Hugh Cleghorn and Forest Conservancy in India

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ABSTRACT

This paper examines the important and pioneering role played by Dr. Hugh Cleghorn, a Scottish medical surgeon, in the implementation of forest conservancy in colonial India. I focus on three aspects of his contribution in India, which preceded forest conservancy in Britain itself. Firstly, I deal with the social and intellectual background of Cleghorn that greatly influenced his ideas on forests. Then I discuss Cleghorn's contribution to forest conservation in India. Here, I analyse Cleghorn's views on the causes of deforestation in India. I then examine his ideas on forest conservancy and the importance of forests. Given the economic and political context, I also show how and to what extent he could use his ideas to influence the colonial state to implement forest conservation. I explain why it was that the colonial state accepted Cleghorn's conservation views. I argue that to the extent that Cleghorn was able to show that forest conservation would maintain the timber supply to support infrastructure intended to exploit India's resources efficiently and thereby generate revenue, the colonial state accepted his proposals. Finally, I discuss what kind of forest conservancy, based on Cleghorn's ideas, was adopted by the state.

KEYWORDS

Deforestation, forest conservation, Scottish scientists, Cleghorn, colonial India

1. INTRODUCTION

A public resolution by the Government of India of 10 January 1865 noted:

> The Governor General in Council avails himself of this opportunity to express his sense of the great service rendered to the State by Dr. Cleghorn in the cause of forest conservancy … His long services, from the first organisation of Forest management

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> in Madras, have, without question greatly conduced to the public good in this branch of the administration. In the Punjab also … Dr. Cleghorn's labours have prepared the way for the establishment of an efficient system of conservancy and working of the forests of that Province.[1]

The above excerpt summarises the important role played by Dr. Hugh Cleghorn in initiating forest conservancy in the Madras Presidency and in the Punjab. This adoption of forest conservation was one of the responses of the colonial state to the denudation crisis that developed in colonial India in the second half of the nineteenth century. One of the most important reasons for the denudation crisis was the rapid railway establishment and expansion promoted by the colonial state.

The expansion of railways was in turn shaped by the colonial social and economic structure or the economic[2] relation between the metropole i.e. Britain and the colony i.e. India. Towards the middle of the nineteenth century, the colonial state instituted or encouraged infrastructure projects such as the railways to efficiently extract resources from India through trade. The colonial state started promoting the expansion of railways especially to boost agricultural exports[3] from India. Among the colonial railway networks by the end of the nineteenth century, India had the largest and most advanced railway network. The total number of railway miles grew from 20 in 1853 to 23,627 in 1900.[4] Most of the railway lines built were export-oriented, connecting India's agricultural interior with the ports.[5] Thus, the railways were to a large extent tuned to Britain's requirements.[6]

With the expansion of railways, India was transformed into an exporter of agricultural products such as cotton, jute, tea, coffee, wheat and oilseeds.[7] Between 1860 and 1910, a period of substantial railway expansion in India, India's trade[8] with Britain (India's imports and exports combined) trebled. This was equal to the sum of British trade with China, South Africa, and Australia combined.[9]

As railway construction and operation expanded to facilitate increased trade, the railways' timber demand on the forests increased causing deforestation. The railways depended directly on the forests for their sleeper and fuel supply. Given the limits to natural resource extraction, the huge and incessant timber demand of the railways on the forests led to deforestation as will be discussed later.

To make the state perceive an ecological crisis such as deforestation, the crisis had to be first observed, measured and analysed by scientists.[10] These colonial actors by virtue of their expertise were able to play an important role in shaping colonial forest conservation policies. Hence, their contribution cannot be ignored.[11] These actors included surgeons such as Alexander Gibson, Edward Balfour and Hugh Cleghorn, all members of the Indian Medical Service. The role played by Hugh Cleghorn in initiating and shaping forest conservancy in India, even before forest conservation was adopted in Britain, was key. He was one of the colonial actors who could be dubbed pioneers in developing new institutions that continue to function in the ex-colonies with more or less the

same structure and aims. It is therefore worthwhile to examine his character and actions in detail.

This paper is divided into three sections. The first section deals with the social and intellectual background of Cleghorn. The next section examines Cleghorn's contribution to the implementation of forest conservation in India. It specifically examines Cleghorn's intellectual role as opposed to institutional role in influencing the colonial state's forest conservation policies related to timber supply for the railways. The third section summarises the arguments of the paper.

2. SOCIAL AND INTELLECTUAL BACKGROUND

Hugh Cleghorn's Scottish background was as influential in his life as was his Indian involvement. He was born in 1820 in Madras, India where his father was the Administrator-General in the Supreme Court. In 1824, along with his parents, he returned to his family estate in Stravithie near St. Andrews, in Scotland. A characteristic feature of Scottish forestry from the seventeenth century onwards was the improvement of the landed estates by planting trees and using forestry techniques imported from the Continent, especially from France.[12] His childhood at Stravithie familiarised him with the rural way of life and put him in touch with nature[13], which seems to have laid the foundation for his love of plants and trees that occupied so much of his time later in life.[14]

After completing his school and undergraduate education from Edinburgh and St. Andrews, Cleghorn went on to study medicine at Edinburgh in 1837 for five years. During this period of study he developed an interest in botany,[15] which became his favourite subject. After graduation in 1841 he was appointed to the Indian Medical Service and posted to Mysore, India.

During his tenure as a doctor in Mysore, Cleghorn, on the advice of the eminent botanist Joseph Hooker, began studying plants[16] and became an expert in them. This expansion of interest and expertise in botany was typical of the Scottish medical surgeons employed in the Indian Medical Service. This was because the surgeons were trained in the French-influenced Enlightenment tradition of Scottish[17] universities where disease, climate and plants/trees were clearly connected. Professors John Hope in Edinburgh and William Hooker in Glasgow, who advocated rigorous field observation, holistic approaches to nature and tree-planting programmes taught many of the Scottish surgeons.[18] The expansion of medical surgeons' expertise in non-medical areas could also be seen in their increasing employment as superintendents of botanical gardens in India[19] where their knowledge was put in service by the colonial state to gain knowledge about not only the tropical diseases, but also about the natural and agricultural resources of India.

Officials and fellow scientists often consulted Cleghorn regarding the medicinal and economic plants of India.[20] In 1848 due to poor health Cleghorn

returned to England, where he continued to extend his botanical knowledge. His interest in economic botany extended to his study of the forests. In 1850 the British Association for the Advancement of Science asked Cleghorn and other scientists to report on the influence of tropical forests on the climate and the resources of those countries. This report, which was published in 1852, among other things, discussed the economic and physical effects of tropical deforestation, especially in India. It used various examples of deforestation in Europe and in India to show that lack of an effective forest conservation system could lead to ecological disasters.[21] Cleghorn clearly believed that forests played an important role in the ecology and climate of tropical countries.

While appreciating the ecological importance of forests, Cleghorn also recognised their economic importance. The 1852 report contained a list and description of trees that were economically important. Writing about the economic value of the Indian forests, he noted:

> It is not only in affording indigenous woods … serving all the purposes to which timber is applied, that the Indian forests claim our attentive consideration. *In them* [the Indian forests]*, nature presents to us other sources of wealth, many of which are imperfectly known, but may under judicious management, yield a considerable increase to the present revenue*. [22]

Cleghorn saw the forests as a resource that, if managed properly, would not only provide raw materials to be used for various purposes but would also be a source of revenue. This interest in the economic productivity of forests probably stemmed from the fact that Scottish forestry of the first half of the nineteenth century was characterised by the dominance of productive forestry. The tree-planting programme undertaken by landowners in Scotland at the time was instituted with the view of meeting the industrial needs of the country at profitable prices.

The importance Cleghorn attached to the economic value of forests can be also seen in the following excerpt of a letter he wrote in 1851 to J.H. Balfour, the Director of the Royal Botanical Gardens, Edinburgh, before leaving for Madras from England.

