THE SEVENTEENTH HERMANN PÁLSSON LECTURE (2021)

The Climatic Motive for Leaving Scotland, c.1770-c.1890

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SCOTLAND CONTRIBUTED in significant per capita numbers to the estimated 55 million European migrants during the period 1815–1914 who were compelled to tramp land and cross ocean to reach the New World. Driven chiefly by economic dislocation, food and resource shortage and the prospects offered from a life lived elsewhere, the structural underpinnings to this resettlement had origins common across territories. Of the two million people from Scotland who swelled this flow, the motivation was similar but not simply the consequence of panicked flight.[1] Given the high proportion of Scotland's natural population growth that left each year between 1861 and 1930 – an average 44% per decade – the range of people who headed south to England's towns and countryside, or arrived at the docks in Greenock to begin the most significant leg of their departure overseas, must have held occupations, and been in possession of skills and professional training, beyond the confines of agricultural labourers, the unskilled, unemployed or unemployable classes. Many if not all of those settler migrants had judged the prospects of staying within Scotland to be limited, as persistent hunger, land insecurity, underemployment and overcrowded unhealthy towns, left few opportunities for future comfort in a mature economy and society.[2] Every adult migrant had made a decision that was personal and contingent on local circumstances and resources, although discernible economic and demographic factors gave shape to this movement. My focus is on one factor that was universal but specific, and which impacted upon Scots universally and specifically: the nation's climate. Sometimes with direct causal effect, sometimes with delayed impact, the changing climate informed the decision-making process. To illustrate part of

1 Akenson 2013, 23; Baines 1985, 58–65; Carrier and Jeffery 1953, 14, 20; Devine 2011, 85–90.
2 Bueltmann and Morton 2019, 209–243; Bueltmann, Hinson and Morton 2013, 37–55, 65.

a wider argument on the ways in which climate change has shaped Scotland's history of emigration, I link contemporary debate on the association between seasonality and ill health with coterminous exhortations to emigrants of the health affirming climate found in North America and the Antipodes.[3]

Cold weather is associated with increased mortality, and extreme temperatures and temperature shocks are linked with both raised mortality and lowered life expectancy.[4] Statistical evidence points to populations moving away from cold regions inimical to health.[5] Since the start of the twentieth century, the effects of climate change have been observed most directly through the frequency and escalation of weather events.[6] Rising sea levels, coastal erosion, and amplified wind speed have been logged along with their attendant impact on agricultural output and patterns of wildlife migration, breeding and feeding. Climatic causes have been attributed to short and cyclical periods of food shortage, famine and near famine, social dissonance and direct disorder, planned seasonal and temporary migration and – as seen especially in parts of Africa and the Global South – unplanned flight, forced homelessness and statelessness.[7] In Scotland, the 'ill years' of the mid 1690s and the Highland destitution of 1837 and the 1840s are all associated with climate induced migration.[8] Hosted by the city of Glasgow in 2021, debate on climate change at COP 26 was framed by the impact a global temperature rise of 2°C above pre-industrial levels would have on the incidence and effects of climate events. The people of Scotland are now experiencing more sunshine, more wind, and more rain than their forebears did in the twentieth century.[9]

Moderate population growth

The willingness of Scotland's people to emigrate has produced long-term demographic consequences. Under cloud filled skies, Scotland's population grew more slowly than did England's. From an estimated 1.27m in 1755 to 1.6m in 1801 – an increase of 25% – the nation lagged behind the population growth of England where the 6.1m people recorded at the mid-point of the eighteenth century rose to 8.9m by the start of the nineteenth century, an

3 Morton 2021.
4 Deschênes and Moretti 2009, 664–5, 674–677.
5 Ibid., 677–9.
6 Methmann and Oels 2015, 51–6; Black, Bennett, Thomas et al., 2011, 447–449.
7 Foresight 2011, 43–65.
8 Cullen, Whatley, Young 2006, 269–270; MacAskill 2013, 95–97; Whatley 2012, 8; PP, *Select Committee on Emigration* 1841, 59, 69–71, 83–5, 163–4, 176–181.
9 Scotland's Environment 2021.

increase of 45%.[10] These rates of growth have varied each decade (Table 1), but the disparity has persisted: over the century and half from 1851 to 2011, intercensal rates of increase show England's population grew by around 216%, whereas Scotland's grew by only 83%.[11]

		England	Scotland
1851	1861	12.0	6.0
1861	1871	13.5	9.7
1871	1881	14.6	11.2
1881	1891	11.6	7.8
1891	1901	12.1	11.1
1901	1911	10.3	6.5
1911	1921	4.7	2.5
1921	1931	6.0	-0.8

Table 1: Intercensal population percentage change, England and Scotland, 1851-1931

Differences in the crude death and crude birth rates are negligible until the first two decades of the twentieth century, with the unadjusted natural increase in England and Scotland showing little difference (Table 2). Evidence arranged by Anderson and Morse demonstrates that fertility was higher in Scotland than in England, but nuptiality was generally lower, with Scots having children in the early years of marriage before stopping earlier.[12] Scotland's level of net migration per 1,000 people was, by contrast, not less than two and half times that of England.[13]

	% Population change		CBR		CDR		Net out-migration per 1000		Gross emigration per 1000	
	E&W	Scot	E&W	Scot	E&W	Scot	E&W	Scot	E&W	Scot
1861-70	13.2	9.7	35.2	35	22.5	22.1	1.0	3.9	2.8	4.6
1871-80	14.4	11.2	35.4	34.8	21.4	21.6	0.7	2.8	4	4.7
1881-90	11.7	7.8	32.5	32.3	19.2	19.2	2.3	5.8	5.6	7.1
1891-00	12.2	11.1	29.9	30.2	18.2	18.5	0.2	1.3	3.6	4.4
1901-10	10.9	6.5	27.3	28.4	15.4	16.6	1.5	5.7	5.5	9.9
1911-20	4.9	2.6	22.7	24	14.6	15.3	1.7	3.5	4	7.3

Table 2: Percentage population change, Crude Birth Rate (CBR) and Crude Death Rate (CDR), Net migration and Gross Emigration, England and Wales, and Scotland, 1861-1920[14]

10 Anderson 2018, 10–11.
11 Ibid.
12 Anderson and Morse 1993, 9.
13 Anderson 2018, 119.
14 Anderson and Morse 1993, 8 (table 3).

