periods in any detail, the changes wrought by people. The impact hunter-gatherers made has not been explored in the region, and yet the finds at Daer are among the most extraordinary in the country: they are from such an early period, at such a high altitude and probably in an environment nothing like the woods that later developed. Were these hunters closer to those of the Late Palaeolithic than the Mesolithic? The almost total absence of environmental evidence for early farming communities is disturbing when western Scotland and the Irish Sea is proving so central to exciting new interpretations (Schulting 2004; Sheridan 2007). When monumentality is as stunningly exemplified as at Blackshouse Burn it is deeply frustrating that pollen analyses from a bog almost inside that huge enclosure are only known in outline form: old pollen samples can be reanalysed.

From the Bronze Age we begin to be able to tell stories. Farmers moved into the climatically harsher hills not in some ‘golden age’ (Terry 1995) but at a time of climatic deterioration (Tipping 2002). Why did they do this? Were agricultural techniques so adaptable by then, perhaps deliberately non-specialist, that the same economy could be practiced in upland and lowland (Tipping 2005a)? Were there no core areas? Do the frequent and rapid climatic shifts newly described for the region (fig. 4) lie behind the baffling patterns of short-lived land claim and abandonment seen in pollen diagrams? Where did farmers go when they left an area? Judith Turner asked this 30 years ago and the question has not been resolved. How large were these woodland clearances? What did farmers do in them? Were the clearings large enough to promote soil erosion, as hinted at around Buiston? How culpable were farmers in land degradation? Were they hapless onlookers as an unpredictable climate washed their soils away? There is a small corpus of work now about the hills south of Crawford, enough to build on, but archaeological work needs to be driven by research rather than rescue, the work has to be fully integrated from project design to fruition, and the questions need to be clever ones. Most are to do with the changing geography of the Bronze Age – can we map this, following farming communities generation by generation in one valley?

It is likely that environmental interpretations for the middle to late Iron Age have developed faster than archaeological ideas. One reason why Lisa Dumayne-Peaty sought a Roman origin for the extraordinarily extensive woodland clearances we see was the apparent absence of an Iron Age archaeology that could account for them. This is still the case, with highly industrious farmers in a nearly invisible archaeological landscape. If this thriving economy was propelled by the native population what role did Roman occupiers play? Were parts of the region economically disadvantaged? Again we have not been able to make a geography on this period. We continue to describe clearances as extensive without attempting to quantify this (Tipping and Tisdall 2005).

Dark Age population collapse continues to be of more interest to palaeoecologists (Turner 1983; Ramsay and Dickson 1997) than to archaeologists and historians (Ralston and Armit 1997; Alcock 2003) in explaining the apparent regeneration of woodland and loss of farmed land. This difference in interpretation is again of interest, particularly as the archival record emerges to flesh out our understanding of the landscape. It may be that palaeoecologists are misinterpreting their records. Much of the expansion of woodland is from trees that may have colonized not farmland but the edges of the raised mires so relied upon in the region by pollen analysts. It is possible that we are confusing land abandonment with land management and the need to conserve and protect woods. As the archival record from the medieval period begins to show us the variety and complexity of ways people worked on and with the land, palaeoecologists seem to lose confidence in their techniques. Few have tried to work with the spatial precision and temporal resolution needed to satisfy the historian (Tipping 2005b) but it is important that we try because economic and social histories are not environmental histories, and our relation with the environment is the most critical problem that humanity faces in the coming century.

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Abbreviations

Proc. Soc. Antiq. Scot. = *Proceedings of the Society of Antiquaries of Scotland*
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Further Reading

General introduction

There is no modern synthesis for the general reader of Holocene environmental change in Clydesdale in particular.

- *Scotland After the Ice Age: Environment, Archaeology and History, 8000 BC–AD 1000* by Kevin Edwards and Ian Ralston (2003, Edinburgh University Press) is a good general introduction, probably at undergraduate level, with chapters on Holocene climate change, geomorphological change, soils, vegetation and faunal changes. These are illustrative rather than comprehensive. The book then has chapters on all archaeological periods to the medieval, but the links between environment and archaeology are not fully considered.

Climate change

The importance of future climate change has led to many popular books introducing the science.

- *The Two-Mile Time Machine: Ice Cores, Abrupt Climate Change, and our Future* by RB Alley (2000, Oxford, Princeton University Press) and *The Ice Chronicles* by PA Mayewski and F White (2002, London, University Press of New England) give a hands-on feel for the subject by two of the leading exponents.
- *The Weather Makers: The History and Future Impact of Climate Change* by T Flannery (2005, London, Allen Lane) is a superb discussion of the evidence, the consequences and what we can do.
- *Land of Mountain and Flood: The Geology and Landforms of Scotland* by A McKirdy, JE Gordon and R Crofts (2007, Edinburgh, Birlinn) is a superbly illustrated general account of the geology and landforms of Scotland which illustrates the sorts of geomorphic change we see, but without the level of analysis presented in this chapter.
- *Glasgow and Ayrshire: A Landscape Fashioned by Geology* by Colin MacFadyen and John Gordon (2006, Edinburgh, Scottish Natural Heritage), is an attractive, low-priced introduction.
- Scotland's Beginnings: *Scotland Through Time* by Michael Taylor and Andrew Kitchener (2007, Edinburgh, National Museums Scotland) is a low-priced, well-illustrated and very informative introduction which highlights ecological as well as geological change.