Unlike the densely forested North Island, settlers encountered grasslands on the South Island's east coast, enabling them to more easily establish pastoralism and agriculture without the hassle of forest clearance. Several gold rushes – most importantly Otago's from 1861 – attracted migrants, including significant numbers of Chinese, to the South Island. Finally, the New Zealand Land Wars, waged between confederations of Maori tribes, and the Crown and its Maori allies, broke out from the 1840s and continued to challenge European settlement until well into the nineteenth century.

Massive environmental change followed settlement, on a scale perhaps globally unrivalled either in its rapidity or documentation.[8] Forests made way for farms. Grass seed replaced indigenous vegetation. Swamps disappeared. In the hunger for land, government nullified Maori customary title. Within a relatively short period, New Zealand functioned as a giant imperial farm, supplying raw materials and food to Australian, British and other markets. The South Island boomed for much of the nineteenth century. Primarily this occurred on the back of the east coast pastoral industry but also because of the gold discoveries in its central and northern areas. Fortunes – and population – shifted to the North Island in the twentieth century. Refrigeration enabled dairy and meat products to be shipped overseas to imperial consumers, generating the impetus and capital to convert much of the newly-opened North Island's lands recently prised from its Maori owners.[9]

In a country so heavily reliant on primary production for the economic and social well-being of its inhabitants, not to mention for attracting future migrants, climate – 'the sum of weather changes experienced' at a place – mattered greatly.[10] Propagandists regularly promoted New Zealand's climatic similarities to Britain. According to imperial tourist, Charles Dilke, such similarities explained why 'the English fauna and flora are peculiarly well fitted to succeed at our antipodes'. It meant, he continued, that 'our men, flies, and plants – the 'pick' of the whole world – have not even to encounter the difficulties of acclimatization in their struggle against the weaker growths indigenous to the soil'.[11] Countless others marvelled at the remarkable growth rates of crops, staggered in awe at gargantuan vegetables or marvelled at the remarkable rapidity and ease with which overseas plants, animals and people acclimatised into New Zealand. Indeed, New Zealanders began to regard their country as not simply *like* Britain, but as a *better* Britain.[12] In a large measure this rested on perceptions of the beneficial effects of its climate to the growth of both introduced plants and agricultural processes and to the growth and health of Europeans themselves.

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accuracy of measurement and an ability to replicate experiments elsewhere became hallmarks of science, and qualities – or virtues – of the scientist.[50]

benefits. Removing forestry from direct competition with agriculture on the lowlands, he argued for its development on highlands. Quoting European, Indian and American authors, he associated forests, through their regulation of climate and soils, with the preservation of New Zealand's climate. Destruction of high altitude forests, cautioned Walker, would mean bidding 'farewell to the smiling fields in the vallies [sic] below and abundant pasture on the lower slopes of the hills'.[59]

Climatic anxieties thus buttressed his arguments for forest conservation and for government to take an increased role in society. Since a key plank of Walker's arguments rested on the forests-rainfall theory, he attempted to settle any uncertainty about it in New Zealand by examining temperature records and matching these up with deforestation rates. Walker hoped his research would shore up his belief that deforestation 'exercises an injurious effect on both [climate and permanent water supply], whilst the formation of plantations in dry and arid regions ameliorates the climate and renders the water supply more copious and permanent.' Consulting records of New Zealand's average rainfall between 1866 and 1875, however, revealed that mean rainfall had actually risen slightly despite accelerating rates of deforestation.[60] Walker dismissed the reliability of such figures. According to him, meteorological observations had improved significantly in this period, rendering his attempt unscientific.[61] Walker's efforts to measure the effects of deforestation on climate perhaps reflected attempts to increase the legitimacy of state forestry through recourse to statistics. Experience in India may have prompted Walker. Foresters in India only began to accept climatic theories in the face of observational evidence.[62] As with other climatic conservationists, however, intuition and observation ultimately informed his belief in the powers of forests to attract rain: these would ultimately lead to the dismissal of climatic

first duties of an enlightened Government' concerned '[t]he preservation of the forests of a country'.[67] Many other articles appeared on this topic in the 1880s, including in recently-published farming journals, indicating the support of some in this sector. In 1880 A. Lecoy, a retired French forester, published his advice.[68] Lecoy implored the New Zealand Government, for the sake of the climate, to increase the extent of state forests. Private individuals, he pointed out, would not leave forests standing for the benefit of society as a whole. Only state forestry, he noted, offered the way forward, bringing financial gain as well as climatic and hydrological stability.[69]