> [W]ith our present information as to the Economic and Pharmaceutic resources of the Malabar Coast, where they [sic] are I am convinced, many products as yet insufficiently known and appreciated but which as the light of European Science penetrates these unfrequented forests will be applied to many useful purposes in the arts and manufactures; if my services are required on the Western coast [of India], and if my health is strengthened to endure the unfeeling influences of that climate, I shall exert the energies allowed to me to develope [sic] the unknown value of these forests.[23]

This excerpt also shows Cleghorn's belief that European science could be used not only to conquer nature but also to develop the natural resources so that economic benefit could be extracted from them.

In 1852 Cleghorn returned to India as professor of botany and Materia Medica[24] in the Madras Medical College, an appointment that reflected his expertise and interest in medical and economic botany. While in Madras, Cleghorn pursued his interest in economic botany by becoming a member of several societies such as the Madras Literary Society[25] and the Madras Agri-Horticultural Society.[26] These two societies were engaged in promoting the development of natural and agricultural resources in the Madras Presidency. They were able to do this by organising exhibitions, publishing exploration reports and by establishing horticultural gardens. These activities were also encouraged by the state so that development[27] of India's natural and agricultural resources took place.

Because of his involvement in the exhibitions and activities of especially the Madras Agri-Horticultural Society Cleghorn became aware of the magnitude and kinds of Indian timber that the British needed for various purposes. According to Cleghorn, given the huge amount of wood being exported from the Madras Presidency and the large amount of timber imported into Britain, it became important to ascertain 'which is the best kind of timber for each particular purpose, and 2d[second], whence the supply can be obtained with the greatest certainty and economy'.[28]

In addition to exhibitions, to develop India's natural resources, colonial officials such as Lord Harris[29]felt that experienced botanists should be sent out on explorations. By sending out scientists to explore the Indian flora, Lord Harris, like Dalhousie, was sure that '[T]he importance of thus bringing western science and appliances to bear upon the dormant natural resources of the country, and the ultimate benefits which may be expected to accrue from such researches, there can hardly be any doubt'.[30] This was the period when the colonial state and its officials believed in the supremacy of western science and technology especially in its ability to conquer nature and derive economic benefit from it.[31]

Cleghorn too felt that explorations of countries not only resulted in increased knowledge but also helped in the discovery of hidden resources of a country that could be potentially profitable[32] and useful for the development of European capital in India.[33] For instance regarding his botanical explorations in the Madras Presidency,[34] Cleghorn noted that:

> It will thus be seen that the result of our excursion was not without interest. Some curious botanical novelties were found; *the timber resources of the district were ascertained; and a large tract of country suitable for coffee culture was traversed*, which will doubtless be the scene of future colonization[35]

Similarly, later, through his exploration reports in the Madras Presidency, he was able to provide information on the distribution and capability of different kinds of timbers to the railway engineers.[36]

3. CLEGHORN'S CONTRIBUTION TO FOREST CONSERVATION IN INDIA

Having looked at Cleghorn's social and intellectual background, I will now examine Cleghorn's intellectual role in the implementation of forest conservation in India. In order to do this in the first sub-section I analyse Cleghorn's views on the causes of deforestation in India. In the second subsection I examine Cleghorn's ideas on forest conservancy and the importance of forests. This subsection also throws light on how these ideas, given the economic and political context, were used by Cleghorn to pioneer forest conservation not only provincially but also at the all-India level. I also discuss briefly what kind of forest conservation was adopted by the state.

A. Cleghorn on Deforestation and its Causes

There has been a lot of debate, among environmental historians studying India, on the magnitude and causes of deforestation especially in the colonial period. Historians on the forest history of colonial India are broadly divided into two groups. The first group comprises imperial foresters who glorify the colonial phase of forest history as bringing a halt to deforestation that had taken place before.[37] They contend that with the advent of forest conservation and scientific forestry deforestation was brought under control.[38]More recently Grove[39] has argued that there was significant deforestation in the pre-colonial period that continued into the colonial phase. Overall, this group of imperial forester historians see the pre-colonial and early colonial phase as forest destructive periods.

The second group of forest historians led by Ramachandra Guha argue that the colonial period was a watershed in the ecological history of India as unprecedented and large-scale deforestation took place.[40] For Guha[41] in the pre-colonial phase there was ecological equilibrium due to customary practices of the local forest communities. As Rangarajan[42] rightly argues it would be wrong to assume that there was ecological equilibrium in pre-colonial India. He points out that the forest line was a shifting boundary that fluctuated depending on extension of agriculture and political control. Further, he contends that in the colonial period there was a qualitative break in the extent of denudation when compared to the pre-colonial phase. Also, Arnold and Guha[43] point out that in environmental arenas such as forests, the second half of the nineteenth century was a period of great state intervention where science and technology in an age of high imperialism were used to conquer nature. These included the development and implementation of technologies (e.g. dams and railways) that greatly modified the physical environment including forests.

Cleghorn too saw deforestation as an inevitable result of colonialism's 'modernisation' process. Reflecting on the causes of deforestation in the British colonies after his retirement from the Indian Medical Service, he noted that:

> During the first stage of colonisation in most countries, as for instance Australia, India, and America, and while settlers are thinly scattered, demands on the wood supply are usually so limited as not to cause undue destruction of indigenous forest, nor to occasion alarm for future requirements. But immigration goes on, agricultural industry is extended, railways are formed, all these causing encroachments on the forests to take place, and ultimately denudation follows...[44].

The denudation in the colonial context also made him conscious that such denudation reaching crisis proportions had not taken place in Britain. He said:

> That such [denudation due to expansion of the railways, agriculture etc.] has not been the result in our own country is doubtless due to our insular position, and to our rich resources of mineral fuel. Of the first, and the advantage we thereby possess of being able to draw supplies from all quarters of the globe, nothing short of a convulsion of nature can deprive us....[45]

Thus, Cleghorn recognised that Britain did not face a denudation crisis because it had good supply of coal and because it could obtain timber from its empire.[46] For example, Cleghorn was aware that Britain obtained timber for building its ships from the forests on the southwestern coast of India.

Cleghorn's explorations in the Madras Presidency made him aware not only of the economic wealth of the forests but also of the deforestation taking place there. Even before these explorations, Cleghorn was familiar with the denudation that had taken place in the Malabar and Canara regions. In these portions of the Western Ghats the forests were depleted to supply timber for British shipbuilding in the early decades of the nineteenth century.[47] Also, while exploring the forests of Mysore and Canara, Cleghorn felt that kumari or kumri[48] cultivation had a destructive effect on the forests. When Cleghorn was at Shimoga in Mysore, he observed and 'remarked the wholesale destruction of forests in that district, chiefly through kumri cultivation'.[49] Due to his suggestion kumri was prohibited in Mysore in 1846 along with certain areas in Coorg.[50]

Cleghorn, like most colonial officers and the state, believed that permanent cultivation was better than shifting cultivation as crop production from such land would be more. According to him 'the kumri was a wasteful and barbarous system'.[51]Hence 'every effort should be made to do away with it as far as possible'.[52] However, anthropological studies[53] have shown that shifting or swidden cultivation is ecologically stable and often helps in repairing long-term damage to forests. Cleghorn's rejection of kumri, like other colonial foresters of his time, has to be placed in a broader political and economic context of the imposition of an absolute notion of landed property by the colonial state, where all land including that under forests would be under imperial supervision and control.[54]For the European colonisers and the state, space was centrally administered with rights of occupation and usage clearly defined. This concept of space was incompatible with the collective and unwritten customary rights over land and the migratory habits of shifting cultivators. Also, the state needed

revenues from productive activities where the individual rights over land and/or forests had to be licensed. Shifting cultivators had no established rights in land nor did they pay any taxes. Hence, shifting cultivation was repressed.[55] This apathy towards shifting cultivation was part of the British distrust of nomadic groups whom they wanted to bind down to plough cultivation.[56]

Cleghorn was the first scientist in India to point out that in addition to kumri, increasing timber demand by the railways for sleepers and firewood was the most important reason for deforestation in India. By the 1850s Cleghorn knew that railway construction in Scotland had initially made heavy demands on the forests of Scotland[57] for carriage and wagon building and also for sleepers, which may have made him more sensitive to the impact of railways in the forests in India.

