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Railway-Induced Deforestation and Hydrological Disruption in the Nilgiris District, Colonial Madras Presidency

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ABSTRACT: The Nilgiri Mountain Railway (NMR), built between 1891 and 1908 across the southern escarpment of the Nilgiris in the Colonial Madras Presidency, has been considered a UNESCO World Heritage Site and an engineering miracle. However, its environmental impact in terms of ecosystem construction and use has been barely touched by scholarly research. This article attempts the historical-ecological examination of the environmental impact of the NMR using the colonial Public Works Department records, Madras Forest Department Annual Progress Reports, and the Nilgiris District Gazetteer, 1908, 1918 & 1934. This study presents three interdependent aspects of environmental changes that the railway caused along the alignment during excavation and in the plantation hinterland it would serve, as well as the fuelwood consumption from the steam locomotives, which led to the increase in the attrition of the shola-grassland vegetation cover across the district. It also draws attention to the ecological costs of the NMR by focusing on the railway in relation to the larger colonial changes on the Nilgiri plateau.

INTRODUCTION

The Nilgiri Mountain Railway (NMR), which stretched from Mettupalayam, in the plains, up to the precipitous slopes of Udhagamandalam (Ootacamund, or simply Ooty), in the mountains, has held a special place in the History of Colonial India, traversing a distance of forty-six kilometres in the process. In 1854, the line was proposed for the first time and subsequently deferred due to the immense difficulty of the Nilgiri escarpment until it was finally sanctioned in the late 1880s, when work began in 1891, and the first section (between Mettupalayam and Coonoor) opened to traffic on 15 June 1899 (Sargeanut, 1899). The extension to Ooty was completed by 1908. Its steepest sections, from 326 metres at Mettupalayam to 2,203 metres at Ooty, were the only Swiss-designed Abt rack-and-pinion system in India, (Weber, 1911) which has gradients of up to 1 in 12, threading sixteen tunnels and crossing 257 bridges and 209 curves (Price, 1908). This earned the railway, a place in the UNESCO Mountain Railways of India World Heritage site list in 2005, cementing its reputation as one of the greatest feats of colonial engineering in South Asia (UNESCO World Heritage Centre, 2005).

But that reputation has always hidden the ecological cost of achieving this success. The NMR was not built on the terrain. It was intersected with one of the most unique and delicate montane ecosystems of the subcontinent, the shola-grassland mosaic of the Nilgiri plateau. At that time, the colonial planters had access to the plateau, and they were engaged in clearing the land for coffee, tea, cinchona and eucalyptus cultivation. This led to the creation of a compound ecological disruption: a plantation expansion in the hinterland that the line opened up; sustained timber extraction and fuel wood for the line's operational requirements; and destabilisation of the slope due to the presence of shola forest cover, which had previously held extraordinarily high moisture, even during the dry season. The impact of these consequences didn't fade away even after the end of the colonial era. Recurrent landslips are an issue along the NMR corridor (Bunyan et al., 2012).

In the existing literature or research the primary focus is on the Abt System, the construction challenges and railway's role in the hill station economy but the environmental questions were rarely addressed (Kerr, 1995). The present study attempts to fill this research gap. It relies on colonial Public Works Department correspondence, Annual Progress Reports from the Madras Forest Department, and District Revenue Records. The inquiry is organised around two research hypotheses. First, what were the patterns of deforestation that were related to the construction and operation of the railway? Second, what effects did the railway have on the physical infrastructure (the landscape itself as well as the drainage pattern) of the Nilgiri slope?

These hypotheses are not simply historical but have significance on the environmental study. The Colonial railway's role in the formation of pressures such as shola fragmentation, altered monsoon hydrology, chronic slope instability, and a decrease in stream flows in the catchments which supply water to three states currently Tamil Nadu, Kerala, Karnataka facing the Nilgiris today is not an antiquarian exercise, and understanding its history is important for the future. [8] This is a prerequisite for the intelligent conservation and infrastructure planning within the Nilgiri Biosphere Reserve.