These migrant flows fluctuated yearly as they did each decade, but again the trend is unyielding. Between 1825 and 1850 an estimated 10,000 Scots emigrated each year, rising to around 25,000 per annum mid-century through to 1875. The 1850s and 1880s were heavy years of overseas migration while the first two decades of the twentieth century saw historically high levels of migration to England.[15] Between 1853 and 1930, when Scotland was home to between 13.7% and 10.9% of Britain's population, a disproportionately high 19% of British emigrants came from north of the border.[16]

Demographic pressures give clues to the willingness to emigrate. Despite low nuptiality in most regions of the country, the persistence of high marital fertility resulted in an excess of young adults unable to be absorbed even in Scotland's growing economy. Anderson estimates that, in the absence of emigration, an excess of 190,000 males aged 20 to 29 would have been hunting for jobs in 1891, even after the death and retirement of male workers is factored in. To find employment for this 20–29 cohort, occupational growth in the region of 22% would be required.[17] Yet the widespread but lower growth of jobs that did occur was insufficient and neither frictionless nor sufficiently flexible to prevent broken time or unemployment. The underemployed and the 'redundant classes', for whom emigration held most potential, would have found their labour market opportunities worsened had their peers not taken their leave of the nation.

Looking back with frustration, Willie Ross, Secretary of State for Scotland in 1966, blamed a lack of jobs and houses when addressing the General Assembly of the Church of Scotland on the long standing causes of emigration.[18] The structural underpinnings to emigration are both overlapping and cumulative, with few examples of direct causality other than short-lived access to indenture, assisted migration, the attraction of newly opened gold fields or imperially-directed employment schemes such as that established in 1870 by the Colonial Treasurer in New Zealand, Julius Vogel. Two-thirds of Scotland's counties lost population to out-migration between 1861 and 1911, and after 1860 the bulk of those who left for overseas came from the towns and cities.[19] In part this was a consequence of internal movement from the rural areas to the towns and, while the proportion of incomers in the urban regions remained constant between 1851 and 1891, these arrivals were more than matched by outward migration. Gray has argued that by the 1870s the overly

15 Baines 1985, 10, 61; Anderson, 2018, 115; Bueltmann, Hinson, Morton 2013, 67–8.
16 Baines 1985, 60.
17 Anderson 2018, 161.
18 Ross 1966.
19 Anderson and Morse 1993, 16; Devine 2004, 88.

simplistic model of 'troubled agriculturalists seeking cheap and plentiful land in the New World' was increasingly inapplicable. Glasgow's census for 1871 recorded that a quarter of its 477,156 residents who were Scottish-born came from outside of Lanarkshire and Renfrewshire. In 1871, within the four nations of the British Isles, those who were Scots-born comprised the highest percentage of people enumerated in a county different from where they were born.[20] A decade later, only 48% of Perth's population was native to the county, for Greenock it was 50%, Edinburgh and Leith 50.8%, Glasgow 51.3%, and Dundee 55.1%. In London, the great metropolis, it was 62.9%.[21] These returns are indicative of relentless flows of people making short and longer movements across Scotland. This included migration from and between urban areas, with the western Lowlands, the most populous part of the nation, recording net outmigration during the 1880s and 1890s. As well as the attraction of the English labour market, transatlantic seasonal work meant skilled craft and industrial workers left for the growing towns and cities of North America as they trailed British capital investment overseas.[22]

In the mix of overlapping and cumulative elements to the migration decision, to what extent was climate a push factor for urban migrants, as it is often adduced for those who scratched a living within the challenging environment of the north-west Highlands and Islands? Scotland's climate is more extreme than England's and is the coldest of the four nations. Edinburgh is four degrees latitude north of London, and in 1820 was on average four degrees cooler. The Scottish capital's latitude is 2.5°N of Dublin and was, on average, nearly three degrees cooler.[23] Sir David Brewster reported these data for his comparison of calculated and observed estimates of mean temperature across the world. Both calculations showed difference within this relatively compact island archipelago, and Scotland's position as the coldest part of Britain is further confirmed in more detailed comparisons of Edinburgh, Perthshire and the Central England Temperature (CET) series. The latter is an amalgam of several data runs, and contains observations from London, Oxford and Lancashire, as well as including the Edinburgh data.[24] During the period 1780 to 1801, the CET returned a yearly average of 48.4°F, whereas Edinburgh (Figure 1) reported 47.1°F, and diary evidence compiled by Margaret McKenzie for Delvine in Perthshire observed an average of only 46.0°F.[25]

20 Ravenstein 1876, 203.
21 Ravenstein 1885, 175.
22 Gray 1990, 35–7.
23 Brewster 1823 [1828], 200–225.
24 Manley 1953, 242–261.
25 Wheeler, 1994, 177–182.

