
UNIT 30 ENVIRONMENT, SCIENCE AND TECHNOLOGY

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30.1 INTRODUCTION

In the history and the historiography of modern India, science, technology and environment are closely related subjects. Massive demographic change, aided by science and technology, has changed the landscape beyond recognition. Neither Babar nor Warren Hastings would be able to tolerate the present aspect of the country. The transformation has recently attracted the attention of historians of India. It is not that technology, science and ecology as fundamental factors in Indian history escaped the notice of the past generations of historians. Nevertheless, it is only in the 1990s that a fair number of historians in India took these themes up as independent topics of research. However, there is no agreement among them about the impact of science and technology on the welfare of the population and the climate of the country. Their disagreements reflect deep divisions within public opinion, and in the government and politics of the country. There is science lobby, an economics and planning lobby, and an environment lobby. There are cries of coming disaster, and hot denials that there is cause for alarm. It is said that because of greenhouse effect of global industrialisation, the glaciers from which our rivers descend are receding fast. Historians have been sensitised to the problems of science and environment by these public debates. From the 1990s, independent historical monographs on these subjects have begun to appear. Even before that, however, certain historical questions had figured in their discussions as regards science and technology : was modern science and technology distorted by the phenomenon of colonial rule? What were the state of the sciences and the level of technology before the establishment of British supremacy? Such questions have been renewed recently.

30.2 EARLY HISTORIOGRAPHY

The British rule over India found a moral justification for itself by virtue of the benefits of reason and modern science it had extended to the colony. The British view of Indian civilisation was that it was long on religion and short on science. Seven centuries ago, early Muslim visitors to the country had a different view of the civilisation then prevailing in the land. Al Beruni gave equal and serious attention to both the religion and science of Hind around 1030. The Muslims themselves brought with them several new technical products, such as paper and the Persian wheel. Europe, which at that time borrowed several techniques from China and the Islamic world, later strode ahead in course of the scientific revolution of the seventeenth century and the industrial revolution in the eighteenth century. This constituted, upon the British conquest of India, the ground for

the European claim of scientific and civilisational superiority. The Indian scientists who emerged during the late nineteenth and early twentieth centuries in the colleges and universities of British India did not deny the positive role the British had played in bringing modern science to India. At the same time, they maintained that India had an ancient scientific tradition. This dual attitude is reflected in the work of the Chemistry Professor of the Presidency College of Bengal, Dr. P.C. Ray, who, besides making major chemical discoveries in the field of nitrates, wrote a work on *The History of Hindu Chemistry*. Published in two volumes in 1902 and 1908, this was a world-renowned scientist's historically substantiated refutation of the imperialist idea of science as the achievement of Western enlightened thought alone. That science had multi-civilisational origins would be argued by many other historians in the future, including Joseph Needham of *Science and Civilization in China*.

Within the leadership of the nationalist movement in India, two distinct attitudes crystallised at about this time as regards modern science and its historical effect on Indian civilisation. Mohan Das Karamchand Gandhi denounced railways, lawyers and doctors, and declared machinery to be a 'great sin'. He said in *Hind Swaraj* (1990) : 'It is machinery that has impoverished India'. Jawaharlal Nehru, his disciple, could not agree with this view of the matter. In a tract entitled *The Unity of India* (1941), he declared: 'Politics led me to economics, and this led me inevitably to science and the scientific approach to all our problems of hunger and poverty.' As Prime Minister he transformed the landscape of India by means of the Five Year Plans, the great dams and the steel plants. Modern day radical environmental historians invoke Gandhi rather than Nehru in the debate about science, technology and the ecological question.

In the later colonial period, an ecological query emerged: how far had the face of the country changed over time? The economist Radhakamal Mukherjee, who wrote a work on *Social Ecology* (London, 1942) in this period, examined historical evidence of riverine and ecological change in an interesting work

entitled *The Changing face of Bengal: a Study in Riverine Economy* (Calcutta, 1938). Nor was he the first to record ecological evidence of change. Even in the early nineteenth century, the British official D. Butter, in a report entitled *An Outline of the Topography and Statistics of the Southern Districts of Oudh* (Calcutta, 1839), had reported the 'unremitting advance' of the hot summer wind (*loo*) in recent decades. It may be noted that the northern Gangetic plains, the area he reported on, had experienced large-scale deforestation from the Mughal period onwards. But in the other areas, agriculture was still considerably mixed with jungle in the early nineteenth century, a fact commented on, for instance, by James Taylor in the *A Sketch of the Topography and Statistics of Dacca* (Calcutta, 1840). Colonial officials showed an interest in historical geography, and a pioneering work in this respect was Alexander Cunningham, *The Ancient Geography of India* (London, 1871). Later Jadunath Sarkar wrote *The India of Aurangzeb (Topography, Statistics and Road)*, (Calcutta, 1901) Such works recorded evidence that even before modern science and technology intervened, demographic and commercial factors had been changing the face of the country over time. It is only recently, however, that this issue has been explored by historians in a self conscious ecological manner.