LITERATURE REVIEW

- One of the earliest historical accounts of the development of the Nilgiris under British rule was in Frederick Price's Ootacamund: A History (1908). The book, written at Lord Ampthill's request, the governor of Madras, primarily records the political, administrative and social development of the colonial hill station of Ootacamund. Price gives a wonderful account of the construction of the Nilgiri Mountain Railway (NMR), which was a geological challenge to deal with, in the form of the Abt rack-and-pinion system. The book contains much useful and up-to-date information about the planning and building of the railway and its importance in modernising the administration and providing access to the hills. It is a mostly celebratory and colonial point of view, though. The author does not discuss the environmental impact of the construction of railways, such as deforestation, change of drainage, loss of habitats or displacement of indigenous people. The book is thus a valuable primary source of historical information about the inception of the NMR, but it is somewhat deficient in its implications for ecology, an aspect of the NMR that the present research aims to fill in. [9]
- The Nilgiri Mountain Railway is recognised as a site of Outstanding Universal Value (OUV) in the World Heritage Nomination Dossier prepared for the Mountain Railways of India by UNESCO. It points out the engineering innovation of the railway, especially its unique rack railway, architectural aspect and importance in the development of hill stations during the colonial rule. The dossier has succeeded in establishing the heritage importance of the railway and offers a discussion of conservation and management strategies to preserve the railway infrastructure. Still, environmental effects are only considered management issues and not processes of history. The document doesn't assess the ecological changes in Nilgiris due to the railway construction nor explore its long-term environmental impacts in terms of deforestation, land-use alteration or loss of biodiversity. So although the dossier is essential to create an understanding of the heritage value of a railway, it does not provide a lot of information about environmental history. [10]
- This Fissured Land by Madhav Gadgil and Ramachandra Guha is considered to be one of the seminal texts in the field of environmental history in India. The colonial environmental policies have been seen as a radical shift in the ecological structures of India by bringing control over forests into the hands of the state, commercialising natural resources, and pushing traditional community-based resource management practices to the margins. The author shows that British forest policy was largely aimed at providing the timber necessary for commercial purposes and the Imperial needs in particular, such as railways. [11] The Indian Forest Acts of 1865, 1878 and 1927 are explained in the discussion to demonstrate how legislation was used in colonial India to institute state control over forests and to allow the forested resources to be exploited on a large scale. While the authors have not specifically investigated the Nilgiri Mountain Railway, their theoretical build is a crucial underpinning of the study of the ecological changes that were occurring with the colonial railway. The book, however, does not attempt a localised study of the Nilgiris or an evaluation of the direct effects of the railway construction on mountain ecosystems, thus creating opportunities for more in-depth study at the local level. (Guha., et al., 1989)[12]
- Richard Grove's Green Imperialism is an investigation of the development of colonial environmental thinking in the eighteenth and nineteenth centuries. Grove believes that the issues of deforestation, climate change, rainfall, soil erosion and degradation spurred the establishment of early conservation policies in the British Empire. [13] The book offers a crucial conceptual tool for attempting to understand the paradoxical character of the colonial environmental

policy. Colonial governments encouraged commercial use of forests but also saw the value of forest conservation as a way to ensure climatic stability and water resources. Grove's arguments are particularly pertinent to the Nilgiris since the colonial government repeatedly expressed their concerns about the impact of deforestation on stream flow, rainfall and mountain ecology. However, that is not an aspect of the Nilgiri Mountain Railway which is explored in the work. Its value is primarily in terms of its intellectual history, rather than in its environmental impacts as a railway infrastructure.[13]