In all his forest reports, especially between 1857 and 1860, he observed that the timber demand by the railways was an important cause of deforestation in the Madras Presidency. For example, in his third report on forest operations in the Madras Presidency, he noted:

> There are many causes at work, which are gradually thinning the ranks of our indigenous forests. The first, and by far the most formidable of these, is railway requirements. It is scarcely credible the many thousands of large forest trees which have been felled in the neighbourhood of the various lines of railway within the last few years.[58]

Cleghorn noted that although there were several causes of deforestation, the timber requirements of the railways had the maximum negative impact on the forests much more than that of shipbuilding.[59] Similarly in 1861 when Cleghorn was deputed to the Punjab to explore the hill forests there and to provide information[60] on forest distribution especially of timber yielding kind he wrote '[T]he forests of the Western Himalayas have been subjected to greatly increased demands in connection with the progress of Railway enterprise, and of advancing civilization …'[61]

In order to judge the significance of Cleghorn's arguments on railways as the major cause of deforestation it would be useful to look at the magnitude of railway building and expansion and the amount of timber that the railways consumed. Railway construction in India began in the late 1840s. By 1860-1861, one of the intense periods of railway building, about 1300 miles of railway lines were under construction. The number of sleepers that railways required varied from region to region. Cleghorn calculated that each mile of railway in the Madras Presidency required 1760 wooden sleepers,[62] which would last on an average for about eight years. Including the renewal of sleepers, the total requirement of sleepers in the Madras Presidency was 22,000 per hundred miles annually.[63] These sleepers were obtained from the local forests of the Madras Presidency.

Railway construction took place from 1860 onwards in the Punjab. During the time[64] that Cleghorn explored the hill forests of the Punjab, the lines of the Punjab Railways were being built. They covered a total distance of 252 miles

and connected Amritsar with Multan. Each mile of the Punjab Railways required about 1800 sleepers.[65] In the Punjab, a deodar[66] tree on an average yielded about 11-12 sleepers.[67] The Punjab Railways, required a total of 453,600 sleepers, which meant that 41,236 deodar trees had to be felled[68] between 1860 and 1864.[69]

In addition to sleepers, the railways, especially in the Punjab,[70] needed wood from the forests for fuel. The firewood for the Punjab Railways was obtained from the plains forests (rukhs) in the Punjab. The annual requirement[71] for 252 miles of railways was 1,100,000 maunds[72] for both workshops and engines as well as steamers. Of this, 613,000 maunds of firewood were actually consumed by the engines annually.[73] This formed 55.5 % of the total firewood required by the railways. The total yield of 287,000 acres of rukhs[74] was 3,278,000 maunds. By comparing the total amount of fuel required by the railways and the total amount produced by the rukhs, one can see that in the 1860s the rukhs contained only about three years' fuel supply for railways and steamers. As more and more lines became operational in the 1870s and 1880s the firewood demand of the railways in the Punjab increased greatly.

Cleghorn was certainly right in pointing out that the railways demand for sleepers and firewood was denuding the forests. Deforestation due to railway expansion in colonial India was an example of how the physical environment was drastically modified due to the state's introduction and development of technology.

B. Cleghorn's Views on Forest Conservancy and the Implementation of Forest Conservation

Cleghorn saw forest conservancy at the all-India level as a solution to the above denudation problem. In order to understand what sort of forest conservancy he wanted to implement it would be useful to first find out what conservancy meant to Cleghorn. For him, the goal of forest conservation was long-term i.e. to meet the needs of the future.[75]

Cleghorn saw a clear dichotomy between forest conservancy by the state and that by private interests based on their goals. As he noted in his address to the 19th annual meeting of the Scottish Arboricultural Society:

> Few private individuals can afford to take that higher view of forest conservancy which wishes to make provision for generations yet unborn...They are generally engaged, not in the husbanding of state forests, where the good of generations yet to come guides your measures, but in forests belonging to private individuals, where the chief objects are, to meet the current demand for estate purposes, and to yield a good annual revenue.[76]

For Cleghorn, state conservancy had long-term interest such as providing timber for the future generations. Private conservancy however, was mainly

concerned with meeting its short-term needs and generating good revenue from its forests.

Cleghorn felt that forest conservation through control or regulation of forest cutting could only be provided by the state. Private enterprises or individuals would be denied access to the forests.[77] This was because Cleghorn had seen in Burma that when teak forests were thrown open to private businesses they were denuded by the profit motive in a context of competition between enterprises. This deprived the state 'of those supplies which were indispensable to the public service'.[78] Thus, Cleghorn believed that state and private interests in forest conservancy were incompatible.

In order for the state to implement forest conservancy the forests had to be brought under its control. As Baden-Powell, a colonial officer, noted 'Forest conservancy starts from a basis of property. You cannot conserve a Forest or the Forest area of any district, unless you have either an absolute or a more or less limited proprietary right in it.'[79] When the forests were not under state control there was deforestation as Cleghorn noted:

> [T]hroughout the Indian empire large and valuable forest tracts were exposed to the careless rapacity of the native population, and especially unscrupulous contractors and traders, who cut and cleared them without reference to ultimate results, and who did so, moreover, without being in any way under the control or regulation of authority.[80]

For example, in the case of kumri cultivation Cleghorn felt that because of lack of control over this type of cultivation valuable forests had been destroyed and hence kumri had to be banned as I discuss later.[81] Also, in the Punjab Cleghorn observed that private contractors often employed improper methods of felling and transporting timber that led to the exhaustion of the hill forests there.[82] Hence, given the short-term interests of the local population in the forests, Cleghorn believed that state intervention in forest conservation was necessary.[83]

However, when Cleghorn wanted the state to implement forest conservation he had to use the economic/commercial arguments rather than ecological ones. This is contrary to Grove's[84] argument that scientists used ecological arguments to press for forest conservation. In fact, Cleghorn and his fellow scientists such as Gibson and Balfour had lobbied the state to implement forest conservation for ecological and climatic reasons[85] since the late 1840s. The state, however, implemented forest conservation at the all-India level only in 1864 when there was timber scarcity for supplying the railways.[86] This implementation was primarily due to Cleghorn's efforts in highlighting the timber crisis for the railways as I discuss later.

For the state, the aim of forest conservation was to maintain timber supply for meeting the needs of the railways and other public works and to generate revenue, especially after the Mutiny. This was because, as discussed before, the dominant economic interest of the British colonial state by the 1810s was

to transform India into a market for British manufactured goods and into a raw material supplier for British industries through the railways. As discussed in section 2, despite his ecological awareness, Cleghorn saw the forests as a resource to meet not only the raw material needs of various purposes but also as a source of revenue. Also, right from his initial posting in India, he was aware of what kind of timber and how much timber Britain needed from Indian forests.

Even if the basis of Cleghorn's argument for forest conservancy was ecological as Grove argues, he was aware of the difficulty[87] of proving the influence of forests on the rainfall or on the ecological system of any region.[88] Not only was there a deficiency of evidence[89] showing the influence of forests on rainfall and climate but the existing evidence was also subject to many interpretations. In any case, it is doubtful that the colonial state would have adopted ecological conservation, given its goal of maximising resource extraction. Also, at that time in Britain,[90]unlike in other European countries such as France and Germany there was no forest conservation system.[91]

Another reason why Cleghorn highlighted timber scarcity for the railways to push for forest conservation was because in the mid-1850s he had successfully implemented forest conservancy in the Madras Presidency earlier than any other province in India. There, in a report in 1856, Cleghorn suggested the establishment of forest conservancy in the Madras Presidency as a solution to the railways timber scarcity.[92]At the end of that year, the Madras Forest Department was formed with Cleghorn as the Conservator of Forests.