30.3 RECENT HISTORIOGRAPHY

In the new historical studies of science, technology and environment that emerged in the 1990s several key themes and questions provided a sophisticated framework of discussion. What was the politics of science and technology? Were they the means of

imperial domination and / or national reconstruction? What was the technological impact upon the economic organisation of life – to enrich or impoverish? What was the popular reception of science – acceptance or resistance? What was the impact of ecological change upon the question of welfare – partially beneficial or wholly negative?

Commentaries on recent historical writings have pointed out that the above-mentioned concerns were not entirely new. In fact, the same issues had implicitly formed a part of imperial, nationalist and popular discussions and sayings. Let us take a few instances. For one, imperial planners who laid down the railways, among them Bartle Frere of Bombay in 1863 proclaimed clearly that the railways would quadruple the British Military strength in India. For another, one strand of nationalist opinion, represented by Gandhi in 1908, declared openly: ‘Railways, lawyers and doctors have impoverished the country, so much so that, if we do not wake up in time, we shall be ruined.’ To take a third and rather interesting instance, there had been attempts to study the popular response to the innovations of the modern age among the nineteenth century folk songs collected by William Crooke. One was on the train and it ran as follows: ‘Eating no corn, drinking water / by the force of steam it goes / it goes on no plain road, on rods of iron it goes / In front of the engines, behind the cars, *bhak, bhak* they go.’ The attitude reflects neither approval nor rejection, just a strange new addition accepted as part of the landscape, it has been argued. What was new about the new historiography was that it dealt with all these questions in a connected way, in analytical frame. Earlier discussions of science and technology had not always shown good, critical sense. On the one hand, patriotic Indians sought to upstage Western Science and Technology by claiming to have discovered everything in the Vedas. On the other hand, colonial statements on scientific and technological progress were simply and approvingly reproduced by some historians without examining the motives behind those statements.

Among recent works on science and technology which have all focused in one way or the other on the question of power and politics may be mentioned Dipak Kumar, *Science and The Raj* (New Delhi, 1995); David Arnold, *Colonizing the Body: State Medicine and Epidemic Disease in Nineteenth Century India* (Berkeley, 1993), Gyan Prakash, *Another Reason : Science and The Imagination of Modern India* (Princeton, 1999); David Arnold, *Science, Technology and Medicine in Colonial India* (Cambridge, 2000). Arnold and Prakash, both belonging to the Subalternist school, regarded science as an integral part of the political sphere. Arnold brought science under the technique of colonial discourse analysis; Prakash on the other hand, treated science as part of the discourse of imagining the nation as a modern, rational body of people. Both saw the new technology as a means of forging ‘a link between space and the state’ (Prakash, *Another Reason*), and science, therefore, as very much a matter of power and domination. In the name of science, the colonial administration pursued policies of domination biased towards maintaining imperial authority and not the welfare of the colonised. In the name of science again, the nationalist movement and the Indian scientists sympathetic to that movement sought an alternative centre of power, an imagined community called the nation that would liberate itself by means of the modern spirit of scientific rationality. As for the colonised themselves (the so-called subalterns), the subalternists speculated that popular resistance to colonial domination might arise from the people’s mental association of railways and telegraphs with calamities such as famines and epidemics. There emerged historical studies of the mortality caused by plague, malaria, small-pox, cholera and the influenza epidemic of 1918; the political unrest and administrative chaos caused by disease; and the popular response to harsh colonial public health policies.

