Modernisation of Sri Lanka's Traditional Irrigation Systems and Sustainability

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ARTICLES

*Modernisation of Sri Lanka's Traditional Irrigation Systems and Sustainability**

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Arnold Toynbee described the ancient irrigation system of Sri Lanka as an amazing system of irrigated agriculture, which developed over a millennium. It was partially transformed during its encounter with British colonialism with new values, technological systems, administrative structures and a legal code. After the independence in 1948, this transformation continued with foreign aid and technical expertise from the West.

The shortcomings of modern irrigation systems with respect to planning, policy and sustainability are now recognised (WCDD 2000). Here, it is argued that the indigenous irrigation systems in Sri Lanka offer a useful counterpoint of one that has been sustained and had many favourable attributes. There are lessons to be learnt from contrasting different modes of irrigation practice in the light of sustainability.

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> J.S. Kennedy (1933), director of irrigation in Ceylon under the British, outlining new 'scientific' irrigation practices to replace the 'pre-scientific'.

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In his survey of world civilisations, Arnold Toynbee (1946 [Vol. 1]: 81) described the ancient irrigation system of Sri Lanka as an amazing system of waterworks where hill streams were tapped and their water guided into giant storage tanks from which ran channels into other large tanks. Below each tank were hundreds of little tanks. Notwithstanding occasional disruptions by internecine conflict or malaria, the irrigation system has been sustained since before the third century B.C.

The south-west of Sri Lanka (Figure 1) has ample water and is known as the 'wet zone' (Somasekeram 1988). The rest of the island is referred to as the 'dry zone'. Intercepting these zones is a mountainous region from which rivers fan out. The dry zone is prone to droughts, and irrigation works to regulate, transport and conserve water are essential to support agriculture.

There are up to 20,000 village tanks and several large reservoirs fed by the rivers throughout the island. These village tanks along with the ancient large-scale irrigation works, are a salient legacy that has sustained inhabitants over many centuries.

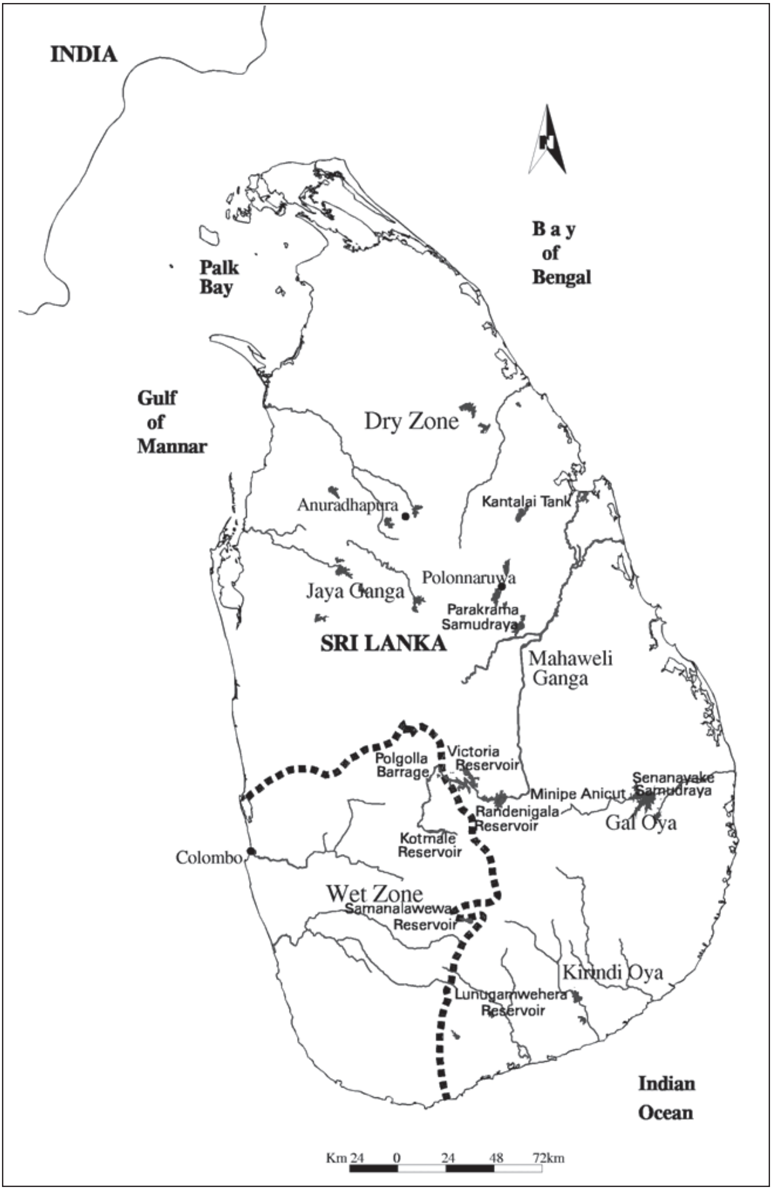
This hydraulic society flourished at times and floundered at others since before the third century B.C. to medieval times. The irrigation system generally grew over time reaching its peak in the north-centre of the island: in Anuradhapura in the tenth century and in neighbouring Polonnaruwa in the eleventh century (Indrapala 1971). During this period Sri Lanka was under a single or multiple monarchies, the boundaries of which varied.

Much virtue was attached to monarchs who constructed and maintained irrigation works.[1] On occasion the irrigation works were sacked by invaders (from India or during the internecine wars amongst the local monarchs). Disease would drive away populations, too. Notwithstanding these disruptions, these societies were stable for long periods.

Much changed in the country with the arrival of the European imperial powers. The Portuguese (1505–1658) and the Dutch (1658–1801) were primarily interested in commerce and did not significantly affect the hydraulic society in the dry zone, an area not altogether under their control. However the British, who ruled from 1801 to 1948, conquered the entire country and profoundly reordered the society (Webb 2002).