Given the economic and political context and the existing level of technology, and his earlier experience in the Madras Presidency, Cleghorn realised that there was only one way his suggestion for forest conservation would be implemented by the state. This was by showing that conservation would help solve the timber scarcity that threatened the progress of the public works. Thus, as Rangarajan[93] rightly argues whatever may have been the ideological affinity of the colonial official his action on the ground was shaped by the economic and political context in which he operated.

Cleghorn first of all had to arouse awareness of the timber scarcity crisis so that the state would implement forest conservation.

> [T]he enhanced value of timber had led to an indiscriminate felling of the finest trees, threatening speedily to exhaust the deodar forests, and to deprive the State of those supplies which are essential to the construction of Public Works.[94]

Cleghorn was the first scientist to warn the state of the timber scarcity that would result for the public works in the future if uncontrolled felling of trees were allowed in the hill forests of the Punjab. He concluded that as

> [T]he demand [by the railways and other public works on the forests] is certain to continue, while the sources of supply are limited, and the physical difficulties of transport from the Himalayan forests being very great, systematic and skilled management are imperatively called for.[95]

Thus, given the demands made on the forests by the railways and the limited sources of timber supply in the Punjab, Cleghorn argued that forest conservation was necessary. Based on his report and suggestions the state implemented forest conservation in the Punjab in 1864 and also all over India. The establishment of state forestry in India was one of the first instances of large-scale state reservation of forests in the world. It, in fact, influenced environmental thinking in the United States in the late nineteenth and early twentieth century that led to massive forest reservations there.[96] Later[97] in his address to the 19th annual meeting of the Scottish Arboricultural Society Cleghorn noted, 'The introduction into India of railways, and the rapidly increased demand for timber for sleepers and fuel, at length forced the attention of the Government to the vital question of forest management.'[98]

Grove[99] asks why the state accepted the conservationist views of scientists such as Cleghorn when it involved the curbing of the uncontrolled operation of capital. The state's acceptance of forest conservancy was contradictory, according to Grove, because the unfettered operation of capital for profit was the basis of colonial expansion. There was nothing contradictory, I argue, in the colonial state's action. In fact, it accepted the conservationist views of the scientists such as Cleghorn only when their arguments did not run counter to its long-term interests. As long as the scientists were able to argue that forest conservation would maintain the timber supply to support infrastructure intended to exploit India's resources efficiently and thereby generate revenue, the state accepted their proposals.

The colonial state as a capitalist state did not act at the behest of individual capitalists but rather on behalf of what was beneficial to capital and to the metropolis as a whole, i.e. Britain, in the long term.[100] In the case of forest conservation in India, by accepting the conservancy proposals of the scientists, the colonial state put restrictions on timber extraction by the private capitalists and made sure that sufficient timber supply to the railways and other public works would be provided for. By doing so the state ensured that British capitalists and Britain would continue to derive long-term economic benefits from India. The state, like Cleghorn, was aware that, in the face of no restrictions on timber extraction, the capitalists with short-term profits in mind would denude the forests.

Hence, the state's and Cleghorn's two main concerns while implementing forest conservancy were (a) maintaining timber supply for the railways and other public works and (b) obtaining sufficient revenue yield from the forests. Even Cleghorn's selection of trees to be conserved in the forests was based on their economic importance to the state in terms of their revenue yield or in meeting the needs of public works. For example, in the Madras Presidency, Cleghorn reserved teak, sandalwood and blackwood trees during the first year of the forest conservancy, 1856-57. In the very next year of forest operations, he extended his list of reserved trees to include ayni[101], venge[102] and erul.[103] Of these ayni was being considered for shipbuilding purposes of the British navy while venge,

erul and ayni were on the list of timbers being experimented with as sleepers for railways.[104] Moreover, Cleghorn regularly supervised the felling of trees for sleepers, seeing to it that they were felled in the proper season.

Given the state's active involvement in railway establishment and expansion, at the all-India level too it adopted forest conservancy to maintain timber supply for the railways. But before carrying out conservation the state first brought the forests under its control and restricted the existing use-rights of local communities.[105] Forest conservation[106]mainly involved increasing the timber supply through the natural reproduction of the existing forests. This included all reproduction by means of seeds shed by trees in the forests or by coppicing[107] from the roots of cut trees or by a combination of both.[108] For the cutting of trees, the German scientific forestry method was systematically adopted at the all-India level from 1864 onwards. This meant reduction in the number of trees cut in the various forest divisions by selective felling of mature trees and by rotation felling.[109]

Cleghorn did not find the above kind of forestry, involving selective and rotation felling of trees, unfamiliar, as he had experienced Continental forestry in Scotland. In fact he was actively engaged in it as Brandis noted: 'Dr. Cleghorn paid great attention to a proper arrangement of cuttings, so as to secure the maintenance and promote the natural reproduction of forests.'[110] Also, Cleghorn had seen and experienced productive forestry in Scotland where forests were maintained and cut to meet the industrial needs there. Thus, the forests became a crop that was maintained and harvested for the railways rather than for ecological reasons.

The state's main motive of meeting the railways' needs through forest conservation was also reflected to a large extent in the way the hill forests were worked under the system of scientific forestry. Natural reproduction of forests was aided by silvicultural operations[111] that converted the mixed oak- conifer forests to pure coniferous ones.[112] This conversion of mixed forests to monocultures not only affected the forest ecology, but also ran counter to the survival needs of the local people. Thus, the forests became a reshaped landscape to meet the railway needs.

Despite the above technological fix of natural reproduction of forests through scientific forestry, denudation continued with the expansion of the railways. Because technological fixes cure the effect and not the cause of an ecological problem they cannot become a long-term solution. In the 1870s at the height of the railways' demand for sleepers the annual harvest of trees in the Punjab hills fluctuated between 29,000 and 67,000.[113] This figure doubled in the early 1880s.[114] Due to this enormous timber demand of the railways, most of the deodar forests were either overworked or completely drained.[115] The state did not want railway expansion to cease even though most of the forests were worked beyond their permanent capacity.[116] Therefore, in addition to the felling of local forests, the state started leasing in forests from the native states such as Bus-

sahir and Chamba to supply timber for its railways especially in the Punjab.[117] In the 1880s timber for railway sleepers was also obtained from the forests of the native states of Kashmir, Kaputhala, Mandi etc.[118]

In addition to the management of existing forests, afforestation was also taken up as part of forest conservation in certain instances. Cleghorn was also actively involved in the promotion of afforestation especially to meet the firewood needs of the railways in the Punjab. Cleghorn, who was the Officiating Conservator of Forests of India argued:

> It appears evident from the concurrent testimony of all the Officers consulted that extensive clearances are now overtaking the country adjoining the Punjab and Delhi Railways … *Unless large plantations be formed, the [timber] agent anticipates serious difficulty in working the line from the increasing dearth of fuel … The Railway has hitherto drawn its fuel from the Rukhs estimated to contain three to seven or at most ten years' supply, when all will be exhausted in regard to immediate use....*[119]

Thus, Cleghorn highlighted the fact that the establishment of fuel plantations in the Punjab would meet the railways' need for fuel both immediately and in the future. Based on Cleghorn's proposal and Dr. Stewart's report the state established firewood plantations in the Punjab.[120] For the state the establishment of plantations for firewood was more cost-effective than that for sleeper supply because of the much shorter gestation period of firewood-yielding trees when compared to that of the timber-yielding trees such as deodar.[121] Summing up Cleghorn's contribution to the establishment of plantations and to forest conservancy Brandis wrote

> Under his direction numerous new plantations were established, while existing plantations were maintained and extended. Establishments for the protection and proper management of the forests were organised in all districts.[122]

Just as the state's forest conservancy involving natural reproduction of forests through scientific forestry failed to curb deforestation due to railway expansion, so also did its afforestation method of raising firewood plantations in the Punjab. By 1870s the pressure on the rukhs exhausted them.[123] Hence, the railways' firewood demand was met from the village forests and the forests of native states.[124] The total firewood yield of the plantations and of the rukhs by 1880 was 93,254,200 cubic feet or 23,313,550 maunds.[125] This firewood yield could last for about five years if the opened railway mileage were the same. Because of this scarcity, from the 1880s the railways increasingly began to use local, imported and Bengal coal as fuel as freight charges decreased.[126] Therefore, the formation of new fuel plantations was discouraged and stopped by 1880.[127] As firewood demand decreased, so did concern with conservation.