- One of the most detailed interdisciplinary studies of the Nilgiris, edited by Paul Hocking, is Blue Mountains. The volume is a synthesis of historical, anthropological, ecological, geographical and ethnographical data which discusses the environmental features of the Nilgiri plateau, like the shola-grassland system, biodiversity, indigenous population and settlement pattern. [14] The contributors discuss the relationship between the ecological systems and the indigenous groups like the Todas, Badagas, Kotas and Kurumbas. The project illustrates the impact of colonial uses of the land, such as plantation farming and administration, on traditional land use. The railway is referred to in the general context of colonial development, but the environmental impact of the railway is not systematically assessed. The ecological and ethnographic information given in this work, however, provides much background to consider in relation to the long-term ecological impacts of the Nilgiri Mountain Railway. [15]
- Investment in Empire is a book on the financing of colonial railways in India by Daniel Thorner. The author critically reviews the guaranteed railway system launched by the British government and suggests that the investment in railways benefited mainly the British investors but created many financial burdens on the Indian economy. [16] The work presents a detailed analysis of the aspects of capital investment, guarantees of the government, administration of railways and economic policy. While essential for the study of the economic underpinnings of the building of railways in the colonies, the study gives little regard for the environment or for the ecological changes which occurred in the areas through which the railways were built. [16]
- The Cambridge Economic History of India provides a larger perspective on the history of Indian railways and is edited by John Hurd. He assesses the financial aspects of railways, freight services, commercial system integration, agricultural markets and industrial development. [17] Hurd finds that railways played a key role in changing India's economy through increased market integration and goods and transport. But his analysis is essentially economic and administrative with no particular attention to the degradation of the environment, change of landscape or ecological effects of railway expansion. [18]
- While Building the Railways of the Raj focuses on the financial aspects of the railway construction, Ian Kerr's focus is on the lives of the railway engineers, contractors and labourers who worked to build the railway network in India. The author discusses techniques of construction, recruitment of labour, adaptation of technology, and colonial engineering.[19] The book offers good information on the human aspects of railway building but is comparatively poor in ecological aspects of change. Forest clearance, forest alteration and degradation are still marginal problems in Kerr's overall study.

Area and Period of the Study

Geographical features

The Nilgiris district is located in the northwest corner of Tamil Nadu and starts to rise sharply from the Coimbatore plains to the south and the Mysore plateau to the north, along several steep gradients that have shaped the landscape ever since the early days of history. Above about 2,000 metres, the plateau was dominated by a distinct shola-grassland mosaic long before Europeans came to colonise the area. [20] As high rainfalls, low temperatures and the amazing water-holding capacity of shola soils created a landscape of perennial streams and reliable water resources, which was admired by European observers even as the policies they implemented worked to reduce it.

The Nilgiri escarpment, down which the NMR rolls from Coonoor to Mettupalayam, is one of the steepest continuous gradients in the subcontinent, the drop being over 1,800 metres in a horizontal distance of about thirty kilometres. Soils found on this escarpment are very prone to erosion and mass movement when disturbed or removed from the site, especially those with deep organic horizons under the influence of forest cover and lateritic soils occurring above the basement rock.[21] A crucial geological observation to be made is that the embankments and cuttings the NMR needed to construct on this topography were intrusions into a very dynamic slope system with a strong interdependence of its vegetation.

Pre-Railway Human Ecology

Before the colonial era, the Nilgiri plateau had several different communities using different systems of land use, which were relatively harmonious with the ecological features of the land. The Badaga, who, slightly later, settled the plateau, engaged in mixed agriculture on the more sheltered valley floors, while the montane grassland character of the interfluves was preserved by the Toda economy of buffalo herding, which left the shola patches mostly unaltered. [22] The Kota provided craft products; the Kurumba lived on the outskirts of forests and were cultivators and collectors. It was not an unchanging and pristine ecology, the montane grasslands themselves being in part anthropogenic, maintained by centuries of pastoral burning, but it was an ecology in which the patches of shola and the permanent streams of water that they regulated were broadly conserved. [23]

European settlement of the Nilgiris was a gradual process, which started to gain momentum in the 1820s when John Sullivan of the Madras Civil Service spotted the plateau as a suitable location for a European sanatorium. Ootacamund was formally established as a hill station in 1821, and the place saw rapid transformation of the plateau's land use – forests were cleared for the cultivation of plantation crops like coffee, tea and cinchona, which led the grazing lands into private estates, and the tribal communities were progressively displaced through a combination of land alienation and revenue policy. [24] By the early 1890s, when railway construction started, it facilitated and intensified a transformation.