In 1948 Britain made Sri Lanka independent, and since then there has been a multi-party democracy. Notwithstanding the anglicised sensibilities of the new native rulers, the ancient irrigation works continued to be a source of nationalistic pride. The legacy of virtue attached to constructing irrigation works endured. The first large-scale irrigation project undertaken after independence was the Gal Oya River Valley Development Scheme, which was modelled after the Tennessee Valley Development Project in

FIGURE 1
Irrigation Works of Sri Lanka



Note: The dashed line demarcates the wet and dry climatic zones.

the United States (MacFadden 1954). While there were rhetorical appeals to past national glory, the conception, financing, construction, administration, social organisation and engineering were now foreign. Several other such irrigation schemes followed, the foremost of which was one to dam and divert the longest river, the Mahaweli. Several other schemes, such as, the Lunugamvehera, the Mahaweli and the Samanalawewa, followed. External agencies like the World Bank oversaw the planning of these schemes and transnational corporations were the designers and contractors (Caine 1953).

There were several major changes after the European conquest. There was the twenty-fold rise in population and the magnified technological power for irrigation works. Land now supplanted water as a scarce resource. European technological and administrative thinking dominated the indigenous, resulting in new sensibilities about irrigation, land tenure and agriculture.

After independence in 1948 there were more changes. The 'green revolution' changed the practice of agriculture in some areas from an organic multiculture with indigenous crops aided by buffaloes, to a chemically-intensive mechanised monoculture (Farmer 1977). In addition to irrigation, there was the new demand for hydroelectric power generation. Foreign financiers and new urban and industrial constituencies for cheap hydropower were new actors.

An early nineteenth-century witness to this system of irrigation, Tennent (1860: 424), describes it as follows:

> For upward of fifteen centuries these reservoirs, when duly attended to successfully, defied all the dangers to be apprehended by inundation ... vast numbers of these tanks though utterly deserted, remain in this respect, almost uninjured to the present day.

In our time we can recognise his description as a characterisation of the sustainability of the system.

Tennent was no ordinary traveller, but the second most powerful British colonial officer in Ceylon. He produced a prodigal volume of literature, which practically every colonial administrator, missionary and schoolchild in Ceylon read. Tennent (ibid.: 423) wrote after visiting the Minipe Anicut on the Mahaweli river as

> [The Mahaweli] sweeps through the luxuriant solitudes, past wide expanses of rich but unproductive land, under the shade of forests whose

> timber and cabinet wood alone would form the wealth of an industrious people.

While Tennent's response is in terms of wealth to be exploited, the response of the Veddah, indigenous people, as captured by a folk song (De Zoysa 1881; also cited in Brohier 1934: D37) was sensual:

> Yonder, yonder spreads the Sorabora tank!
> O! Mahaweli-ganga whose waters cry as they run!
> O! Mahaweli thy waters never fail!
> O! tank in whose waters sport the Queen of blue flowers!

Tennent's tenure in Ceylon marks the beginning of the encounter of the irrigation system with modernity. Appreciation of native achievement would diminish in the late nineteenth century as Enlightenment ideals gained sway in Britain. Subsequent British officials brought with them modern values, such as, the primacy of the scientific and technological enterprise, efficiency, individual rights and rationality in decision making.

Political independence did not change the quest for modernisation in Ceylon and modernisation ideals became almost an official creed by the 1960s (Myrdal 1968). The renovation of irrigation works was shaped by these ideals and its engineering was based on modern hydraulics.

Transformations of water management systems, particularly during the period of the colonial state, have received critical attention in India. The role of the colonial state in water management has been compared by David Hardiman (1998) in the context of well irrigation in Gujarat, and Rohan D'Souza (2003) in the context of the transformation of the canal irrigation systems in Orissa in eastern India in 1863. Hardiman shows that although colonial intervention did not destroy the traditional hierarchical 'village communities' during the colonial period, it had the impact of depriving the rural poor of access to their resources.

D'Souza (ibid.) investigates the reason for the financial failure of the colonial state's attempt to obtain flood control and irrigation through canal irrigation in Orissa in 1863. Canal irrigation was used as the technical means to control and regulate the delta's hydrology in a scheme that was to be supported through a market imperative. D'Souza attributes the failure to a defeat of the colonial state's attempt to recast the phenomenon of deltaic inundation into commodity form.

In a study focused on south-eastern Tamil Nadu in south India, Mosse (2003) seeks to address the manner by which political and social organisation

was affected by the ecology of water flows and the role of social institutions in managing water. In Tamil Nadu Mosse documents that the colonial state misconceived native political processes and ecology of tanks systems, and sought to find its legitimacy on its capacity to wield the power of science, technology and rational administration to bring the uncertainties of famine and flood under instrumental control. Not all British rulers subscribed to this notion, but the post-colonial state's water resources policy was built on this idea. Mosse argues that risk and uncertainty are inevitable characteristics of livelihood in south India and neither the colonial nor the post-colonial state was able to counter risk and uncertainty any more than the measures of the warrior kings or the landlords (*zamindari*s).

These studies demonstrate the need and potential for detailed investigation of the relationship between water and society as a historical, ecological and sociological phenomenon. There is much that is common to both India and Sri Lanka, such as, cultural affinities and the history of colonial experience. There are also interesting contrasts such as climate, the role of the East India Company (which was not involved in Ceylon), and the particularities of island geography.

In this article, the modernisation of the irrigation system in Sri Lanka is examined from the viewpoint of the sustainability of the environment, technology, economy, livelihoods, social harmony and political autonomy. First, village irrigation and agricultural practices in the pre-colonial period are described. Thereafter, the transformation brought about in the colonial and post-colonial periods, particularly in the Mahaweli basin, is examined. Finally, traditional and modern practices are compared for the lessons that can be learnt.