Scattered throughout both Scotland and England there are ecclesiastical records and extant diaries from the seventeenth century that provide insight into regional climate variation and adaptation.[26] For Edinburgh, beginning in 1764, we have Scotland's longest single run of temperature data, albeit augmented by observations for Dunfermline between 1805 and 1820. Over the period to 1896, the mean annual temperature in the city was 46.8°F.[27] There were two years, 1816 and 1879, in which the temperature was below average in every month. During the 1878/9 winter, snow fell as early as 30 October and as late as 1 May. These years were particularly bad for agriculture, and the price of oats was high (with 1816 producing the second dearest market price between 1795 and 1850).[28] The coldest decades (Figure 2) were 1811–20 (46.1°F) and 1764–70 (46.2°F); whereas the warmest spans were 1841–50 (47.3°F) and 1891–96 (47.4°F).[29]

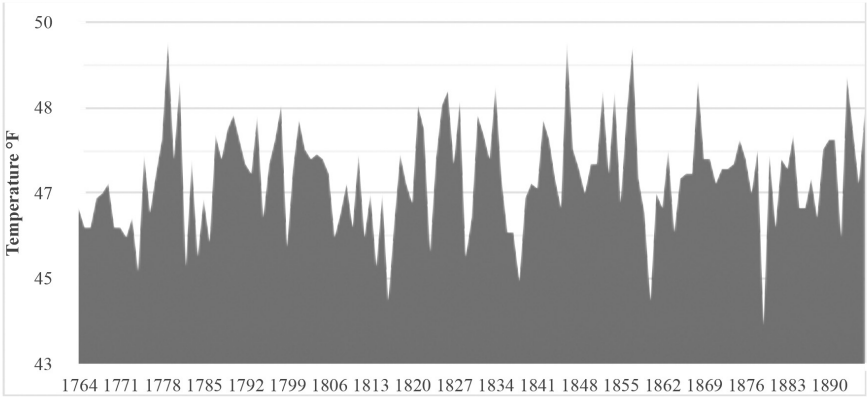

Figure 1: Annual mean temperature for Edinburgh, 1746-1896

External events have caused significant disruption to Scotland's climate, bringing agricultural, economic and health challenges in their wake. The major volcanic eruptions in Iceland during 1783 to 1784 led to the coldest annual temperature being recorded in Perthshire.[30] Turbulent weather followed the volcanic eruptions of Tambora (1815) and Krakatoa (1883), the

26 MacDonald 2013, 487–509.
27 Mossman 1897, 116–118.
28 Forbes 1861, 321–4.
29 Mossman 1897, 116–120.
30 Wheeler 1994, 178–9.

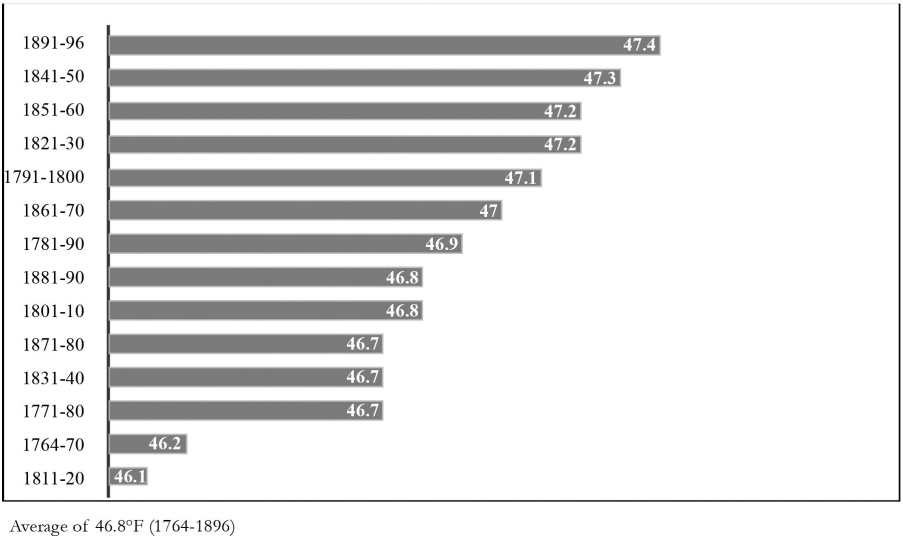

Figure 2: Rank of average decadal temperatures in Scotland

latter heralding a particularly bad winter, cooler summers and strong winds throughout 1884–5. The year 1816 stands out in any survey of the nation's weather as the effects of the volcanic ash were felt over the next two years. The winter of 1815/16 was one of the severest, the twelve months of 1816 returned the second greatest deviation from the annual temperature mean for the century, and the fourth highest incidence of days with snow over the period 1770–1896. High-magnitude volcanism contributed to changes in prevailing wind directions across central Scotland, and also a spell of frequent gales: 67 (1816), 56 (1817) and 72 (1818) when the norm between 1770 and 1896 was for thirty gale days per year.[31]

Weather events led to economic, material and physical loss. The Scotland-wide storm of 12–16 January 1818 shook buildings in Edinburgh and uprooted trees close to Gordon Castle in Moray. Efforts made to build protection for the harbour at Wick were undone by a storm in 1827 which took a good portion of the sea wall away.[32] In Moray, the storm of 3–4 August 1829 which broke open the harbour of Garmouth also led to areas of Elgin being washed away. Heavy rain fell in Huntly and life was lost in wrecked ships, with rainwater flowing down the Cairngorms towards Speyside and south

31 Mossman 1897, 167–8, 173–5; Dawson et al, 1997, 339–341.
32 Stevenson 1874, 131.

towards Donside and Deeside.[33] Various buildings and up to nine bridges were destroyed, the impact worsened by the suddenness of the downpours after a period of drought in May and June. The return of stormy weather on 27 August led to more damage with bridges, mills and housing being affected.[34] The storm over the Hebrides in 1839 – the result of one of the deepest ever depressions, with signs of tornado and whirlwinds – resulted in ships at harbour and at sea being wrecked. An estimated four hundred people died across the British Isles from this storm. Winds of around 75–90 knots were experienced in Scotland, and in London the wind was described as a 'violent hurricane', whereas the greatest human and financial loss was in Liverpool.[35] The 1840s also began with storms and hurricane-strength winds, with strong winds recorded in the south-west of the country in 1844, and the effects of a severe south-westerly gale were disruptive to the citizens of Edinburgh in January 1845.[36] Yet it was the warmth of 1846 that triggered a crisis. The cool of the 1845 summer was followed by a mild winter and warm months for the rest of 1846, achieving the warmest British summer that century (49.6°F).[37] This provided the conditions conducive to the potato blight which resulted in perhaps the best-known landlord assisted emigration scheme in Scottish history, but there were others before and after. The tipping point in favour of emigration from parts of Sutherland followed the harsh winter of 1771–2, and again in 1781 after an unseasonably cold summer with little rain but early snow.[38] The food shortages experienced across the Highland and Islands during 1837 came after persistently low crop yields collapsed to perilous levels following the cold spring of 1835, two harsh winters in 1836 and 1837, and then a wet summer, with the resulting hardship reported directly to the 1841 Select Committee on Emigration.[39] Here is evidence of a compelling link between adverse climate events and emigration, with such experiences returning in the late 1880s when the people of Lewis were metaphorically and in some cases literally washed away by unseasonably rough seas that hampered the fishing trade, and heavy rain along with temperature extremes that weakened agricultural yield.[40]