The NMR Alignment

From Mettupalayam (326 m), the route heads up the southern escarpment in a series of switchbacks and rack sections to arrive at Coonoor (1,712 m) – a twenty-eight-kilometre stretch of the route which stands out as the most dramatic and ecologically sensitive. It is this area where the gradients are steepest and where the railway had the greatest requirement for cutting down through forests and building the highest concentration of bridges and retaining walls. The railway line extends from Coonoor and continues across the plateau to Wellington, Aruvankadu, Ketti, Lovedale and Ooty for around 2,203 m, and this line was completed in 1908.[25] The concentration of the sixteen tunnels on the Mettupalayam–Coonoor section is reflected by the relatively high density of bridges, 257 of which are distributed along the 60 km of the line: only about one bridge for every 180 m. The dense concentration of tunnels and bridges on the line as a whole is matched by the general tendency of the topography along the escarpment to be broken and by the drainage complexity of the terrain, which, before the introduction of plantations, had a dense network of seasonal and perennial flows across the slope.(UNESCO, 2005)

METHODOLOGY

This study relies on three main repositories for the primary archival research. The Madras Presidency Proceedings of the Public Works Department are housed in the Tamil Nadu State Archives, Chennai, and the construction correspondence, engineering reports and operational records regarding the construction of the NMR are spread over several decades of files from approximately 1885 to 1947. These records describe not only the engineering choices made in building the railway but also the complaints, damage reports and repairs that reveal the hydrological impacts of the railway construction in a detail that no other record will capture. The railway's hydrological impacts as well, such as landslips, drainage obstructions, and embankment failures. The main sources of data on forest clearance, timber volume removals, and the evolving boundary of the Nilgiris Forest Division during construction and operating years are the Madras Forest Department Annual Progress Reports, which are also housed in the Tamil Nadu State Archives. [26]

Central government records relating to NMR are maintained at the national level (not provincial) and are held by the National Archives of India in New Delhi. The successive colonial editions of the Nilgiris District Gazetteer offer a description of the district which is both administrative and ecological and are invaluable for the examination of change in land use over the study period.

Results of the Study

The construction of the Mettupalayam–Coonoor stretch of the NMR involved the clearing of a long stretch of vegetation along the escarpment face, such as the removal of forest cover along the cuttings, the establishment of a working camp at various locations in the area and the extraction of timber for sleepers and bridging materials from the forest. The sanctioned timber extraction records of the Madras Forest Department from the 1890s show that the amount of timber extracted had increased substantially during this period when the railway was under construction and that the amount of the species which was suitable for sleeper production was greatly increased above the level of the previous ten years. [27] Public Works Department

correspondence from the construction period records the demand from the Public Works Department for standing timber on the alignment of the railway in the Nilgiris Division, and the Forest Department's reply shows it was prepared to allow this taking and, in several cases, had expressed concern about the sustainability of timber extraction at the levels required by the construction programme. [28]

The space between the alignment where it was and the buildings themselves was not so great an absolute amount of space, considering the shortness of the length of the alignment. In the long run, more important was the hurried extension of plantations that took place after the Coonoor section was opened in 1899. The Nilgiri District Gazetteer notes that the increase in tea cultivation area in the district was considerable during the first decade of the twentieth century, when bulk transport was inaccessible previously.[29] The expansion was not wholly on the railways alone, but the extent of the tea area, as shown on the early twentieth-century Survey of India sheets as compared to the late nineteenth-century ones, reveals a definite extension of the boundaries of the plantations into areas served by the new line, which points to the interpretation that the railway was a commercial catalyst for clearance that was already underway.