Ecological history, which emerged as a separate branch of history in the 1990s, was a response to the world-wide environmental movement. In 1987, C.A. Bayly declared in *Indian Society and the Making of the British Empire, New Cambridge History of India, Vol II*, (Cambridge, 1987): ‘Ecological change in India is the coming subject, but no overview has appeared.’ Bayly himself concluded that the hundred years following 1780 witnessed ‘the beginnings of extensive deforestation in the subcontinent. The first work of the new ecological history, Ramchandra Guha’s *The Unquiet Woods: Ecological Change and Peasant Resistance in the Himalaya* (Delhi, 1991), concerned itself with the Sublternist theme of domination and resistance rather than with the actual tracking of environmental change over the long duration. It was a study of the emergence of a popular movement in the Himalayan foothills against the commercial exploitation of the forest resources of the Himalayas. The next work, Ramchandra Guha and Madhav Gadgil’s *This Fissured Land: an Ecological History of India* (Delhi, 1992), was wider in scope, and it took the following position: ‘In India the ongoing struggle between the peasant and industrial modes of resource use has come in two stages: colonial and post-colonial. It has left in its wake a fissured land, ecologically and socially fragmented beyond belief and, to some observers, beyond repair.’ Other works, which focused on conservation and the adverse ecological consequences of colonial policies, included Richard H. Grove, *Green Imperialism: Colonial Expansion, Tropical Island Edens, and the Origins of Environmentalism 1600 – 1860* (Cambridge, 1994) and Mahesh Rangarajan, *Fencing the Forest: Conservation and Ecological Change in India’s Central Provinces 1860-1914* (New Delhi, 1996). The loss of the rights of the forest-dwellers was a principal theme of ecological history, as was the development of resistance and of efforts at conservation.

More conventional economic histories had already focused on the impact of colonial rule on the environment. The advance of the agricultural frontier and irrigation canals, with the attendant problems of salination, water-logging and spread of disease, were studied, among others, by Elizabeth Whitcombe, *Agrarian Conditions in Northern India: the United Provinces under British Rule, 1860-1900* (Berkeley, 1972); Ian Stone, *Canal Irrigation in British India: Perspectives on Technological Change in a Peasant Economy* (Cambridge, 1984); and M. Mufakharul Islam, *Irrigation, Agriculture and the Raj: Punjab 1887-1947* (New Delhi, 1997). It emerged that the roads and canals interrupted the natural watercourses, yet on balance it could not be denied that irrigation increased agricultural productivity. A study of the impact of the railways, by Robert Varady among others, shows that the railways depleted the Himalayan timber region, wiped out the remaining jungles on the plains, and could carry on only because of the advent of cheap coal. Roads and railways formed disease-laden puddles, spread epidemics and speeded up soil erosion. Nevertheless, economic historians such as John Hurd and Mukul Mukherjee, have concluded that the railways promoted internal trade, reduced seasonal fluctuations and inter-market price differentials for grain and cotton, and integrated the market in bulk commodities.

Economic historians, rather than ecological historians, have mapped the long-term recession of forest and pasture under the onslaught of agriculture in Indian history. Shireen Moosvi, in her *Man and Nature in the Mughal Era* (Symposium paper, Indian History Congress, 1993), established that cultivation doubled between 1601 and 1909 at the expense of pasture and waste in Northern India.

A balanced picture emerges when we take together the work of the mainstream economic historians and the new historians of science, technology and environment. New dimensions of history have emerged, the harmful effects of modern science and technology on environment have been highlighted, yet the benefits have also been stressed.

30.4 ROLE OF TECHNOLOGY IN MODERN HISTORY

The emergence of environmental history has induced historians to rethink the role of science and technology in modern Indian history. This is because environmental historians have drawn attention to the manner in which technological progress has affected the natural environment, sometimes quite adversely in certain areas, during the colonial and post-colonial periods. The earlier uncritical attitudes to technological progress have given way to a more critical treatment of the theme of science and technology. British colonial historians were quite certain that British rule in India had worked to the betterment of the lot of the Indians through the introduction of science and technology. They were also convinced that Indians, at least initially, were resistant to the radical technical innovations such as railways and telegraph. This formed part of J.H. Kaye's explanation of the revolt of 1857 in his famous book, *A History of the Sepoy War in India* (London, 1867). The Hindu priesthood, said Kaye, were confounded by the railways cars, which travelled, without horses or bullocks, at the rate of thirty miles an hour, and the electric wires, which in a few minutes carried a message across a whole province. The prodigious triumphs over time and space achieved by these 'fire carriages' and 'lightning posts' put to shame the wisdom of the Brahmans and, in his view, produced a reaction resulting in the revolt. The British colonial view was that, after the suppression of the revolt, there was genuine progress brought about by the improvements in technology, communications and transport. In the well-known book *Modern India and the West: a Study of the Interactions of their Civilizations* (London, 1941), the editor, L.S.S.O' Malley, who was a colonial official, devoted a whole chapter to 'Mechanism and Transport'. In this chapter he surveyed the new forms of communication, including railways, broadcasting and films, and his estimation of the consequences for India were clearly positive.