33 Dawson 2009, 157, 161.
34 Lamb 2005, 116, 124–6.
35 Ibid., 131–3.
36 Mossman 1897, 104.
37 Lamb 1988, 168–172.
38 *Scots Magazine* 1774, 221; *Scots Magazine*, 1782, 612.
39 PP, *Select Committee on Emigration* 1841, 5, 14–17, 48–9, 66–70.
40 PP, *Condition of the Cottar Population* 1888, 7; PP, *Population of the Western Highlands and Islands* 1890, 9–10.

Environmental determinism

There is more than temporal overlap in the intellectual development of the new discipline of meteorology and the opening up of the settler colonies in North America and the Antipodes. The work of Sir John Sinclair posited an early comparison of cultivable soil in Scotland and Canada before meteorologists such as David Brewster and James D Forbes followed his lead in testing the climatic advantage of clearing land to expose the soil to solar light with the aim of reducing moisture levels.[41] More generally, the salubriousness of colonial destinations was promoted alongside agricultural advantage and the ease of building property without consideration of damp.[42] With connections made to the public health movement that gained prominence after the intervention of Chadwick (1842) and the public health legislation of 1848 (England) and 1867 (Scotland), meteorologists presented a climatic rationale for leaving the environmentally disadvantaged rural areas and the health-weakening towns and cities.[43] Yet persistent opposition to rewarding 'failure' led political economists to question the deployment of colonisation schemes to fund emigration. Malthus also warned of a vacuum effect which might make any policy of emigration futile. The remaining economic resource, he theorised, would attract internal migration and support an attendant rise in the birth rate, returning climate challenged regions once again to unsustainable population levels.[44]

In many of the reports submitted to the Old Statistical Account of 1791–9 – upon which Malthus relied for his analysis – population growth was ascribed to periods of climate advantage, along with early marriage and land subdivision.[45] Those who undertook the parish report for the New Statistical Account of 1834–45, were instructed to report on climate change, the state of agriculture, the supply of food, and the health of the population.[46] In the hands of ministers with a scientific interest, such as Rev Charles Clouston in Sandwick in the Orkney Islands, reports were now imbued with the methodologies of the meteorological committee of the Royal Society of Edinburgh (RSE), which had formed in 1820. Instrument readings were taken, and links drawn between rain, wind, frost and illness in county and town alike. Tabular data was presented by some and all provided descriptive

41 Although not all agreed that the practice was effective: Anon 1829, 524.
42 Inches 1836, 102.
43 Chadwick 1842 [1965], 29–43; Hanley 2002, 23–25.
44 Malthus presented his arguments as an expert witness, as reported in PP *Select Committee on Emigration 1827*, 311–27; Richards 2013, 43.
45 For example, Kilmuir, Inverness 1845, 270.
46 Malthus 1803, Book II, chapter X.

observations. The soil and climate in Eaglesham, County of Renfrew, for example, was a case 'equal to any county for salubrity, fertility and health', yet in wet years, with near 762mm of rain falling in 1845, the same climate and soil was attributed to a rising incidence of 'influenza, rheumatism and consumption'.[47] In Stirling, the humidity and heavy soil had contributed to catarrh, sore throats and influenza; and in Eccles, near Berwick, the long period of wet weather in 1830 was remembered for contributing to a rise in several acute diseases.[48]

The Scottish Meteorological Society (SMS), formed in 1855, built on the climate research conducted by the RSE and the Statistical Accounts 'to ascertain the leading features of the Climate of different Districts, into which Scotland may be divided', to 'inform on agriculture and horticulture' and on 'public health, notably the appearance and spread of epidemics'.[49] SMS council member James Stark, the first statistician of the newly created General Register Office for Scotland (GROS), had earlier observed the effect of seasons on levels of mortality in Scotland's towns. He discovered that when the east and north-east winds blew over Edinburgh, Leith and Glasgow in November and December it worsened mortality levels to an extent greater than the coldest season of January through to March.[50] Stark found the incidence and spread of epidemics was always more likely to occur when the temperature was cold (Table 3), unlike the colonial experience of South-East Asia, the West Indies and Southern Africa, where reports confirmed British soldiers endured greater illness in times of heat.[51] When Stark's work was developed by Dr Alexander Buchan and Sir Arthur Mitchell of the SMS, it was learned that the death rate of those aged over 80 peaked in the coldest weather whereas, for those aged over 40 and over 60, levels of mortality reached their high at the onset of winter. The age groups whose health was least susceptible to weekly variation in climate were those aged 5–20.[52]

47 Eaglesham, County of Renfrew 1845, 384.
48 Stirling 1845, 394; Eccles, County of Berwick 1845, 51.
49 'Forms part of *Laws and regulations of the Scottish Meteorological Society* 1858.
50 Stark 1851, 83.
51 PP, *First Detailed Annual Report* 1861, liv.
52 Buchan and Mitchell 1875, 230.