Chamberlain's challenge: the climatic lobby in the 1880s

Although the extent of forest conservation increased in the 1880s, the conservation lobby in parliament remained vocal in the 1880s in the face of continuing deforestation elsewhere. In 1882, Henry Chamberlain, Auckland's MHR, presented a quite extraordinary discussion of conservation and settlement exclusively reliant on the forests-climate link. Based on Lecoy's report (see above), Chamberlain noted that in Germany and France, both countries that 'had for long ages studied the advantages of maintaining and retaining their forests', the 'desirable quantity' of forestland was one quarter of the total area. In Canterbury, Chamberlain instanced that the area was only two per cent; in Auckland, seven per cent. Deforestation in a region with a 'moist hot climate' such as Auckland's, Chamberlain noted, was particularly dangerous for 'the climate would become very different, and scarcely anything would be able to be produced there.'[70] Chamberlain advocated drawing up maps showing highland areas and forest areas and then using this information to inform forest legislation. In his discussion, the MHR ascribed to forests almost exclusive control over climate:

> Persons seeing the amount of forest and forest reserve would be able to judge what kind of climate any particular district would be likely to possess, which would influence them in choosing a place to settle in, and people would be also able to see where they could purchase forest land whenever Government might have it for sale.[71]

Interestingly, unlike most other advocates who left the lowlands to agriculture, Chamberlain favoured integration of forestland with farming. Although sympathetic and recognising that wasteful deforestation 'was a deplorable fact', Richard Oliver, Minister without portfolio, replied that 'very often there was no option between letting the lands lie idle and sacrificing valuable trees.'[72] Land settlement triumphed over forest conservation.

The following year Chamberlain, undaunted, introduced another bill aimed at protecting forested areas from 'the wooded ranges to the plains and lowlands' specifically for climatic and catchment reasons. Bolstered by rainfall statistics, Chamberlain demonstrated that deforestation had dried up the colony's climate (Table 1).

Table 1. Chamberlain's Findings on New Zealand Rainfall Decline

Region	Decline in Rainfall over last seventeen years (measured in inches over five year periods)		
	1867-1872	1872-1877	1877-1882
Auckland	48	43	40
Southland	46	41	42
Canterbury	27	25	22

Based on NZPD, 1 August, vol.45, 1883, p.212.

He also charged that deforestation increased flooding and pointed out that conservation would extend the timber trade.[73] Eight other MHRs spoke during the debate, of whom five supported Chamberlain's espousal of the forests-climate link.[74] J.W. Barnicoat (Nelson) argued that by enacting forest conservation humans:

> had it to some extent in their power to transmit the soil and the climate, in all their richness and excellence, that they themselves now enjoyed; for forests had

1915) meant that unlike the amateurs who advocated the climate-forests link, Cotton would not support scientifically unsound theories. Cockayne, although self-taught, became a leading advocate of ecology in New Zealand and relied on sound scientific experiments to conduct surveys into environmental processes, both perspectives which did not favour the forests-climate link.[96] Meteorology in New Zealand was also much weaker than in the US, forming a different set of social and political circumstances under which science took place, differences which reinforce David Livingstone's assertion that locality profoundly affects the meaning and reception of science.[97]