In addition to the maintenance of timber supply for the railways and other public works, generation of revenue became one of the objectives of forest con-

servation by the state, especially after the Mutiny.[128] As C. F. Amery, a forester in the NWP Forest Department noted,

> The Forest Department, as a first result of its labours, is expected to promptly meet the timber requirements of the Railways and Public Works Department, to bring timber within the reach of the people and to execute all operations of felling, conversion, transport with intelligence and economy, so *as to produce a fair revenue from the estates administered by it*…[129]

Hence, Cleghorn had to highlight the financial viability of forest conservancy in his reports. For example, he highlighted the beneficial financial results in the Madras forest conservancy report for 1858-59 submitted to the state.

> From the returns of my assistants in Canara, ... rendered to the close of the official year, it may be seen that the operations have in these ranges been financially profitable. Large supplies of timber have been furnished to public departments at a time when such was indispensably necessary.[130]

Even in deciding where the practice of kumri in southern India was to be allowed and where it was not to be, Cleghorn used the revenue and timber yielding potential of the forests as a guide.

> In North Canara (Supah and Yellapur), where there is much most valuable timber, and the conservancy of which is financially profitable, I would be more careful. I would disallow all Kumari without previous sanction.... Great supplies of timber have been made to public departments from these two taluks, and the railway pressure is now heavy upon them. We cannot afford to give up any of the fine forests for Kumari.[131]

Earlier in his 1852 report to the British Academy for the Advancement of Science Cleghorn had noted that 'It [kumri] directly injures the revenue, and produces in those that take to it, lawless and vagabond habits.'[132] Initially, Cleghorn was unsuccessful in getting kumri banned using climatic reasons in the Madras Presidency.[133] However, between 1857 and 1860, in his discussions as the Conservator of Madras Forests with the state and with revenue officers, coffee planters he argued:

> The chief evils of this [kumri] rude system of culture are the destruction of valuable timber, at present urgently required for shipbuilding and railways, and the rendering of land unfit for coffee cultivation.[134]

Also, he remarked that if it were not for the prohibition of kumri in Mysore and Coorg 'the same amount of timber would not have been available for railway purposes'.[135] However, Cleghorn had no objection to kumri being practised in areas

> Where trees do not attain a great size, laterite being near the surface, or where timber cannot be removed to a road or river from physical obstructions or where there is extensive bamboo jungle, there is not the same objection to this cultivation.[136]

Even if kumri caused deforestation as long as it was not a threat to the timber supplies for railways and other public works it could be practised. Thus, for Cleghorn, forests were important: first, to meet the state's timber and revenue needs rather than the needs of the local population. Second, the forests were important from an economic point of view rather than an ecological one. For both Cleghorn and the state, forests were mere crops to be maintained to meet railway needs and to yield good revenue. Hence, orders prohibiting kumri cultivation were issued by the state.

> In this paper Dr Cleghorn replies to the reference made to him ... on the subject of Kumari cultivation in Canara, and the proper measures to be taking [sic] for checking it.... The Government now prohibit Sarkar Kumari, or Kumari cultivation in Government forests, without previous permission. This permission should be given sparingly, and never for spots in the timber forests.[137]

Just as in the case of private contractors cutting forests, Cleghorn did not want the shifting cultivators to have control over the cutting of forests. Thus, by prohibiting kumri, the state could have complete control over the forests and wastelands and could increase its revenue from the forests.[138]

Similarly in the Punjab, Cleghorn was conscious of the state's revenue generation objective when he advocated forest conservancy. In a note on the preservation of plains forests or rukhs written with Dr. Brandis he stated:

> The conclusion at which we arrive, after a careful consideration of the data before us, is, that the hill forests are not likely to be more than self-supporting … *We look therefore to the forests in the outer hills and plains of the Punjab for the yield of a regular surplus revenue* … Independently of the grave question of fuel supply for Railways and steamers, a sufficient area of the best Rukhs should be reserved, and permanently placed under the Forest Department for the production of timber, firewood, charcoal, & c. *This will yield a steady surplus revenue, which may from time to time be required to make improvements in the other forests*.[139]

Thus, in pushing for the conservation of the rukhs or the plains forests in the Punjab, Cleghorn emphasised their revenue-yielding potential to the state. Although Cleghorn believed that private enterprises were interested in profits from forests rather than the state, he himself highlighted the profits and revenue derived from forests to the state.

Most of Cleghorn's suggestions, in fact, cohered with the goals of the colonial state and were therefore implemented. In 1864-65, he along with Dr. Brandis became the Joint Commissioner of Forests and advised the state in the general organisation of forest administration at the all-India level.[140] His achievements were recognised when in a public resolution dated 10th January 1865, the Gov-

ernment of India designated Cleghorn as the 'founder of Forest Conservancy in India'.[141] He briefly held the post of the Inspector- General of forests in 1867 and finally retired from his service in India in 1869. His importance and influence in the field of forest conservancy in India can be seen from the following note by Brandis:

> When Cleghorn laid the foundation of an effective system of Forest Conservancy in Mysore and Madras, Forestry was very little known in India. A commencement had been made in several places, but Dr. Cleghorn was the first to carry out conservancy measures on an extensive scale.[142]

Cleghorn's importance in forest conservancy can also be gauged from the fact that after retirement from his service in India, he was appointed as a confidential adviser to the Secretary of State in the India Office to select candidates for the Indian Forest Service.[143]

4. CONCLUSION

Although the pre-colonial phase in India's environmental history was not a period of ecological equilibrium, the colonial phase was marked by unprecedented ecological changes that were irreversible. This was especially in the arena of forests in the second half of the nineteenth century. The forests had to bear the brunt of, among other things, the introduction and development of technology by the colonial state. The main purpose of technology introduction such as the railways was the maintenance of and efficient extraction of resources from the colony. However, railways themselves consumed natural resources such as timber and firewood from the forests. Hence, due to the expansion of railways massive deforestation took place.

In order for ecological crises such as deforestation to be perceived by the state they had to be observed and analysed by scientists. Hugh Cleghorn, a Scottish surgeon, was one such scientist who not only observed and analysed the causes for deforestation but also provided a solution to stop it. He pioneered the implementation of forest conservation not just provincially in the Madras Presidency and the Punjab but also all over colonial India in 1864. This was even before forest conservation was adopted in Britain. His social background and education played an important role in expanding his interest in forests and later influenced his ideas on forest conservancy.

In addition to his social and intellectual background, the economic and political context in which Cleghorn worked in India was greatly influential in shaping his ideas on forests, deforestation and forest conservancy. By the 1850s trade had become the dominant mode of Britain's exploitation of India's resources. One of the ways by which the colonial state boosted trade was by building railways. But as railway expansion continued there was depletion

of forests. Therefore, Cleghorn observed that the building and expansion of railways was one of the main causes of deforestation. But because, like most colonial officials, Cleghorn believed in the supremacy of western science and technology to develop resources he did not object to the continuance of railway building. Rather he found a technological fix for the deforestation problem caused by the railways.