Months	Mean temp. (˚F)	Deaths*	Percentage**
Jan	36	5,621	9.16
Feb	27	7,747	12.62
Mar	36	6,310	10.29
Apr	44	5,324	8.68
May	44	5,203	8.48
Jun	55	4,624	7.54
Jul	60	4,330	7.06
Aug	57	4,313	7.03
Sep	52	4,037	6.58
Oct	44	4,225	6.89
Nov	40	4,374	7.13
Dec	35	5,238	8.54
1855	44	61,346	100

Table 3: Influence of temperature on mortality in Scotland, 1855[53]

Scotland			Insular Districts			Mainland Rural Districts			Town Districts		
Male	Female	Both	Male	Female	Both	Male	Female	Both	Male	Female	Both
22.45	20.48	21.36	17.05	15.39	16.15	18.86	17.80	18.19	29.16	25.47	27.06

Table 4: Deaths per thousand of the population in Scotland, 1855-1864[54]

Of the towns, Greenock had the highest death rate during the first decade in which these data were collected by the GROS (1855–1864), at 32.2 deaths per thousand. Glasgow returned 30.1, Dundee 27.8 and Leith at 22.9. Aberdeen was the heathiest city at 22.45 deaths per thousand, but this return was still worse than the Scottish average of 21.36, the average for the insular districts (16.15) and the mainland rural districts (18.19). Overall, death rates in the towns were one-third higher than in the rural districts, and always greater for men (Table 4).[55] These results contextualise two known aspects of Scotland's migration history after mid-century: that emigrants were more likely to be

53 PP, *First Detailed Annual Report* 1861, liv. *Corrected Deaths, each month reduced to 30 days; ** Percentage to the total corrected deaths.
54 PP, *Tenth Detailed Annual Report* 1867. Adapted from table XXII.
55 Ibid., xxix.

male, whereas internal migrants were more likely to be female, and that emigrants came predominantly from the towns.[56]

When reflecting upon his three decades of work, George Symons, creator of the British Rainfall Survey in 1860, claimed there was now no doubting a causal relationship between meteorology and public health.[57] Were the Scottish towns particularly unhealthy? Certainly, the English towns and cities had inadequate, dilapidated and slum housing to match those north of the border. The growth of back-to-back housing in England throughout the late eighteenth century was sufficiently common by the 1830s and 1840s to exacerbate levels of housing density; and where there was overcrowding then a correlation with the incidence of disease was adduced.[58] The average number of people per house in Glasgow increased from 3.82 in 1801 to peak at 5.85 in 1811 followed by a period of improvement until 1841 when the figure rose to 5.23. Sharing rooms as well as beds was commonplace. Scottish urban dwellers had fewer rooms to live in than those of equivalent class in England. Analysis of the Board of Trade data on overcrowding across the British Isles, compiled in 1904, confirms Scotland as the British outlier (Table 5). Not the poorest but comprising the artisan classes, still Gazeley et al suggest those captured in this survey were more likely to prioritise spending on food over accommodation. Despite their average or better income, the majority were confined to one- and two-roomed properties.[59]

Number of Rooms per Household	Scotland (%)	Rest of Britain and Ireland (%)
1	2	4
2	53	6
3	30	9
4	9	21
5	2	22
6	4	28
7+	1	10

Table 5: Number of rooms per household (1904)

56 Ravenstein 1885, 196–7; Devine 2004, 88.
57 Symons 1892, 151.
58 Flinn in his introduction to Chadwick, 1842 [1965], 6–8, and in Chadwick's *Report*, 196–9, 243–4.
59 Gazeley, Newell, Scott 2011, derived from Table 6, 135.

Within this reduced living space, infant mortality was the most significant factor reducing levels of life expectancy. The birth weight of babies born to women in Scotland's cities was lower than those born to mothers who lived in the Borders, Highlands or the smaller Lowland towns.[60] Once grown, the greater height of adults born and raised in rural Scotland confirmed evidence from contemporary dietary surveys that suggested access to nourishment was more advanced in the rural areas.[61] The social reformer Mary Lily Walker (1863–1913) was 'heartbroken' at the high rate of infant mortality in Dundee, ascribing it to the widespread employment of mothers in the city's jute industry. The inadequacy of postnatal care in the first few weeks after birth was further hindered by inadequate rest and little nutritious food.[62] Walker correlated rates of infant mortality with number of rooms, showing the rate was progressively worse for those living in less than three rooms. Even when two rooms were available, the family tended to use one room as a scullery and one room to live in.[63] The death rate for those living in a one-roomed property in Dundee was around twice that of those living with four rooms and more, and nearly four times greater when considering only those under the age of five. The average age of death was almost halved among those who lived in the one-roomed properties of the city.[64]

The consequences of overcrowding for the health of the people in the towns and cities was not just an issue of germ transfer. Cheek-by-jowl living impacted on air quality, and both issues were influenced by climatic settings. Stark highlighted the 'biting' east and north-east winds that increased mortality levels in Edinburgh and Leith, yet acknowledged that 'keen air' and constant breezes into both towns was beneficial for respiratory health and the avoidance of consumption.[65] The incidence of croup was most often found in towns closer to sea level: Glasgow, Greenock, Dundee and Perth.[66] The number of microorganisms in the atmosphere was also related to the urban and climatic context. Thomas Carnelley, who held a chair of chemistry at the universities of both Dundee and Aberdeen, collaborated with Dundee's Medical Officer of Health to measure the amount of carbonic acid, organic matter, and microorganisms in the air of different classes of house and school rooms.[67] The centres of Dundee and Perth were found to be the

60 Ward 1993, 44.
61 Graves 2018, 3.
62 Walker 1910, 34–5.
63 Ibid., 37.
64 Carnelley. Haldane, Anderson 1887, 71–3.
65 Stark 1851, 86–7.
66 Ibid., 87.
67 H E R and P P B. 1890, 522.

unhealthiest locations, being where the disturbance of dust occasioned by wind and the movement of people led to the greatest concentration of airborne microorganisms.[68] Carnelley's conclusions advanced the need for 'pure aërial food for the scholars' of the city.[69]

Increased incidence of illness came with rain and with damp (Table 6).[70] Precipitation levels were oftentimes remarkably different north and south of the border, with for example 980mm of rain falling in Scotland in 1864 and only 424mm in England. The correlation between daily deaths, cold and dampness was postulated in Stark's analysis, with the appearance of frost increasing the mean death rate despite later hours of sunshine benefiting the overall temperature of the day. While he would not use the data to identify the rise and fall of fever as an epidemic, he maintained 'the weather followed the same law to which we have seen all diseases are subject, viz that it was most fatal during the coldest months, least fatal during the warmer, and in its fatality strictly followed the law of mean temperature', as Table 6, for the eight principal towns of Scotland, shows.[71] Given the climatic challenge facing rural Scotland, the western Highlands and Islands especially, this evidence suggests that any attempt to escape such hardship by relocating to the town was simply an act of clustering anew in areas where mortality rates were highest, and of joining others who themselves had a compelling reason to follow the chain of migration overseas.