This attempt to learn lessons from contrasting two different modes of irrigation practices in the light of sustainability is in line with the Millennium Development Goal of the United Nations, to learn lessons so as to 'integrate the principles of sustainable development into country policies and programmes and reverse the loss of environmental resources'.

Pre-Colonial Irrigation

Human settlement in Sri Lanka extends at least 30 millennia before present (Deraniyagala 1992). For instance, a dam had been constructed during 4 B.C. at Maduru Oya at the exact site chosen by the engineers under the

Mahaweli project.[2] It was rediscovered during the excavations. The prevalence of Naga (snake) symbols at irrigation sites lead some to speculate that the Nagas, who were one of two tribes on the island were accomplished in irrigation. There is folkloric evidence that the other tribe, the Yakhsas, constructed the initial dam of the Sorabora Wewa reservoir (De Zoysa 1881).

Irrigated agriculture coexisted with the '*chena*' or the slash-burn and fallow agriculture and hunting, fishing and gathering of yams, vegetables, bees' honey and fruits. From then until the fifteenth century an irrigation system with over 20,000 village tanks, and a social and political system evolved. Alongside these independent small tanks, the kings and chieftains supervised the construction of massive tanks and canals (Gunawardana, 1971). While there is evidence that some village tanks were fed by the larger irrigation works, most tanks were fed by rainwater and nearby streams.[3]

By the thirteenth century there were 10,000 small village tanks. The monarchs constructed a network of large tanks and canals. Much virtue was attached to kings who constructed and maintained irrigation works. For example, King Parakrama Bahu (A.D. 1153–86) who was instrumental in building several large irrigation works (Brohier 1934 [Vol. 1]: 5) describes his motivation as:

> In my kingdom are many paddy fields cultivated by means of water, but few indeed are those which are cultivated by means of perennial streams and great tanks. By rock, and by many thick forests, by great marshes is the land covered. In such a country, let not even a small quantity of water obtained by rain, go to the sea, without benefiting humans.

At times, the capital works of the kings were motivated by aesthetic or egotistical reasons instead of by agriculture (Gunawardana 1971).

The quality of irrigated agriculture had its ebb and rise in the two millennia prior to colonial rule (Siriweera 1994: 38–48). In particular, after the thirteenth century, many of the large-scale irrigation works were disrupted and abandoned in the Rajarata region (north-central), which was the seat of government and irrigation. With the break-up of the irrigation system, there was decline and internal migration to the central hills. The capital was relocated there as well. Some of the causes have been described as internecine and external wars, loss of soil fertility, epidemics of malaria and the reduction or elimination of the Kulinas (see various arguments in

Indrapala [1971]). This decline also coincided with abrupt climate change with the 'Little Ice Age'. However, the impact of this on an equatorial region such as Sri Lanka is yet to be understood.

The disruption in the thirteenth century is perhaps the most dramatic instance of the ebb of the pre-colonial irrigation system due to social and environmental factors. Whilst these large-scale works were abandoned for some centuries, village agriculture that did not depend on them persisted. The prototypical village had a tank, fields, gardens with fruit and other trees, *chena*s and the temple. These tanks were rain-fed and when possible, fed by diversions from streams or other tanks. Most people in a village (typically about twenty families) were kin and were presided over by hereditary headmen (Codrington 1938). An irrigation headman, known as a *velvidane*, was chosen amongst the villages. The *velvidane* coordinated the maintenance of the tanks, sluice, ditches and the distribution of water to the different fields. Tank water was regulated by a sluice and conveyed by ditches to the fields (Leach 1961: 64).

The fields were rotated amongst families for equity as some were on lower ground or closer to the tank. There were different practices of land tenure, such as, cooperative, private, monarchic and monastic ownership (Gunawardana 1971). While, this sketch is particular to the irrigation, practices in the dry zone of Sri Lanka were not much different (Obeysekere 1967). Each family was required to maintain the ditch passing by their field. The maintenance of the tank was the responsibility of all. Each adult was required to provide forty days of labour, a practice known as *rajakariya*. This service was used either in capital works for the king, temple or in the maintenance of the irrigation works (Leach 1961). Paddy growing in these villages was a way of life closely interwoven with other social activities. Tasks such as tilling, sowing, weeding, harvesting and maintaining watch over the crops at night were done communally (D'Oyly 1975 [1835]). A village council dealt with disputes, debts and petty offences. Children had responsibilities such as driving away monkeys, collecting firewood and tending the cows.

Local Autonomy and Control

Wittfogel (1957) has argued that the political economy of Oriental hydraulic societies engendered centralisation of power in a despot, with a bureaucracy and unpaid labour. Such despotism is unlikely to have sustained the irrigation system for long as the political system is overly dependent on the sagacity and skills of the rulers. Contrary to Wittfogel's

model, Leach (1959) shows that the villages in Sri Lanka were highly decentralised in a manner that was the very antithesis of the state. Leach argued that the large tanks constructed by powerful rulers were essentially ornamental and that the villages never really depended on them for survival.[4] Each village possessed its own small-scale irrigation system, which was maintained by the villagers themselves. Leach also finds no evidence to show that a centralised bureaucracy existed to run the village irrigation works.[5]

Technological Development

Hydraulic control through barrages, weirs, anicuts, sluices and valve pits testifies to indigenous technological prowess (Parker 1909). The valve pit or the *bisokotuwa* was a pivotal invention in the construction of tanks (ibid.). While the extent of transfer of irrigation skills from India is not known, there is evidence for substantial indigenous innovation and skill in the construction of irrigation works. The Yoda-Ela canal, which is over 85 km long, has one stretch of over 16 km with an altitude difference of merely 15 cm,which is negotiated without the water stagnating, testifying to sophisticated surveying skill. Recently, complex relationships between small tanks have been established (Mendis 1999).[6] Water from one tank percolated to others that were at a lower elevation. This process irrigated the fields in-between. Another feature of the construction was the accommodation of terrain in design. These networks, in harmony with soil and landscape, are at odds with the hierarchic and geometric motifs of modern hydraulic engineering.[7]

Sustainability

The sustainability of cultivation is implicit in the characterisation that Emerson Tennent (1860, p. 424) makes of the ancient practices:

> For upward of fifteen centuries these reservoirs, when duly attended to, successfully defied all the dangers to be apprehended by inundation ... vast numbers of these tanks though utterly deserted, remain in this respect, almost uninjured to the present day.