The other major cause of deforestation Cleghorn felt was kumri cultivation. For him kumri cultivation was bad because the people who practised it were not under the control and supervision of the state. This stemmed from Cleghorn's notion of absolute land control by the state. He firmly believed that state control and supervision over forests was necessary, even before forest conservancy was adopted. Cleghorn argued that private access to forests, whether it involved the timber contractors or the tribes engaged in kumri, would only destroy them. Hence, he saw to it that kumri was prohibited in Mysore and in most parts of Canara.

Even Cleghorn's arguments for the establishment of forest conservancy in India were to a large extent shaped by the economic and political context. Contrary to Grove's[144] argument, scientists such as Cleghorn were not successful in using ecological/climatic reasons to argue for forest conservation to the state. Rather, given the economic and political context of the colonial state's promotion of railways, Cleghorn had to highlight the timber scarcity for the sleeper and fuel needs of railways. The state accepted Cleghorn's suggestions for forest conservancy as long as they were in tune with its long-term interest of efficient resource extraction from India. Railways played an important role in efficient resource extraction. Hence, maintenance of timber supply to the railways became the main aim of the state in forest conservancy. After the 1857 Mutiny, due to a depleted exchequer, revenue generation became the other important concern for the state in forest conservancy. Hence, Cleghorn had to highlight both the revenue yielding potential of forests and the maintenance of railway timber supply, to press for forest conservancy to the state.

As a result of Cleghorn's arguments, forest conservancy was adopted all over India in 1864. But before that all forested land came under state control. Access was denied to the local population, or limited, especially in timber yielding forest areas. Forest conservancy meant that forests became a crop of trees that were selectively harvested through scientific forestry to meet the timber needs of the railways and other public works of the state. Through some silvicultural techniques of scientific forestry certain kinds of trees that were important from the state's point of view were favoured at the cost of trees that were important to meet the needs of the local population. Thus, scientific forestry was a technological fix that Cleghorn and the state used to maintain timber supply for the railways. Similarly, the firewood needs of the railways and other public works determined the establishment of plantations.

Both the natural reproduction of forests through scientific forestry and the establishment of firewood plantations as technological fixes did not prove to be long-term solutions to the deforestation crisis caused by railway expansion. In fact, deforestation continued with both these measures in place. Conservation, indeed, was only undertaken to meet railway needs and even abandoned in the throes of a fuel crisis and also after that crisis forced fuel conversion to coal.

By focusing on the role of state and state officials such as Cleghorn in the implementation of forest conservation, the impact on and of local indigenous communities on forest policies cannot be ignored. As Sivaramakrishnan[145] argues, state forestry as 'development' was contested and negotiated during colonial rule. Given the difference in perception of forests for the colonial state and the forest communities, it will be interesting to research on how these communities reacted to the changes, such as the banning of shifting cultivation, imposed by the state that affected their livelihood. Another important area for future research would be to examine what alternative sources of livelihood these communities had when they were displaced and what was the ecological impact of their displacement.[146]

Overall, during the colonial period the forests were altered in two ways due to the introduction and development of technology. First, they were denuded to meet the timber and firewood needs of the rapidly expanding railways. Second, there was a change in their composition as they came under state ownership due to another technology, i.e. scientific forestry. Scientists such as Cleghorn played an important role in promoting the above kind of forest conservancy through scientific forestry. His faith in scientific forestry was an example of his firm belief in the power of European science to conquer nature and to find solutions to environmental problems. Hugh Cleghorn's actions on the whole supported the state's goal, despite any reservations he might have had, and he was rewarded commensurately.

NOTES

Abbreviations used

PWD - Public Works Department
Progs - Proceedings
Prog. No.- Proceeding number.
Rev - Revenue.
Agri - Agriculture.
Comm – Commerce.

[1] Parliamentary Papers 1871 [c.466], 95.

[2] After the 1857 Mutiny due to a depleted imperial exchequer, there was pressure on the colonial state to generate revenue. This extraction of revenue/surplus had to be done without provoking any rebellion. This could be done by boosting British trade with India rather than by increasing land tax or by territorial expansion (Cain and Hopkins 1993: 333).

[3] Britain's exploitation of India's resources through trade by the early 1850s was mostly focused on increasing India's export surplus to meet the home charges which were transferred annually from India to Britain (Bose and Jalal 1999: 99). Home charges included the cost of the secretary of state's India office in London, costs of war at home and abroad, purchase of military stores and pensions for British military and civilian officials. By 1900 the home charges amounted to between seventeen and eighteen million pounds sterling (Bose and Jalal 1999: 99).

[4] Morris and Dudley 1975: 194–5.

[5] Gadgil 1971: 133.

[6]The shaping of state-promoted projects in colonial India based on metropolitan requirements became more pronounced by the end of the 1860s. This was because improved communication and transportation, tightened Britain's control over India with even minor decisions on Indian policy being made in Britain (Farmer et al. 1977: 559).

[7] Bose and Jalal 1999: 99.

[8] This is not to deny that other factors such as the opening of the Suez Canal were important in boosting the trade figures but the primary role of the railways in facilitating and promoting trade cannot be denied (Tomlinson 1993: 100).

[9] Headrick 1988: 20.

[10] Grove 1995: 7.

[11] Ibid.: 12.

[12] Anderson 1967, I: 279.

[13] McIntosh 1895: i.

[14] Ibid.

[15] Botany was one of the subjects that one had to study while studying medicine.

[16] Royal Scottish Arboricultural Society 1890: 202.

[17] This was unlike the English medical schools (Grove 1995: 11).

[18] Grove 1997: 67.

[19] Ibid.: 66.

[20] Royal Scottish Arboricultural Society 1890: 202.

[21] Cleghorn et al. 1852: 79.

[22] Cleghorn 1845: 1, italics added.

[23] J. H. Balfour Correspondence III.

[24] This was a branch of botany dealing with plants important from an economic and medical point of view.

[25] Dr. Edward Balfour was a member of this organisation.

[26] He became the Secretary of this society in 1853.

[27] As discussed earlier, the colonial state, by the 1840s under Governor General Dalhousie and especially after the Mutiny of 1857, began to focus on technological progress and material development in India (Hutchins 1967). Through the application of science and technology to various fields such as agriculture, communications, transport etc. the state wanted to develop India's resources so that they could be increasingly and efficiently extracted (Bryant 1996). However, because these development strategies were pursued within the structure of colonialism or colonial relations the extraction of resources from India was largely to meet Britain's requirements.

[28] Madras Exhibition Report 1852–53: 53 in Cleghorn Papers, Box 9, No. 3.

[29] He was the Governor of the Madras Presidency.

[30] Extract from the Minutes of Consultation 14th July 1854: 3, Cleghorn Papers Box 9 No. 2.

[31] Arnold and Guha 1998: 12.

[32] Cleghorn Papers Box 9 No.7.

[33] Cleghorn 1861: xi.

[34] It was one of the provinces where forest conservation was taken up much earlier than at the all- India level. Cleghorn was made the first Conservator of Forests in 1856 in the Madras Presidency.

[35] Cleghorn 1861: 586, italics added.

[36] Ibid.: x.

[37] Ribbentrop, 1900: 37, 61.

[38] Stebbing 1922, I: 532.

[39] Grove 1995.

[40] Guha 1983: 1882–6.

[41] Guha 1983: 1883.

[42] Rangarajan 1999: 10–12, 15.

[43] Arnold and Guha 1998: 12.

[44] Cleghorn 1873: 3–4.

[45] Cleghorn 1873: 4.