1864	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean Temp (°F)	36.8	33.8	37.9	47.1	51.4	54.2	57.5	55.4	52.9	46.2	41.4	40.2
Rainfall (in.)	3.13	4.85	4.54	1.89	1.60	2.64	2.56	1.52	4.51	4.17	3.98	3.42
Westerly winds (no. of days)	14	12	14	12	14	18	17	17	20	8	11	13
Easterly winds (no. of days)	7	8	11	9	11	4	6	5	3	15	10	10
Total Deaths	3151	2830	2915	2455	2233	2235	2107	2219	1966	2052	2254	2411
Daily Deaths	102	98	94	82	72	74	68	72	66	68	75	78

68 Carnelley, Haldane, and Anderson 1887, 61–111.
69 H E R and P P B. 1890, 523.
70 PP, *Seventh Detailed Annual Report* 1865, lvi.
71 PP, *Tenth Detailed Annual Report* 1867, lv. The towns are: Glasgow, Edinburgh, Aberdeen, Dundee, Paisley, Greenock, Leith, and Perth.

Causes of Death												
Zymotic Diseases	847	771	764	602	545	533	560	611	632	615	761	756
Smallpox	98	112	92	72	62	61	51	26	42	30	18	15
Measles	32	27	44	36	27	36	45	48	43	56	107	102
Scarlatina	206	133	82	63	55	74	73	93	125	168	174	153
Diphtheria	48	50	39	25	19	19	14	26	28	20	25	30
Whooping-Cough	138	110	158	138	121	89	82	97	81	59	88	89
Croup	54	41	48	30	30	30	35	35	32	42	33	47
Typhus	183	206	224	182	159	152	153	150	155	162	233	244
Diarrhoea, Dysentery, Cholera	41	35	35	26	36	48	85	111	102	48	29	31
Consumption	331	345	385	318	308	280	266	280	222	198	209	222
Respiratory Organs	705	554	552	435	358	332	264	246	213	317	374	402
Heart Disease	109	124	107	107	83	102	80	67	65	70	82	92
Brain Disease	194	150	202	191	177	169	165	158	143	154	135	177
Age	210	144	170	112	92	109	85	90	74	92	108	126

Table 6: Showing the connection between climatic change and death from certain conditions in the eight principal towns of Scotland.[72]

The pull from agents and 'boosters'

The potential health benefits derived from emigration to more salubrious climates featured in evidence submitted to government inquiries.[73] This content was at times impressionistic, but noticeably progressed in step with attempts to discern 'laws of association' between meteorology and the incidence of illness and mortality, taking analysis beyond the kind of health tourism prominent in earlier decades. The examples of Walter Scott, Thomas Ruskin, Charles Darwin and Karl Marx are indicative of those who sojourned in a Mediterranean climate or sampled the spa waters of Austria and Italy to alleviate illness thought to be exacerbated by the damp of home.[74] More locally, the amount of data available to meteorological societies in England and Scotland during 1865 convinced Alexander Buchan, Secretary of the Scottish Meteorological Society, that informed decisions about seasonal

72 Ibid., liii.
73 PP, *Condition of the Cottar Population*, 1888, 7; PP, *Population of the Western Highlands and Islands*, 1890, 1–28.
74 Bruce 2013, 25.

habitancy across regions of Britains could be made.[75] These were choices for those of ample financial means, directed at short term visits before returning once the incapacity had, hopefully, been relieved.

The connection between climatic determinism and ill health postulated by Stark at the GROS gained impetus from the creation, in 1863, of the Medical Climatological Committee of the Scottish Meteorological Society under the chairmanship of Dr Robert Scoresby-Jackson. Edinburgh trained, and physician to the New Town and Medical Missionary Society dispensaries in the city, Scoresby-Jackson led inquiries into the association between climate and the incidence of ill-health across the world.[76] His paper to the Royal Society 'On the influence of Weather upon Disease and Mortality' was labelled of 'classical interest'.[77] In the 1862 publication upon which that article is based, he found 'Medical climatology is every day taking a stronger hold upon the minds, not only of medical men, but of the general public. Side by side with sanitary science it is developing into a subject of the utmost importance'.[78] By 1897, the former president of the American Climatological Association, Edwin Solley, had found 7,795 cases published within forty-two reports, on the treatment of phthisis by change of climate.[79] This new approach from the 1860s was a 'preventative medicine', supporting those who were prepared to travel and settle abroad for their health and to ask the question: 'where must I go to?'.[80] Scoresby-Jackson's answer, in short, was to look for 'a fair prospect and a pure atmosphere'.[81] Sunlight should be sought, noxious winds should be avoided, and circumventing dampness – the 'especial bane of all delicate constitutions' – should determine one's choice of an elevated location where a steady temperature of between 50 and 60°F (notably warmer than Scotland's 48°F) might be found. The climate of New South Wales was deemed 'healthy', with disease amongst infants being rare, although dysentery and pulmonary complaints were not uncommon. Benefitting the British settler, western Canada would secure 'a clearness, a dryness, a brilliancy in the atmosphere truly delightful after the raw drizzling rains, the fogs and moisture of Europe'.[82] Scoresby-Jackson was aware that once emigrants left Scotland their minds were preoccupied by thoughts other than those pertaining to the general laws of health, but still it was their health that allowed them to make progress, and