It took some time after Independence for studies of technology to acquire an analytical historical perspective. A preliminary venture in this direction was a series of lectures by leading scientists and technical educators at the Nehru Memorial Museum and Library, edited by B.R. Nanda as *Science and Technology in India* (New Delhi, 1977). Here, too, the impact was judged in somewhat uncritically positive terms, with an emphasis on the progressive leadership of Jawaharlal Nehru. Technology was treated in such preliminary works as part of the history of science. It took some time to give more complex and critical attention to technological history on its own. Many historians in the West continued to emphasise the progress brought about by technology transfer from the West to non-Western societies. Daniel R. Headrick's *The Tentacles of Progress: Technology Transfer in the Age of Imperialism, 1850-1940* (New York, 1988) dwelt on the transfer of a range of new technologies, such as railways, botany, urban infrastructures, metallurgy, technical education, etc., with special attention to India. A more critical assessment for India specifically was made in Roy McLeod and Dipak Kumar (eds.), *Technology and the Raj* (New Delhi, 1995). An important article in this collection, 'The Building of India's Railways: the Application of Western Technology in the Colonial Periphery', by Ian Derbyshire, pointed out that railway development in India, unlike UK, secured few direct, 'backward linkage' benefits. Labour market conditions discouraged greater mechanisation. Technical development remained 'colonial-dependent'. In comparative terms, India lagged behind not only the USA, but also Russia, where innovation in constructional, equipment and operational spheres was conspicuously greater.

Backward linkage effects relate to the stimulation of activities in the economy that ensure supply to a new line of production. Forward linkage effects, on the other hand,

mean the stimulation of demand for other products resulting from the new product. In the case of railway construction in India, a forward linkage benefit might have come about with the construction of locomotives. This hardly happened during the colonial period on an appreciable scale. In a pioneering article entitled ‘Great Britain and the Supply of Railway Locomotives in India: a Case Study of “Economic Imperialism”’, first published in *The Indian Economic and Social History Review* (October, 1965), F. Lehmann calculated that during the entire period of British rule in India, not more than 700 locomotives were built in the country, despite the vast railway network that existed by 1947. All the other locomotives came from abroad, and, predictably, most were constructed in Great Britain. Had the railway authorities gone in for building locomotives in India on a bigger scale, this might have laid the basis of a heavy engineering industry before Independence. As it happened, such a development had to await the coming of the Nehru era. One noted author who analysed the limited economic stimulus resulting from colonial technological innovation was Daniel Thorner. He noted the limited effect of colonial railway and steamship enterprise on India’s capital market in *Investment in Empire: British Railway and Steam Shipping Enterprise in India 1825-1849* (Philadelphia, 1950). In yet another notable contribution entitled ‘The Pattern of Railway Development in India’ first published in *Far Eastern Quarterly* (1955), he went even further, and noted: ‘India alone of the countries with great railway networks is unindustrialized.’

It may be noted that such critical observations of the historical role of the transfer of science and technology from Britain to India were still formulated in economic rather than environmental terms. The emergence of environmental history added a new dimension to the existing criticism of the role of technology and science. Both the economic and environmental arguments have been brought together by Ian J. Kerr, the editor of an important anthology of articles on the railroads entitled *Railways in Modern India* (New Delhi, 2001). Kerr has faithfully included the criticisms of the railway network by both the new environmental historians and the more conventional economic historians. At the same time, he has not forgotten to emphasise the positive benefits of railways in particular and technology in general. One aspect of science and technology is the import of Western medicine in India. Here, too, recent research has highlighted not merely the positive effects, but also some of the negative developments. Over all, however, the new research, even when at its most critical (as in the works of David Arnold referred to above), has still not dislodged the impression that technology brought important benefits. Without science, technology and modern medicine, India’s vast and growing population would have been more (and not less) vulnerable to famines and epidemics.

30.5 SUMMARY

The progress of research has established the history of science, technology and ecology as viable branches of the discipline of history. This has added new and important dimensions to general history. At the same time, detailed research has demonstrated the close inter-relationship between the histories of science, technology and environment. All this has altered the shape of history.

30.6 EXERCISES

- 1) Write a note on the role of technology in modern history.
- 2) What are the views of the nationalists on the nature and role of modern technology?
- 3) Discuss some of the historical works on science and technology.