[46] Only when exports of timber from America declined towards the end of the eighteenth century that Britain met its heavy naval timber demand from its own oak forests initially (Anderson 1967, II: 1). Then it began to obtain timber from its colonies such as India

to meet its naval demand. This must have put less pressure on the British forests when compared to the ones in India.

[47] Cleghorn et al. 1852: 80–81.

[48] A type of shifting or slash and burn cultivation practised in Mysore and Canara.

[49] Brandis 1890: 89.

[50] Ibid.; Cleghorn 1861: 138.

[51] Cleghorn 1861: 141.

[52] Ibid.: 137.

[53] Elwin 1939: 107–8; Bose 1967: 119–22.

[54] Rangarajan 1999: 8.

[55] Pouchepadass 1995: 2065.

[56] Bayly 1988 :141.

[57] Anderson 1967, II: 2. However, the deforestation due to railway construction in Scotland did not reach the crisis level it did in India as timber increasingly began to be imported.

[58] Cleghorn 1861: 60.

[59] Ibid.: 32.

[60]This information later enabled the state to calculate and demarcate certain forested areas, depending on their value and location, to be reserved so that a permanent supply of timber to meet the state's needs could be maintained.

[61] Cleghorn 1864: ii.

[62] Given the existing level of technology, wooden sleepers were found to be most suitable for the railways in India at that time. Experiments to prolong the life of the wooden sleepers (e.g. by creosoting) continued even up to the end of the nineteenth century (Tucker 1993: 183).

[63] Cleghorn 1860: 33.

[64] From 1861 to 1864.

[65] Excluding those required for sidings, stations etc.

[66] Deodar (*Cedrus deodara*) was found to be most suitable tree for use in railway sleepers in the Punjab.

[67] PWD Progs Dec 1861 Prog No. 22.

[68] For the construction of this line most of the trees were felled in the hill forests of the Chenab and Ravee river valleys.

[69] PWD (Forests) Progs May 1864; August 1865 Prog No. 36; Cleghorn 1864: 158.

[70] The Punjab was far away from the coalmines. For example, the three closest coalfields to Delhi were the Raneegunge fields in Bengal, the Singrowlee fields at Rewah, and the Mopani fields in the valley of the Nerbudda. They were at distances of 950, 550 and 700 miles respectively. PWD(Forests) Progs Sept 1866.

[71]This calculation is based on the length of the railway lines that the engines travelled in each of the four districts i.e. Amritsar, Googaira, Lahore and Multan and also included the fuel required in railway workshops and steamers.

[72] 27 maunds of wood equalled 1 British ton or 45 cubic feet (Stebbing 1922, I: 284).

[73] PWD (Revenue Forests) Progs January 1865 Prog No. 23.

[74] The fuel trees in the rukhs required 10 to 20 years to attain maturity.

[75] Cleghorn 1873: 2.

[76] Ibid.: 2–3, 6.

[77] Cleghorn 1861: vii.

[78] Ibid.

[79] Baden-Powell 1877: 280.

[80] Cleghorn 1861: v.

[81] Ibid.: 126.

[82] Cleghorn 1864: 30–31.

[83] Grove 1995: 468.

[84] Ibid.: 467–8.

[85] These included showing the connection between deforestation and droughts.

[86] Guha 1983: 1884.

[87] A difficulty currently exploited by U. S. Anti-environmentalists to resist ecologically driven policies.

[88] Cleghorn et al. 1852: 78.

[89] Experiments to establish the influence of forests on the climate, particularly on the temperature and humidity of a country, only started around 1873 in Britain, long after Cleghorn's retirement from the Indian Medical Service (Cleghorn et al. 1874: 7).

[90] Scotland being an exception in this respect (Anderson 1967, II: 314).

[91] Saldanha 1996: 1265.

[92] Stebbing 1922, I: 301.

[93] Rangarajan 1999: 7.

[94] Cleghorn 1864: ii.

[95] Ibid.

[96] Barton 2000: 187.

[97] After his retirement from service in India.

[98] Cleghorn 1873: 5.

[99] Grove 1995: 7.

[100] See Miliband 1980; Alavi et al. 1982.

[101] *Artocarpus hirsute*.

[102] *Pterocarpus marsupium*.

[103] *Inga xylocarpa*.

[104] Cleghorn 1861: 43, 60–61.

[105] Guha and Gadgil 1989: 147; Haeuber 1993: 53; Rangarajan 1994: 161; Sivaramakrishnan 1995: 16.

[106] Forest conservation, through scientific forestry, was cheaper to adopt to maintain railway sleeper supply than the creation of new forests artificially by planting timber trees such as deodar, which had a long gestation period. PWD (Forests) Progs 1866 No. 2.

[107] The process of cutting trees in such a way that the trunk portion remaining in the soil would develop shoots and grow into a tree.

[108] Ribbentrop 1873: 73.

[109] Sivaramakrishnan 1995: 18.

[110] Brandis, 1890: 91, italics added.

[111]This was done through barking or girdling that killed the *less valuable* trees such as oak (Saldanha 1996: 1268; italics added). The valuable trees such as deodar, teak and sal did not form pure forests. They often grew with other species such as oak that were used as fuel, fodder and small timber by the local people (Guha and Gadgil 1989: 147).

[112] Saldanha 1996: 1268; Guha and Gadgil 1989: 147; Sivaramakrishnan 1995: 18.

[113] Brandis, 1878: 372.

[114] Tucker 1993: 181.

[115] Amery, 1876: 219–20.

[116] Ibid.: 223.

[117] This was especially for the Delhi Railways built between 1864 and 1870 (PWD Progs September 1864; PWD Progs December 1864).

[118] Home, Rev and Agri (Forests) Progs Jan–Aug 1880 (Home, Rev and Agri (Forests) Progs Nov–Dec 1881; Sept–Dec 1882; Oct-Dec 1883.

[119] PWD Progs 1866, Prog No. 3.

[120] PWD Progs 1866 Prog No. 25.

[121] PWD (Revenue-Forests) Progs 1866.

[122] Brandis 1890: 91.

[123] Forest Administration Report 1878–79: 20.

[124] Agri, Rev and Comm (Forests) Progs June 1878, Prog No. 12.

[125] Home, Rev and Agri (Forest) Progs Nov–Dec 1881, Prog No. 4.

[126] Railway Administration Reports for 1880–81 and 1882–3.

[127] Home, Rev and Agri (Forests) Progs 17 Sept 1881.

[128] Guha 1983: 1886.

[129] Amery 1876: 220; italics added.

[130] Cleghorn 1861: 36.

[131] Ibid.: 138.

[132] Cleghorn et. al 1852: 84–6.

[133] Ibid.: 85)

[134] Cleghorn 1861: 137.

[135] Ibid.: 138.

[136] Ibid.: 137.

[137] Ibid.: 142–4.

[138] Rangarajan 1999: 24.

[139] Cleghorn 1864: 243, italics added.

[140] Brandis 1890: 92.

[141] Parliamentary Papers 1871: 95.

[142] Brandis 1890: 93.

[143] Ibid.

[144] Grove 1995.

[145] Sivaramakrishnan 2000: 83.

[146] Some research has already started in this area. See Agarwal and Sivaramakrishnan 2001.

BIBLIOGRAPHY

Primary Sources

A. Government Records

Government of India Records held in the National Archives of India, New Delhi

Public Works Department Proceedings November 1862; 1866; Dec 1861; September 1864; December 1864

Public Works Department (Forests) Proceedings May 1864; August 1865; September 1866.

Public Works Department (Revenue Forests) Proceedings January 1865; 1866

Agriculture, Revenue and Commerce Department (Forests) Proceedings June 1878

Home, Revenue and Agriculture Department (Forests) Proceedings Jan-Aug 1880; September 1881; November-December 1881; September-December 1882; October-December 1883;

Forest Administration Report 1878–9

Railway Administration Reports for 1880–81 and 1882–3.