75 Buchan 1865, 463.
76 Scoresby-Jackson 1863, 31.
77 Anon. 1867, 156.
78 Scoresby-Jackson 1862, viii
79 Solly 1897, 126
80 Scoresby-Jackson 1862, viii-ix.
81 Ibid., 32.
82 Ibid., 35, 148, 168–172.

these matters were of special concern for those suffering from consumption. While he was not prepared to identify a single nirvana, his ideal location was near the coast, with a mean temperature of around 60°F, free from excess levels of humidity or dryness.[83]

Emigration agents, novelists, essayists and writers of emigrant guidebooks rejected such hesitancy to loudly extol the salubriousness of a favoured overseas destination, and government officials, looking to boost emigration to their territories, did likewise. In communications to the Treasury and Colonisation Office, agents and promoters focused on the health of those planning to emigrate.[84] Pamphlet writers had long been some of the principal advocates in this regard: in his 1806 Account of Prince Edward Island, for example, John Stewart wrote that:

> Many people here grow to a large size, perhaps in no other country will the proportion of men of six feet high be found greater; the countenances as well as stature of the young people, whose families come from the highlands of Scotland, often exhibit a remarkable contrast to the hard features, and low statures of their parents; plenty of wholesome food, as well as salubrity of air, no doubt contributes to this difference. [85]

Walter Johnstone verged on the sublime in his description of the island in 1822, describing the territory as having 'pure and healthful air, water of the very best quality … seldom a failing crop …' Of the weather in June, he found it more favourable than at home:

> The sun, whose rays are more vertical than in Scotland, appears to have both more light and heat; the sky is generally so pure that the eye cannot discern the least vapour or cloud to intercept the sun's rays; and being without the least breath of wind to fan the opening leaf, the air is sultry and enervating in an astonishing degree.[86]

Mid-century, a correspondent to the Colonial Land and Emigration Commission's periodical, *Colonization Circular*, claimed the climate in New Zealand was 'good for the health of European migrants' despite observing the Maori suffering from diseases of the lung caused by poor nourishment.[87] In a

83 Ibid., 82–8.
84 Haines 1997, 4.
85 Stewart 1806, 118.
86 Johnstone 1822, 10. The letters were addressed to Rev John Wightman, Dumfriesshire.
87 *Colonization Circular*, 19, May 1859, 72.

contemporaneous collection of letters and comments, chosen for publication under the guise of objectivity but designed to boost emigration, the dry air of Australia was deemed beneficial for those suffering from consumption. Rev David Mackenzie, writing of his experience from living in Australia for a decade, claimed 'no climate can be more salubrious than that of New South Wales. It is the climate for invalids. The air is bracy and balmy'. [88] His tales of restorative powers are fanciful, with claims that only five or six people were known to be ill at any one time within a population of 1,200, and of older migrants coming out to Australia 'suddenly [finding] themselves restored to much of the hilarity of youth'.[89] Mackenzie confirmed there was little that could be considered as winter, and while he himself had recorded a temperature of 127°F in January 1837, the average was much more suitable for the European. New South Wales and Queensland were later described by an observer as the 'paradise of the working man', and the rational choice for the migrant in 1887: 'a man whose life might have been saved or prolonged by the climate of Queens … may be killed by a Canadian winter'.[90] Snow in Sydney was rare and newsworthy when it came. Such was the contrast with their new life, 'It reminded us of home more than anything we had ever seen in the colony. Every flake of snow seemed to be singing, as it fell, Dulce, dulce domum! Home sweet home!'[91]

The sway of this positivity was difficult to temper. A survey of *Blackwood's Magazine* found that despite there being articles that cautioned against boasts of 'good shooting, beautiful climate and rolling prairies', the magazine still included a profusion of positive and romanticised accounts of the American west.[92] From the dense struggling throngs upon these British Islands, a man looks wistfully across the Atlantic at the sparsely-peopled lands of the New World and desires elbow-room, it was said.[93] In a report produced for the UK Colonial Secretary Lord Kimberley, John Henry Pope, Minister of Agriculture in the first Canadian government, celebrated that in 1872: '… the inducements to immigrate to Canada are not simply good wages and good living among kindred people, under the same flag, in a naturally rich country, possessing a healthy and pleasant climate, but the confident prospect that the poorest may have of becoming a possessor of the soil, earning competence for himself, and comfortably settling his children'.[94] The climate, he cautioned, had suffered

88 *Emigration* 1848, 3–5.
89 Mackenzie 1845, 3.
90 Morgan 1887, 603.
91 Mackenzie 1845, 6–7.
92 Windholz 2000, 639.
93 Anon. 1861, 554.
94 Anon. 1872, 594.

from 'exaggerated impressions', and winter was to be embraced for its dryness and the protection a layer of snow gave to the soil.[95]

Climate factors and emigration flows

As Ravenstein had observed in 1885, the respective natal and prospective climates comprised the farther inducements to migration.[96] Shipboard diaries from the period are filled with meteorological observations, and the prospects for health and prosperity were common tropes deployed to encourage family members to join the chain of migration.[97] The search for 'laws' of environmental determinism produced evidence of agricultural shortage and detrimental urban conditions that reinforced a climatic motive for escaping overcrowding, atmospheric pollution and the circulation of respiratory infection. As we saw with levels of underemployment for those aged 20-29, it was also the case that without high levels of emigration, Scotland's rates of morbidity and mortality would be recast. A higher proportion of those from healthier age groups, late teens and those in their twenties, emigrated than those from other age groups, the very people for whom the incidence of disease was less associated with climate. In turn, Scotland retained a population more susceptible to climate variation, although the impact of this on mortality would be compensated in part by the preponderance of men within those emigration flows, and by the preponderance of emigrants leaving the mainland districts and the towns. This evidence of an association between environmental factors and raised morbidity and mortality suggests the epidemiological context must be factored into explanations of emigrants' pursuit of improved life chances in the New World.