Permanent buildings were forbidden on land that could be used for agriculture. Only mud houses could be built. Robert Knox (1681), a Britisher stranded and held captive in the island during the seventeenth century,

recounts the sanctions of the villagers against the destruction of highland forests—the forests were said to be inhabited by the spirits of the aboriginal people. The layout of the irrigation system took account of several environmental factors. Forest tanks were built in the jungle just above the village to provide drinking water to wild animals (Goldsmith 1982). Mountain tanks provided irrigation for *chena* agriculture. Erosion control tanks intercepted the silt before it entered the main tank and were periodically desilted along with other irrigation structures. Agricultural practices such as crop rotation and the fallowing of land allowed for sustainable land use.

Irrigation during the Colonial Period

As colonial rulers, the Portuguese (1505–1658) and the Dutch (1658–1801) were primarily interested in commerce and did not significantly influence the dry zone, an area not altogether under their control. The British (1801–1948) captured the entire island by 1815. They abolished *rajakariya* in 1832, calling it a form of indentured service like slavery. Without *rajakariya*, the *velvidane*s were left without the means to maintain the irrigation works.[8] In 1840 the British introduced the 'Crown Lands Encroachment Ordinance' and confiscated all land that could not be established as privately owned. This set the stage to woo mercantilists from Britain to invest in cheap land for coffee plantations.

In the following decades large numbers died of malnutrition (Bastiampillai 1967). Political instability brought about by peasant impoverishment was a factor that led the British to change their policies; they were primarily motivated by an alarming situation in food supplies for the coffee planters (ibid.). The price of rice rose from 4 to 17 shillings, leading to near riots. The cost of feeding the indentured labourers brought from India left the planters agitated and, as a legislator put it, 'Coffee cannot prosper without rice' (Ameer Ali 1972).

The governor, Sir Henry Ward, enacted the 'Paddy Lands Irrigation Ordinance' in 1856 to aid the cultivation of rice. Initial success with pilot restoration schemes of irrigation works would encourage the administration to expand the programme (Abbay 1877). The administration gained additional revenue from the grain tax. In 1887 Governor Gordon created a Central Irrigation Board and reserved a quarter of the revenues from the grain tax for irrigation. By the end of the century 779 village tanks and forty-five larger tanks were restored (Ameer Ali 1972). This resulted in

the area under paddy cultivation increasing from 400,000 to 600,000 acres, with the bulk of the increase coming in the period 1850–80. During this period it was British policy to restore small tanks rather than large ones. Later, the water tax imposed by Governor Robinson in 1867 made cultivation less profitable.

The Irrigation Department, established in 1906 as a successor to the Irrigation Board, renovated tanks and instituted training programmes. Over 100 papers were published on irrigation, flood control and drainage (Iriyagolle 1978). While the ancient irrigation structures were interpreted in terms of modern hydraulic engineering, the indigenous systems of design and construction were lost. Kennedy (1933), a director of irrigation, outlined new 'scientific' irrigation practices to replace the 'pre-scientific':

> The suggestion to deliberately destroy a working tank may sound like rank heresy, but as a matter of fact, the village tanks, like the village cattle are far too numerous for efficiency.

Based on this wisdom, networks of small tanks would be submerged in the construction of new reservoirs.

In the same spirit, Brohier (1956) postulated a four-stage historical pattern of tank evolution from small tanks to large reservoirs. Given his personal prestige, his theory would find wide acceptance in the post-colonial period, such as, at Lunugamvehera project in the south, which has been characterised as another disastrous irrigation experience (Mendis 1999). Indeed, the citizens' report on the environment to the Rio Earth Summit (Public Campaign on Environment and Development 1992) describes the new situation as:

> New large-scale irrigation schemes have submerged and destroyed our ancient irrigation system. Thousands of tanks in the dry zone were bulldozed for the Mahaweli scheme. This scheme planned to supply water to only the larger tanks and to fill-up the smaller tanks. This destroyed the ancient system of having a tank for each village. The villages have been denied the ability to irrigate their farming with their own tanks.

Further evidence against Brohier's theory came after cyclonic floods breached all the ancient large dams in December 1957; there was no evidence for submerged small tanks in any of the exposed reservoir beds (Mendis 1990).

Village councils were incorporated into the irrigation bureaucracy. The *velvidane*s spent most of their time doing paperwork. The colonial officers acted as judges. Given the novelty of the cooperative forms of land tenure, these judges gave capricious decisions. Indeed, a spirit of mutual help and corporate structure broke down in the face of the individualism, litigiousness and apathy, which the new order promoted (Roberts 1967).

The colonial experience of Sri Lanka had a profound impact on technology, agriculture, development ideals and the environment (Webb, 2002). For example:

1. Indigenous technologies declined while some capability in modern technologies developed. Small-scale irrigation works that had provided more local control were supported during middle of the nineteenth century but undermined in the latter part of the British rule (Kennedy 1933; Mendis 2002).
2. Traditional forms of land tenure gave way to the Roman-Dutch legal code (De Silva 1981: 194).
3. Forests and multiple crops for local consumption were replaced by cash crops for exports. Large tracts of forests were cleared (Webb 2002). Forest cover dropped from 80 per cent of the island in 1820 to 40 per cent by 1948 (Baldwin 1991).
4. A hierarchical bureaucracy replaced the feudal society that sustained decentralised agriculture (Ameer Ali 1972).