Hydrological Disruption

Anecdotes and reflections are left behind in the Public Works Department proceedings and operational letters at the Tamil Nadu State Archives, documenting the hydrological consequences of the construction of the NMR. The most direct evidence is the damage reports and repair requisitions, which are produced by the section engineers responsible for the maintenance of the line every monsoon. The record of recurring slope failures, embankment erosion and obstruction of natural drainages on the railway is fairly consistent in the period from 1900 to the 1940s, and the majority of these events have been recorded over the years on the Mettupalayam–Coonoor stretch of the railway, which was the most seriously affected by the steepness of the terrain, the railway's earthworks and the natural drainage of the slopes on this section.[30]

In the context of the ecological literature on the hydrology of sholas, it is not hard to understand the pattern. In conditions of an undisturbed shola cover, soils of the Nilgiris escarpment hold water in a deep organic layer and release it gradually in the stream network during the dry season, which was observed by the colonial settlers, and they appreciated them for the perpetual stream flow. The area where this cover was cleared by cutting, and the area where the natural drainage lines on the slope were broken by embankment construction, resulted in an increase in surface runoff, diversion of subsurface water and reduction of the ability of the slope to accept the monsoon rainfall without failure. From year to year, the same sections of the line show up in the damage log for the engineering response – more culverts, more retaining walls, more catch-drains and so on – but these only tap the symptom and not the cause.

This is complemented by revenue and irrigation records of the same period. The complaints in the Mettupalayam taluk in the Madras Presidency Proceedings are similar to those reported elsewhere in colonial India: that the railway embankments on flat ground interrupted lateral sheet flow of floodwater, but in the context of the Nilgiris, they are unique in that the flow was disrupted from the concentrated streams that had historically supplied water to the fields efficiently from the escarpment to the plains below.[31]

Fuel Wood Demand and Shola Attribution

When the NMR was in operation (1899 until the mid-20th century when diesel came in), the surrounding forests were continually tapped to provide fuelwood for the steam locomotives. Increased firewood allocation by the Forest Department over the steam era (1883–1978) and extraction by the plantation labourers and population in the area at the lower and mid escarpment had led to a gradual reduction in the available forest cover around the stations.[33] The Shola patches those at the upper escarpment were less directly affected because of their remoteness and difficulty of extraction. Surveys in the 1920s and 30s depict a noticeable reduction in the extent of shola area around the major settlements as compared to the earlier maps, due to the high population density of the Ooty hill station, which began to grow after 1908 because of the extension of the railway to the plateau.

DISCUSSION

Perhaps the big takeaway from this study is that the ecological footprint of the NMR is hard to distinguish from the plantation economy that it was designed to serve. The railway did not invent the Nilgiri plantation economy indeed, coffee had been planted on the plateau since the 1840s but its introduction changed the nature of the economy, for it was able to greatly lower

the cost and time required to transport produce to the plains market and to open up the plateau to a variety of investment and labour recruitment that had been previously impractical because of the difficulty of the journey.[32] The deforestation of shola and grassland for tea in the decade following 1899 is not just about the railway or the plantation but about one process looked at from two analytical perspectives. The only thing that is as foolish as giving no credit to the railway is to blame the railway for everything.

The railway was the catalyst for a step-change in the rate and geographical scale of plantation expansion, and its building and working demands directly caused the deforestation and disruption of drainage. In effect, the colonial state constructed a railway to be able to service an extractive economy and then engaged in the extraction of just those forest resources that the railway needed, but in a manner that would not be sustainable over time. This is not, however, a paradox peculiar to the Nilgiris but, as Gadgil and Guha have pointed out for the entirety of India, a feature of colonial resource economies in general, which meant that, for the Nilgiris, the effects of the disruption altered hydrology, slope instability, and streamflow decline could be seen and documented within a few decades of the railway's construction.[33]

These are indeed values, and the fact that the railway has been inscribed on the World Heritage List in 2005 does not suggest that the railway is not worthy of the designation. The interpretative expense of a heritage framework which sees the railway as an achievement and the landscape as a setting, however, is worthy of consideration.[34] The tea gardens that visitors to the NMR today find picturesque are the result of the same process as the colonial clearance that the railway facilitated, and the mistshrouded slopes that give the railway's journey a romantic feel are the slopes from which the original shola cover was removed many in living memory of the railway's opening. An account of the heritage that ignores or simply omits this history does not simply 'overlook' it; it actively perpetuates a colonial normative landscape sensibility which has an actual impact on how the landscape is being conserved and developed currently in the Nilgiris. [35]