James Stark listed emigration data when looking to identify possible externalities, other than climate change, that might explain rates of mortality and morbidity in any one year.[98] A moderate correlation coefficient of 0.64 is recorded between the annual temperature in Edinburgh and the number of emigrants recorded leaving Scotland during the period 1854 to 1862.[99] When the number of annual sailings from Scotland is plotted against deviation from the annual mean temperature over the period 1825 to 1850 (Figure 3), there appears an upsurge in movement following the coldest spells and following the heat - and *Phytophthora infestans* - of 1846.[100]

95 Ibid.
96 Ravenstein 1885, 168.
97 Ritchie 2017, 76–9; Prentis 2004, 296, 299–301, 308–9; Bueltmann 2004, 249–252.
98 PP, *Seventh Detailed Annual Report* 1865, lvi.
99 Mossman 1897 and PP, [Second, Fifth and] *Seventh Detailed Annual Reports*.
100 The data for figures 3,4 and 5 are derived from Forbes 1861, 344–345; Mossman 1896 116–118; Baines, 1985, 300.

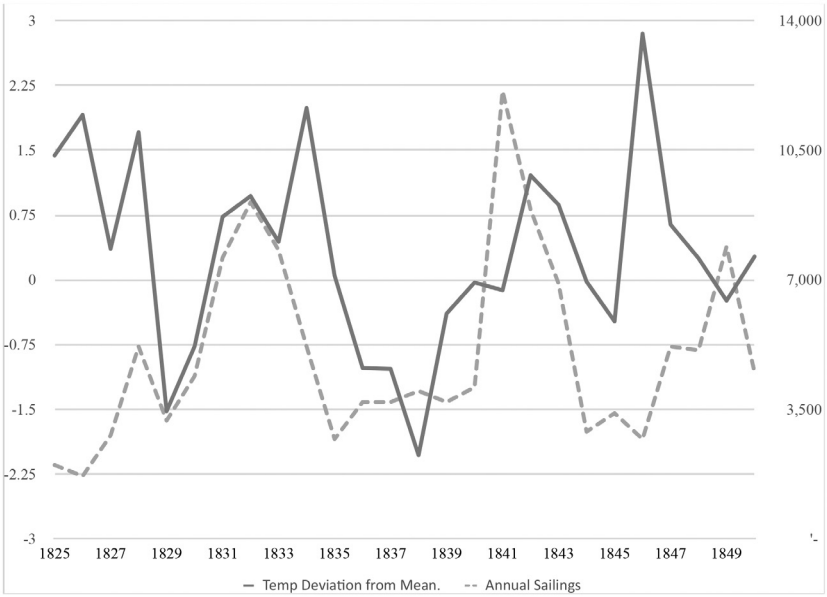

Figure 3: Emigrant sailings plotted against temperature deviation from the mean each year, 1825-1850

The pattern is less direct, but still close, for the same quarter century when annual sailings are plotted against each year's difference between its hottest and coldest month (Figure 4). What manifests is the suggestion of a delayed response, with sailings from Scotland continuing to rise until thirty-six months after each peak divergence in temperature. The measurements used in Figures 3 and 4 reflect the shift by meteorologists to go beyond the average in their search for causation, with weight given to atmospheric change, especially extreme variation that would otherwise be missed, or its effects flattened, when twelve-month averages are reported. Yet Figure 5 shows migration flows shadowing the variation in annual average temperature. This correspondence occurred over the second half of the nineteenth century, when the towns and cities of the lowlands supplied the majority of the people migrating overseas, and when – with increasingly ambitious attempts to alleviate unnecessary loss of life – sanitary intervention was being directed and funded to new levels by local councils, police boards and ad hoc trusts.[101]

Any such claims to association must sit within the complex matrix of climate,

101 Morton 1998, 358–363.

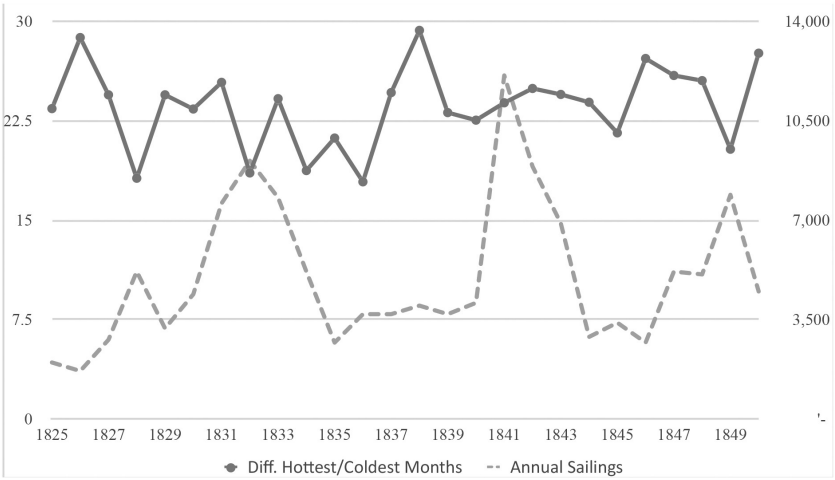

Figure 4: Emigrant sailings plotted against difference between hottest and coldest months each year, 1825-1850

Figure 5: Mean annual temperature for Edinburgh plotted against annual passenger movements by Scottish natives, 1853-1896

demographic and economic factors that have been discussed, alongside the timing and opportunity for public and private assisted migration. The climatic reasons, pressures and incentives that resulted in the movement of people have been neither straightforward nor uniform. Yet from direct and indirect consequences, from the logic of environmental determinism, a climatic motive to emigration supplemented the economic imperative that led urban as well as rural Scots to uproot from their homeland and cross sea and ocean to reach sunnier skies.

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