A small but powerful segment of the native population would be influenced by the British ethos and would determine irrigation policies soon after independence.

Post-Colonial Irrigation

After independence there was support for irrigation schemes for new reasons. There was the incentive of hydropower. Dams were a means of flood control. There was foreign encouragement and funding for these irrigation projects. Dry zone forests could be used for settlement of people from the crowded wet zone. The ruling elite owned vast plantations, obtained by taking advantage of colonial legislation that impoverished the peasants. For these elite, it was preferable to colonise new lands to meet the demands of peasants rather than relinquish their holdings

(Ponnambalam 1980). For some officials land settlement was a means of reclaiming the lands of a mythologised Sinhala civilisation as per historical narratives that excluded minorities. Politicians found it useful to appeal to a pre-colonial glory and sought to locate themselves in the lineage of illustrious monarchs. There was foreign encouragement and funding for these irrigation projects. Sections of the Buddhist clergy, the westernised elite, some farmers and the mainstream political parties could agree upon the principle of such irrigation schemes. The Tamil parties were opposed (Peebles 1990).

The two premier political parties, the United National Party (UNP; they held office from 1948 to 1956, 1965 to 1970, 1977 to 1994, and 2001 to 2004) and the Sri Lanka Freedom Party (which held office in coalitions from 1956 to 1964, 1970 to 1977, 1994 to 2001, and since April 2004), jousted for credit for the irrigation schemes. In this spirit, the Gal Oya development programme was undertaken.

The Gal Oya River Valley Development Scheme was based on the Tennessee Valley Development Scheme, which was held out as a model by foreign experts (MacFadden 1954; Uphoff 1992). Advisers arrived from the Tennessee Valley Authority (TVA) to help plan and implement this programme (Caine 1953: 395). Under this scheme the Gal Oya river was dammed at a site identified by Kennedy (Mendis 1990) and diverted to a tank to be called the Senanayake Samudraya.[9]

To Prime Minister Senanayake, this irrigation scheme had political pay-offs. Supporters of his party were rewarded with plots of land in the newly irrigated area and with jobs in construction. The settlement area was sparsely populated. These populations were preponderantly Tamil and Muslim. Yet the new settlers were largely Sinhalese. The ethnic composition of settlers would reflect the national ethnic proportions, but be wildly disproportionate to the ethnic composition of the locality (Peiris 1964). The fraction of Sinhalese population of the Eastern Province increased from 4 per cent at independence to 15 per cent by 1981. Government officials set about creating a Sinhalese Buddhist character in some previously Tamil and Muslim districts (Peebles 1990). Nationalists from all sides saw these settlement schemes as a land-grab for the Sinhalese even while they disagreed about the justice of it. These settlements became a primary factor in the savage ethnic conflict of the country and violence continues to plague all nationalities living in the area, which have become targets of 'ethnic cleansing' by the government, vigilantes and insurgents (Peebles 1990; Vittachi 1958).[10] The foreign experts and institutions appear to have been ignorant of the ethnic dimensions of land settlement.[11]

Ironically, many critics have disputed the success of the massive TVA investment itself. Chandler (1984) argues that the economic trends were not better in TVA regions than in neighbouring areas. TVA activity led to serious environmental degradation and waste of natural resources and energy. The TVA was charged with becoming an unresponsive bureaucracy partial to perpetuating itself.

Prime Minister Senanayake later regretted the poor planning and implementation of the Gal Oya settlement and added that no settlement project be pursued until all amenities such as roads, schools, houses and dispensaries were in place (Iriyagolle 1978). Nonetheless, several other irrigation schemes were to follow, of which none was nearly the scope of the Mahaweli Project.

The Mahaweli Project

The Mahaweli is the longest river in Sri Lanka. It is 334 km long and drains 16 per cent of the total land area (Arumugam 1969). The first recorded diversion of the Mahaweli was during the reign of King Dhatusena, in the fifth century A.D. when the Yoda-Ela was constructed with a sluice at Minipe from the Mahaweli leading to the Kalawewa tank. Several colonial rulers were keen to pursue a diversion. Sir Henry Ward, governor of Ceylon from 1855 to 1860, recommended to the colonial office in London the immediate diversion of the Mahaweli at Minipe. In 1909 W.L. Strange, an irrigation adviser, brought over from India during the regime of Governor McCallum, unequivocally recommended the diversion at Minipe. Due to financial and other reasons, work did not commence till 1930s, when limited self-rule was granted.[12]

In the 1960s a grandiose scheme was proposed to irrigate 900,000 acres of land through the construction of dams, fifteen reservoirs, several tunnels and channels to carry the Mahaweli water to seven dry zone rivers (to 265,000 acres of already cultivated land and 635,000 acres of forested lands that were to be cleared for cultivation). Thus, this project would affect 40 per cent of the total land area of the country. Eleven power stations were to provide a capacity of an additional 540 megawatts over the existing installed power capacity of 331 megawatts. Over 1 million persons were to find employment through agriculture, agro-based industries and ancillary services. The estimated cost of the project was Rs 6 billion or US $1 billion (1970) over a period of thirty years (FAO 1969).

Karunatilake (1988: 28) identifies many factors motivating this scheme. One was the large expenditure of foreign exchange on the import of foodstuffs such as rice, chillies, onions and milk products. Earnings from the export of the principal crops, namely tea, rubber and coconut declined due to poor prices. Thirty per cent of the rice consumed had to be imported. These foreign exchange problems were exacerbated by the annual population growth of approximately 2.3 per cent in the 1960s. Consequently, there was pressure to cultivate forested and underutilised land. Apart from increasing the demand for foodstuffs, the burgeoning population also had created overcrowding and unemployment particularly in the urban areas.