Comparisons of other Colonial Hill Railway

The Nilgiris sister and UNESCO site amongst the mountain railways of India, the Darjeeling Himalayan Railway, built between 1879 and 1881 across the Darjeeling district of West Bengal, also served a dual purpose access to the hill stations and plantation economy consolidation in a landscape which characterised by ecologically sensitive montane forest.[36] It is suggested that the pattern over the Nilgiris, construction clearance, plantation economy acceleration, and ongoing operational fuelwood demand was not unique to the NMR but representative of colonial hill railways in India as a whole. The Kalka-Shimla Railway, which was constructed in 1903, in some ways is more analytically tractable than either of the comparison cases, partly because it has a longer record of environmental-historical study, including mention of impacts on the Shivalik forests, and partly because of the unique character of the landscape it traversed: a heavily forested terrain in the hills of the Punjab.[37]

Legacy and Contemporary Relevance

The Nilgiri Biosphere Reserve (NBR) was set up in 1986 and covers a large portion of the area traversed by the NMR, which has been the site of intensive ecological research and conservation management for the last 30 years. These studies have been published over this time and are generally interpreted in the context of an expanded plantation and urbanisation pressure in recent years, but the historical evidence that has been collated in the present study indicates that these processes are not new and can be traced back to the colonial period and, in particular, back to the railway-plantation complex that transformed the district from 1891 to 1947.[38] This matters practically. Baselines for conservation and water-management planning in the Nilgiri Biosphere Reserve are often based on the previous available remote sensing information, which is usually that of the 1970s/1980s.

CONCLUSION

This study has carried out the first systematic historical-ecological analysis of the environmental impact of the Nilgiri Mountain Railway in the Nilgiris district over the course of colonial history. From the Madras Forest Department records, Public Works Department construction and maintenance correspondence, district revenue it has identified three interrelated aspects of ecological change resulting from the construction of the railway: direct forest clearance that occurred during the time of construction; acceleration of plantation expansion in the hinterland served by the line; and hydrological disturbance caused by embankments, cuttings and approaches of tunnels on a steep escarpment whose stability depended on the vegetation cover. A

fourth, but diffuse and cumulative, pressure on Shola Cover was generated by sustained demand for fuelwood in the lower and mid-escarpment areas of the district, driven by the use of steam locomotives.

At a conceptual level, the results provide an alternative, more nuanced understanding of the unvarnished engineering success story of the NMR by integrating the railway's history into the ecology of the landscapes it travelled through. The exceptional universal value recognised by UNESCO is very real, and so is the ecological cost that has been recorded here these two cannot be separated by the rules of the heritage discourse. The historical reconstruction provided by this study contributes to the ecological baseline for the Nilgiri Biosphere Reserve, which extends the period of ecological data available for conservation and water-management planning by several decades and is more historically based to better understand the disruptions that are currently being faced by management. The ecology of colonial infrastructure, like all other aspects of the colonial world, has been long overdue for historical investigation, and its fruits have been lying in the archives.

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END NOTES

[1] It is a long steep, slope or cliff that separate two level area lands with different elevation. The *Coonor ghat* is one of the famous escarpment for Niligiri Mountain Railway

[2] [2]Sargeaunt. R.A. Administrative Report on Railways of India, 1899. India, Majesty Stationary Office, London, 1899.

[3] Price, Frederick. Ootacamund: A History. Madras: Government Press, 1908. Reprinted Delhi: Asian Educational Services, 2002.; see also. Weber, J. Rack-Railway Locomotives of the Swiss Mountain Railways, Sage Publication, July 1911, pp. 537-569.

[4] UNESCO World Heritage Centre. Mountain Railways of India. World Heritage List No. 944bis, Nomination Documentation. Paris: UNESCO, 2005.

[5] Bunyan, Milind., Sougata Bardhan, Shibu Jose, The Shola (Tropical Montane Forest)- Grassland Ecosystem of Peninsular India: A Review, American Journal of Plant Science, (3), 2012, pp. 1632-1639.