In the US criticism of the forest-climate link from meteorologists and engineers discredited the theory, forcing foresters to drop it entirely. In contrast to the US, in New Zealand state meteorology was underdeveloped and struggled for funding for much of the nineteenth century and into the early decades of the twentieth. Staff of the New Zealand Meteorological Service (NZMS, 1906-1992), including its director, Rev. D.C. Bates (director, 1909-1927), were not scientifically-trained meteorologists. As historian J.F. de Lisle observes, until the appointment of Bates' successor, Dr. Edward Kidson, a trained meteorologist, in 1927, 'the science was very much in its infancy' with '[t]he resources available in the struggling and often impecunious new colony' only 'able to provide for only the most rudimentary meteorological services.'[98] The NZMS was therefore decades behind the US, having still to build up more rigorous instrumentation and forecasting methods and justify its usefulness to the state. On occasion New Zealand's meteorologists in the late nineteenth and early twentieth centuries even supported the idea that trees could influence local climatic conditions. Although holding that elevation and latitude, prevalent winds and mountains, ground slope and soil character and proximity to sea influenced rainfall distribution in New Zealand, meteorologist John Meeson in 1890 noted that both forests and cultivation had localised effects on climate.[99] '[D]ense neighbouring woods', he observed, 'will diminish local temperature, and so, to some extent, attract rain.' Blenheim settlers, he continued, 'attributed [the slight increase in Blenheim's rain] – rightly or wrongly – to increased cultivation and arboriculture.'[100] In 1907, Bates recommended tree planting to increase rainfall in droughty North Otago. Rather than critiquing forest-climate ideas, New Zealand meteorologists used opportunities such as rainmaking activities to enhance their authority and draw up boundaries between science and non-science.[101] The process of professionalisation in meteorology took place much earlier in the US than in New Zealand. New Zealand's meteorology bureau relied upon non-scientifically trained staff, which perhaps explains the latter's continuing support of the forest-climate connection, a position only really maintained by non-professional groups. Significantly, when in the early 1920s New Zealand created its State Forests Service (SFS), a professional North American trained forester took over the position. Forestry's aim became to ensure regular supply of timber and prevent soil erosion and flooding.[102]

Conclusion

In response to overseas arguments and in light of increasing deforestation, climatic anxieties emerged in New Zealand in the 1860s. Over that century several scientists, engineers and politicians drew attention to the perceived or likely impact of deforestation. Unregulated felling, they argued, variously resulted in rainfall and temperature change, timber scarcity and flooding. Unless prevented through state forest management, climate change and altered hydrological regimes threatened to bring terrifying cycles of drought and flooding. Contestations over the meaning of science exhibited through forest-climate debates in New Zealand from the 1860s to the 1920s evince the importance of scientific methods in supporting a group's claims to authority. For some, climate-forest science meant government

should increase its role in society and establish state forest conservation. Others challenged such claims to scientific authority, questioning the methodology and use of measurement. Both proponents – and detractors – of the forest-climate connection invoked the language and methodology of science to press their claims to authority. In the 1870s, for instance, some politicians questioned the climate-forests idea. It was, they charged, based on anecdote and observation, not hard, observable scientific fact. To rebuke such criticism, New Zealand's recently appointed Conservator of Forests attempted to measure the impact of increased deforestation on rainfall, but without success. In the early twentieth century the forest conservation lobby in New Zealand turned to American forestry precedents, discarding its reliance on the forest-climate connection to press for government intervention on the basis of stronger scientific evidence of timber depletion and soil erosion. In America, meteorologists and engineers successfully discredited the forest-climate connection put forward by foresters. They pointed out its unscientific evidence and reliance on historical examples and unsubstantiated observation instead of scientific data and experimentation. Now associated with non-science, scientifically-trained forest supporters dropped the forest-climate theory in favour of the hydrological impact of deforestation, a theory that they could more easily support scientifically. Reinforced by growing ecological ideas that favoured preservation of indigenous nature as central to national identity, lobbyists for New Zealand state conservation also followed US models and precedents in arguing for the hydrological impact of forests. If the example of colonial forestry in New Zealand emphasises the importance of overseas and local models in initiating state conservation, it also evinces the equally significant role of boundary disputes over science in framing conservation arguments.

[77] NZPD, 1 August 1883, vol.45, p.215.
[78] J.C. Richmond, 1 August 1883, vol.45, p.218.
[79] NZPD, 1 August 1883, vol.45, pp.215-216.
[80] T.H. Kirk, 'Progress Report of the State Forests Department', AJHR, C3D, vol. 1, 1886, p.3.
[81] Two MHRs did discuss climatic conservation. George Beetham, Wairarapa North MHR, denied that forest clearance had caused a drier climate: Beetham thought that the converse, in fact, had occurred despite significant deforestation in the North Island. George Beetham, NZPD, 26 June, 1885, p.206. New Zealand's former Governor, Sir George Grey, summarised the Bill as 'necessary for climatic reasons' and

Zealand', in *New Zealand Weather and Climate*, ed. by B.J. Garnier (no place: New Zealand Geographical Society, 1950), pp.7-25.

[102] Roche, *History of Forestry*, pp.175-265.