Planning

The UNDP and FAO studied the feasibility of the Mahaweli project from 1963 to 1968. The authors termed it a study of a reconnaissance character (FAO 1969). This study did little beyond examining the feasibility of the planned first phase of the project, and yet it gave estimates of what the subsequent second and third phases might yield in terms of water, irrigated acreage and hydroelectric potential. This plan would later be called a 'master plan'. In 1969, a World Bank mission found even this 'feasibility' to be suspect.

Later, errors in soil classifications of the lands to be irrigated were acknowledged.[13] The maps within the master plan of the impacted area were not self-consistent. There was an inflated estimate of imported fruits and vegetables, which, the government claimed, would be saved by cultivation in the irrigated land, notwithstanding the fact that the country did not import any vegetables. It was rationalised that vegetables were not imported only because it was not freely allowed and that the people of Ceylon consume only 60 per cent of the optimum daily requirements of vegetables and fruits.[14]

According to Gamini Iriyagolle (1978), who was a planning official for the Mahaweli up to 1977, 'The World Bank found this plan to be so rudimentary in 1969 that it refused to fund this phase of the project'. This embarrassed the UNP government as it had announced that the project was funded. After further negotiations, the World Bank relented and agreed to fund the first phase in three stages, and it provided half the funds for the first stage because in the words of a World Bank official, 'the government wants it so badly'. The risk for the World Bank was to be offset by the required hiring of foreign consultants for further study and the relinquishment of some political autonomy. The government agreed to

stipulations such as sharp cuts in welfare expenditure, devaluation of the rupee, and dismantling of controls and restrictions.

Construction

The first phase of the Mahaweli master plan involved the construction of a barrage at Polgolla and a tunnel through a mountain into the power-house at Bowatenne. Work commenced in March of 1970. Later that year, the UNP government was defeated in the elections by the United Front, which comprised the Sri Lanka Freedom Party (SLFP), Lanka Sama Samaja Pakshaya (Trotskyite Party) and the Communist Party. The new government criticised the 'harsh terms' imposed by the World Bank. As a result, the project was delayed for two years. When it resumed, state firms handled the construction, this time with consultants from Eastern Bloc countries such as Yugoslavia. The SLFP-led government used constitutional devices to extend its term and was unpopular for reasons such as emergency rule, corruption, inefficiency and food shortages. The UNP, which promised to provide 'a just and fair society', returned to power in 1977, with a five-sixth majority in parliament.

The Accelerated Mahaweli Project (AMP)

The UNP decided to compress the project from the original duration of thirty years to five years. The Mahaweli was cast as the centrepiece of the economic activity of the country; a strategy evident in the following description by the minister for Mahaweli development, Gamini Dissanayake (Ministry of Lands, Land Development and Mahaweli Development 1979: preface):

> The Accelerated Mahaweli Project is quintessentially an action programme on several fronts, in the war we are waging on want. The focal points of this programme are located at Kotmale, Maduru Oya, Victoria, Randenigala and Moragahakanda.... Taken altogether it is the largest development project ever attempted in our country which has a unique heritage of a working system of irrigation and a canal network dating back over 1,500 years, which in years gone by sustained a remarkable civilization.... It is a fitting tribute to our ancient hydraulic tradition that ... we are seeking to complete the tasks left unfinished by our ancient forebearers.... [O]ur people who have been dogged by the

> recurring problem of unemployment, soaring food and fiber prices ... and dearth of energy for the growing industries will be able to put these problems behind for all time. It is also my fond hope that following on the massive resettlement in the Rajarata, which will mark a return to our ancient homeland—our people will respond to the ancient civilization which flourished in the Rajarata and reawaken to their cultural ethos.

The Accelerated Mahaweli Project (AMP) had cost Rs 38 billion according to official estimates by 1988. This figure is comparable to the total value of annual exports of Sri Lanka for 1988 (Rs 34 billion). Of this money, nearly 70 per cent originated from foreign sources, with 40 per cent of the foreign money being provided as grants and the rest as loans. The sources of foreign loans and grants were the Netherlands (Water Resources Planning), Sweden (Kotmale Dam), United Kingdom (Victoria Dam), Germany (Randenigala Dam) and Water Resources Systems Management, Canada. Subsequent to the AMP, there were grants and loans programmes to deal with some perceived shortcoming for environmental assessment (USA), land settlement and demonstrations (Kuwait, Japan, Saudi Arabia), and restructuring (World Bank) (Ministry of Mahaweli Development 2001).

This massive influx of aid became available due to several factors. First, 1 million persons were unemployed in 1977 with a yearly increase of 125,000 (Ministry of Lands, Land Development and Mahaweli Development 1979). The Mahaweli programme was conceived to provide more land for cultivation of foodstuffs, more jobs, and cheap hydropower and raw materials for new industries. Second, the election brought to power a party with free market ideology attractive to several Western countries that preferred the new government to the previous one, and were anxious to make the new government transform the economy into one without controls (Samath 1987). The previous government had instituted land reforms, nationalised several British holdings from colonial times and was friendly with Eastern Bloc countries. Third, contractors who had accumulated machinery and were affected by a declining construction trade overseas lobbied their government to support construction overseas. Forty-four per cent of the total aid was given as grants for the headworks (dams, canals, power houses) with stipulations that equipment be bought from the donor country. On the other hand, downstream development that required little heavy equipment and construction received only 16 per cent of its aid as grants.[15]

The Sri Lankan government created the Mahaweli Authority in 1978 to administer this development project. It was given overriding power, ostensibly to overcome the bureaucratic red tape and to expedite work. It was also removed from parliamentary review and given wide powers to the extent that it was criticised for being a state within a state.