B. Private Papers and Manuscripts

In Special Collections of the St. Andrews University Library, St. Andrews, Scotland

Cleghorn Papers, Ms dep 58, Box 9, Vol. 2,3, 4, 7.

In Royal Botanical Gardens of Edinburgh Library, Edinburgh, Scotland.

Correspondence of J. H. Balfour Professor of Botany at the University of Edinburgh and the Keeper (Director) of the Royal Botanic Garden Edinburgh (1845–1879) and Hugh Cleghorn, Vol. III.

C. Books and Pamphlets

Brandis, D. 1878. *Memorandum on the Supply of Railway Sleepers of the Himalayan Pines Impregnated in India.*

Cleghorn, H. F. 1861. *The Forests and Gardens of South India*. London: W. H. Allen.

Cleghorn, H. F. 1864. *Report upon the Forests of the Punjab and the Western Himalaya*. Lahore: Superintendent Government Printing.

Cleghorn, H. F. 1873. *Address Delivered at the Nineteenth Annual Meeting of the Scottish Arboricultural Society*, November 6, 1872. Edinburgh: Neill & Company.

Ribbentrop, B. 1873. *Hints on Arboriculture in the Punjab; intended for the use of District and Forest officers*. Lahore: Superintendent Government Printing.

D. Journal Articles

Amery, C. F. 1876. 'Report on the Forests of India'. *Transactions of the Scottish Arboricultural Society*, VIII: 215–24.

Brandis, D. 1875. 'On the Distribution of Forests in India'. *Transactions of the Scottish Arboricultural Society*, VII: 107–15.

Brandis, D. 1890. 'Dr. Cleghorn's Services to Indian Forestry'. *Transactions of the Scottish Arboricultural Society* XII: 87–93.

Baden-Powell, B. H.1877. 'The Political value of Forest Conservancy'.*Indian Forester* II: 279–84.

Cleghorn, H. F.1845. 'Notes on the Medical and Economical Resources of the Forests of India'. *The Pharmaceutical Journal* VI : 1–12.

Cleghorn, H. F. et al. 1852. 'Report of the Committee appointed by the British Association to consider the probable effects in an Economical and Physical point of View of the Destruction of Tropical Forests'. *Transactions of the British Academy for the Advancement of Science*: 78–102.

Cleghorn, H. F. et al. 1874. 'Address Delivered at the Twentieth Annual Meeting of the Scottish Arboricultural Society'. *Transactions of the Scottish Arboricultural Society* VII: 5–10.

E. Parliamentary Papers

Selection of despatches and their enclosures to and from the Secretary of State in India in Council on Forest conservancy in India, showing the measures which have been adopted, and the operations which are going on in the several Presidencies and Lieutenant Governorships, from the 31st May 1862 1871[c.466]

Secondary Sources

Alavi, H. et al. 1982. *Capitalism and Colonial Production*. London: Croom Helm.

Agarwal, A. and K. Sivaramakrishnan eds. 2001. *Social Nature: Resources, Representations, and Rule in India*. New Delhi: Oxford University Press.

Anderson, M. L. 1967. *History of Scottish Forestry*, Vol. I. London: Nelson.

Anderson, M. L. 1967. *History of Scottish Forestry*, Vol. II. London: Nelson.

Arnold, D. and R. Guha eds. 1998. *Nature, Culture, Imperialism: Essays on the Environmental History of South Asia*. Delhi: Oxford University Press.

Barton, G. A. 2000. 'Empire Forestry and American Environmentalism'. *Environment and History* 6: 187–203.

Bayly, C.1988. *Indian Society and the Making of the British Empire*. The New Cambridge History of India, vol. 2 (i). Cambridge: Cambridge University Press.

Bose S., and A. Jalal. 1999. *Modern South Asia: History, Culture, Political Economy*. Delhi: Oxford University Press.

Bose, S. 1967. *The Carrying Capacity of Land under Shifting Cultivation*. Calcutta.

Bryant, R. 1996. 'Romancing Colonial Forestry: The Discourse of "Forestry as Progress" in British Burma'. *The Geographical Journal*, 162(2): 169–78.

Cain, P. J., and A. G. Hopkins.1993. *British Imperialism: Innovation and Expansion 1688–1914*. London and New York: Longman.

Farmer, E. L.et al.1977. *Comparative History of Civilizations in Asia*. Reading, Massachusetts: Addison-Wesley Publication Company.

Elwin, V. 1939. *The Baiga*. London.

Gadgil, D.R. 1971. *The Industrial Evolution of India in Recent Times, 1860–1939*. Bombay: Oxford University Press.

Grove, R. 1995. *Green Imperialism: Colonial Expansion, Tropical Edens and the origins of Environmentalism, 1600–1860*. Cambridge; New York: Cambridge University Press.

Grove, R. 1997. *Ecology, Climate and Empire: Colonialism and Global Environmental History, 1400–1940*. Cambridge: White Horse Press.

Guha, R. 1983. 'Forestry in British and Post British India: An Historical Analysis'. *Economic and Political Weekly* XVII: 1882–96.

Guha, R. and M. Gadgil. 1989. 'State Forestry and Social Conflict in British India'. *Past and Present* CXXIII: 141–77.

Haeuber, R. 1993. 'Indian Forestry Policy in Two Eras: Continuity or Change?' *Environmental History Review* Spring: 49–76.

Headrick, D. R. 1988. *The Tentacles of Progress: Technology Transfer in the Age of Imperialism, 1850–1940*. New York: Oxford University Press.

Hutchins, F. G. 1967. *The Illusion of Permanence: British Imperialism in India*, Princeton: Princeton University Press.

McIntosh, W. C. 1895. 'Dr. Hugh Francis Clarke Cleghorn'. *Proceedings of the Royal Society of Edinburgh* September: i–x.

Miliband, R. 1977. *Marxism and Politics*. Oxford: Oxford University Press.

Morris, D. M. and C. B. Dudley. 1975. 'Selected Railway Statistics For the Indian Subcontinent (India, Pakistan and Bangladesh), 1853–1946/47'. *Artha Vijnana* XVII, 3 (September): 187-298.

Pouchepadass, J. 1995. 'Colonialism and Environment in India: Comparative Perspective'. *Economic and Political Weekly* XXX: 2059–67.

Rangarajan, M. 1994. 'Imperial Agendas and India's Forests: The Early History of Indian Forestry, 1800–1878'.*Indian Economic and Social History Review* XXXI: 147–67.

Rangarajan, M. 1999. *Fencing the Forest: Conservation and Ecological Change in India's Central Provinces, 1860–1914*. Delhi; Oxford: Oxford University Press.

Ribbentrop, B. 1900. *Forestry in British India*. Calcutta: Superintendent of Government Printing.

Royal Scottish Arboricultural Society. 1890. 'Presentation to Hugh Cleghorn of Stravithie'. *Transactions of Scottish Arboricultural Society* XII: 198–205.

Saldanha, I. M. 1996. 'Colonialism and Professionalism: A German Forester in India'. *Economic and Political Weekly* XXXI, 21: 1265–73.

Sivaramakrishnan, K. 1995. 'Colonialism and Forestry in India: Imagining the Past in Present Politics'. *Comparative Studies in Society and History* 37, 1 (January): 3–40.

Sivaramakrishnan, K. 2000. 'State Sciences and Development Histories: Encoding Local Forestry Knowledge in Bengal'. *Development and Change* 31: 61-89.

Stebbing, E. P.1922. *The Forests of India*. Vol. I. London: John Lane.

Tomlinson, B. R. 1993. *The Economy of Modern India, 1870–1960*. Cambridge: Cambridge University Press.

Tucker, R. P. 1993. 'Forests of the Western Himalaya and the British Colonial System (1815–1914)'. In *Indian Forestry: A Perspective*, ed. A. S. Rawat. New Delhi: Indus Publishing Company.