[6] Weber.J., 1911. pp. 537-569

[7] [7]Kerr, Ian J. Building the Railways of the Raj, 1850–1900. Delhi: Oxford University Press, 1995

[8] Bhave, Neha & Kulkarni, Himanshu. Detailed hydrogeological mapping in parts of the Nilgiri Biosphere Reserve.2018. 10.13140/RG.2.2.15072.76800.

[9] Price, Ootacamund: A History (1908), preface and chapter 3.

[10] UNESCO. Mountain Railways of India, nomination dossier, Section 4 (Management), 2005.

[11] Gadgil, Madhav, and Ramachandra Guha. This Fissured Land: An Ecological History of India. Delhi: Oxford University Press, 1992. 118–183.

[12] Guha, Ramachandra, and Madhav Gadgil. 'State Forestry and Social Conflict in British India.' Past & Present 123 (1989): 141–177.

[13] Grove, Richard. Green Imperialism: Colonial Expansion, Tropical Island Edens and the Origins of Environmentalism, 1600–1860. Cambridge: Cambridge University Press, 1995. 380–430.

[14] Hockings, Blue Mountains (1989), Introduction and biogeography chapters.

[15] Walker, Anthony R. The Toda of South India: A New Look. Delhi: Hindustan Publishing, 1986. 43–71.

[16] [16]Thorner, Daniel. Investment in Empire: British Railway and Steam Shipping Enterprise in India, 1825–1849. Philadelphia: University of Pennsylvania Press, 1950

[17] Hurd, John M. 'Railways.' In The Cambridge Economic History of India, vol. 2, edited by Dharma Kumar, 737–761. Cambridge: Cambridge University Press, 1983.

[18] *Ibid.*, P. 740
[19] Kerr, Building the Railways of the Raj (1995), chapters 3–5.
[20] Arnold, David, and Ramachandra Guha, eds. Nature, Culture, Imperialism: Essays on the Environmental History of South Asia. Delhi: Oxford University Press, 1995; Bhattacharya, Neeladri. 'Pastoralists in a Colonial World.' In Arnold and Guha, Nature, Culture, Imperialism, 49–85.
[21] Rajan, Ravi. Modernizing Nature: Forestry and Imperial Eco-Development 1800–1950. Oxford: Clarendon Press, 2006. 78–134.
[22] Hockings, Blue Mountain (1989)
[23] Govindharaj, Yoganandham.. Primitive Kota Tribes of Nilgiris Focusing on Traditional, Social, and Economic factors an Ethnographic Assessment. 12. 2023. 162-177.
[24] Grigg. H.B., A Manual of the Nilagiri District in the Madras Presidency, Madras, 1880, pp. 314-327.
[25] Francis. W. The Madras District Gazetters: The Nilgiris, Madras, 1908, P. 222-225.
[26] Administrative Report of the Forest Department of Madras Presidency, 1895-1918.
[27] Annual Administrative Report of Railway Department in India, 1859-1939
[28] *Ibid.*; See also, Nilgiri District Gazetter, 1908, 1934. Madras. Government Press.
[29] Madras Forest Department. Annual Progress Reports, Nilgiris Division, 1890–1940. Tamil Nadu State Archives, Chennai.
[30] Nilgiri District Gazetter, 1908, 1934.
[31] Madras Presidency Revenue Proceedings, Mettupalayam Taluk, drainage petitions, c. 1900–1920.
[32] Madras Forest Department, Annual Progress Reports, Nilgiris Division, 1891–1908.
[33] Gadgil and Guha, This Fissured Land (1992), 153–175.
[34] UNESCO, Mountain Railways of India, Technical Annex (2005). [35] *Ibid.*
[36] For the Darjeeling Himalayan Railway see UNESCO nomination documentation, Mountain Railways of India (original inscription, 1999).
[37] For the Kalka – Shimla Railway see UNESCO nomination documentation, Mountain Railways of India.
[38] Mukhopadhyay, Aparjita. Imperial Technology and 'Native' Agency: a Social History of Railways in Colonial India, 18501920. Routeldge, 2018.