After consulting with the World Bank and several lending agencies, the new government presented the AMP as the centrepiece of its development programme. A new Ministry of Mahaweli Development was established and the programme was presented as a fait accompli:

> It has now been decided by the Sri Lanka government to accelerate the pace of development with a view to complete all works envisaged in the Master Plan in five years. For this purpose, all works (other than the Project which is nearing completion) are grouped together as 12 projects as indicated below which can be studied and executed as such. (Ministry of Lands, Land Development and Mahaweli Development 1979)

The UNP government was elected in June 1977, and had hardly any time to study any of the plans. The FAO/UNDP study along with some presentations of local officials was called a master plan and a 'comprehensive feasibility report'. This master plan was never officially released and a planning official, Iriyagolle (1978), argues that these plans were skimpy and driven by expediency. While the government maintained a public posture that the AMP was a herculean undertaking, it was scaled down so that it would only irrigate 350,000 acres instead of the 900,000 according to the original plan. However, the power-generating capacity was increased from 120 megawatts to 210 megawatts in the Victoria Dam, and from 100 megawatts to 200 megawatts at the Kotmale Dam with the advice of foreign aid officials. Thus, there was a diversion from the peasantry, which benefits from irrigation, to the urban and mercantile sectors, which benefit from cheap hydroelectricity.

In the case of the Victoria Dam, the British engineers and aid officials persuaded Sri Lankan ministers to increase the height of the dam by 5 m to maximise the hydroelectric potential over objections of native engineers. Later, a British Aid official (Pearce 1994) admitted:

> We were flooding a large area for a small volume gain.... At the time, the advantages of the extra height were very clear. We decided we could go for something better. Now it looks over optimistic.

There was no basis for costing the AMP in November 1977, and the Mahaweli Development Board estimated a total cost of Rs 15 billion by simply multiplying the cost in FAO/UNDP report by three to account for current prices (Iriyagolle 1978). A few months later, the minister of finance announced an estimate of Rs. 18 billion. Then the president, speaking at the *vap-Magul*[16] in October of 1978 placed the cost at Rs 30 billion.

Prior to giving aid, the government of the Netherlands financed a study by a group of Dutch consultants called NEDECO. Their report, submitted in November of 1978, reiterated that the FAO/UNDP study did not pretend to be more than an outline, and though NEDECO had 'little time for analysis', it concluded that 'the findings so far indicate a number of major deviations from the original Master Plan' (Iriyagolle [1978]). NEDECO warned that irrigation projects, even those that were much better planned, were quite vulnerable to failure due to a variety of reasons, such as, lack of marketing resources, excessive water losses in transport, uncoordinated distribution of essential goods and in general bad canal engineering. NEDECO suggested irrigating the Northern Province, a recommendation strongly criticised by H.N.S. Karunatilake (ex-deputy-governor of the Central Bank) who insinuated that the NEDECO report was influenced by Tamils to carry the water to the north (Karunatilake 1988). NEDECO cautioned the government that the cost estimates were too low; that the returns from the scheme were overestimated[17] and that inflation was underestimated. This estimate of total cost kept escalating over the years from Rs 6 billion in 1967 to Rs 11 billion in 1975 to Rs 36 billion in 1978 to Rs 50 billion by 1988 (ibid.: 48–62).

On 25 November 1978, during the budget debate, the prime minister was queried as to the wisdom of starting work without completing the feasibility studies. His response was:

> We have decided on the master plan in regard to the Mahaweli project—although the reservoir is planned and the feasibility report is being prepared, you know where the reservoir is going to be. So why not cut the canals?

He then went on to announce that the government would go ahead to construct access roads, cut canals, construct bridges, construct hospitals all before the feasibility studies. The prime minister added that 'he knew all this because he has visited the sites' (Iriyagolle 1978). The finance minister added that 'the feasibility reports are awaited for the dam—what sort of dam—whether it should be rock-filled or earth-filled, where it should be and the geology of the dam'.

Thus, the feasibility studies were far from adequate, proper reconnaissance of the project area had not been undertaken, environmental studies were not carried, financial planning was skimpy yet the project was implemented with undue haste.

Construction at Kotmale

We discuss the construction of the Kotmale dam, the power-house and the tunnel that connected the dam and the power-house. The funding for this project was in the form of grants and loans from the Swedish government. The Swedish government required a Swedish contractor to be hired and SKANSKA, the largest contractor in Sweden, was hired. The circumstances under which SKANSKA was chosen were suspicious—normal tender procedures were not followed and SKANSKA started preliminary work even before any agreement had been signed. The Mahaweli Authority was agreeable to their original estimate of Rs 4.2 billion, yet after protest by local groups their contract was reduced to Rs 2.8 billion on the intervention of the president (Karunatilake 1988: 63–84).

An official report assessed that 1,410 acres of paddy and 3,742 acres of highland would be submerged, and that 13,000 persons would be displaced and compensation for losses other than land would amount to Rs 29 million (Ministry of Lands, Land Development and Mahaweli Development 1979: 7). The archaeological and ecological loss due to the inundation of the valley, which has historical significance, was not assessed.

SKANSKA constructed lavish housing for their expatriate personnel costing over Rs 21,000 per square metre (which was more than ten times the cost of a Sri Lankan luxury house). They also constructed a network of roads on the site that were superior to the best roads in Sri Lanka. Most of these roads were to be inundated after the dam was constructed. They also amassed heavy equipment from Swedish and other European contractors, most of which were hardly used. SKANSKA spent Rs 1.5 billion even before construction on the project had begun. There were routinely cases where expatriates were paid twenty-five times as much as a similarly qualified native. Overall, the total payment to 800 expatriates in the Victoria project was equal to the total payment towards 10,000 native workers.

The dam was unwisely sited on soft rocks. The unstable geology of this area is well known and has been studied by local geologists. Local villagers were well aware of the rock slides in the area. For example, following the 1947 floods that washed away 200 villages, after an investigation, in the 'Report on the Kotmale Landslides and Adjoining River

Catchments' published by the government press, R. MacLagan Gorrie wrote in 1954 (reported in Alexis 1986):

> In the Kotmale valley we have a rather unusual combination of geological, structural, and topographical features which give rise to a strong tendency towards slope failures. Over these features man has no control. But superimposed on these are a different set of conditions for which man is responsible and which have increased the potentialities for slope failures inherent in the area. These are in the main: (1) Removal of forest cover on the upper slopes of the catchments, and from talus debris at the foot of scarp faces. (2) Inefficient drainage of steep slopes under plantation. (3) Ponding of water for paddy cultivation on terraces above unstable slopes.

Although stating that the rock-fill dam was suited to geology, the Ministry of Mahaweli Development reported that 'an investigation of the stability of the slopes is necessary, in particular near to the dam on the left bank.... Rock slides are a possibility' (Ministry of Lands, Land Development and Mahaweli Development 1979: 7).

A Buddhist priest in the area, Ven Niyandara Saranatissa Thero, described the situation in 1991:

> A large reservoir was put up at Kotmale. The mountains around are cracked. Earth slips are frequent. People who had no problem at all, are now facing a situation where they cannot lead their life. (Public Campaign on Environment and Development, 1992)

Poor designs led to the abandonment of the first dam site after the foundation was laid. After several other mishaps and budget overruns, SKANSKA persuaded the Mahaweli Authority to increase their fee and to extend the schedule for completion. As the government was unable to find the additional finance, the height of the dam was reduced from 107 to 87 metres, leading to a loss in storage by 60 per cent and potential power generated by 20 per cent. In June of 1982 a major landslide threatened the entire project. Emergency measures such as rock bolting and excavations were able to reduce the danger. The danger in the future would be exacerbated by the potential breach of filled reservoir (Alexis 1986). The construction was completed in 1985, and a minister arrived from Sweden to commission the dam and the tunnel. The tunnel sprung

a leak even as it was being commissioned. It was operational only for a few days and was shut down thereafter (Karunatilake 1988).

A large fissure was discovered in the tunnel, which SKANSKA attributed to the poor geology of the site. Nonetheless, as they did not provide a guarantee of the work, the Mahaweli Authority awarded a further contract of Rs 750 million, yet again to SKANSKA to repair the leak. When this repair was completed, only one of the three turbines that had been built into the power plant was commissioned as it was found that the Mahaweli did not carry as much water as assumed. The Mahaweli Authority passed on the additional costs to the Ceylon Electricity Board, which under protest raised the electricity tariff in the country. SKANSKA, on the other hand, was awarded a bonus for finishing the work on the dam on time. It was also able to obtain other government construction contracts in Sri Lanka, competing with local contractors.

The Mahaweli Authority belatedly carried out an environmental impact study of the AMP in 1980. An agreement was entered into with US AID for a study to be carried out by a US firm of architects and engineers. Notwithstanding such studies (TAMS 1980) and various recommendations, there was vast denudation of highland forests (Ascher and Healy 1990: 109), soil erosion and accumulation of silt due to construction, such as, in Kotmale.

Kotmale was admittedly the worst part of the AMP. Similar experiences occurred in several other large-scale projects with 'tied' foreign aid and foreign contractors.[18] For example, a French transnational corporation constructed a pump house on the bund of the fifth-century reservoir, Kantalai tank, in 1984. Soon after they left, the dam fissured at the pump house, destroying several villages downstream and killing 240 villagers. In Samanalawewa, even with the hindsight of the Kotmale construction, a $516 million (Rs 20 billion) hydroelectric scheme has been completed with similar results (Yapa 1992).

Lessons from the AMP

The government touted the AMP as a panacea for unemployment, food and energy problems. The AMP did double hydroelectric capacity (although not output, as the turbines were idle due to stream flow that did not match up to expectations) of the country, yet it led to large-scale forest clearing, which unfavourably altered the flow in the river vitiating power production. The AMP was expected to lead to a reduction in electricity tariffs, yet after the project the tariffs were six times as much as before.

The economy also suffered from the inflation due to a large inflow of money—there was inflation of 400 per cent over the period of the project. The finance minister claims that over 40 per cent of the aid was wasted.

Though foreign donors provided the bulk of the capital, Sri Lanka contributed 30 per cent of its public sector investment to the Mahaweli, and the other areas of the economy were cut back. Under circumstances of fiscal stress, the Ministry of Finance and Planning and the Ministry of Mahaweli never settled on the appropriate pace for the Mahaweli development. Financial planning had become so haywire that even the minister of finance admitted that the government was unable to plan with certitude even for a year. This was an ideal situation for fraud (Wijesinghe 1981). In hindsight, the World Bank assessed that the rate of returns from the AMP was much lower than the estimated 11 per cent and that it was a mistake to compress the project to six years because of the inflation it caused, and the heavy use of foreign personnel and machinery which led the cost to rise from the estimated Rs 11–12 billion to Rs 40 billion (Samath 1987). This report went on to apportion blame and added that the government was aware that it was risky. Nonetheless, according to this report there was a shortage of alternatives for foreign aid-giving governments, which were eager to support the party elected to power in 1977 given its capitalist economic policies.

The implementation of the AMP was constantly hampered by inadequate feasibility studies and shoddy technical predictions. The lack of adequate studies on cropping patterns, farm productivity, water needs, farm size and so on left no basis for determining which components of the plan were cost effective (Wijesinghe 1981). Surveyors who normally executed limited perimeter studies were commissioned to survey large areas of lands without survey department controls. Canals ran at elevations below the land to be irrigated. The dams suffered from major structural flaws.

The scheme proposed to settle 1.5 million people, but it had settled only 47,000 families by 1985 (Central Bank of Sri Lanka 1985), which even at four per family works out to 175,000 persons or a fifth of the original estimate. There were significant numbers of people who lost their homes and lands. At Victoria 30,000 persons lost land (Professor Mediwaka, as quoted by Pearce [1994]).[19] Pearce also reports that the high dam was constructed at the insistence of the British officials over the advice of local engineers.

Land settlement was often botched. Some settlers received much poorer lots remote from irrigation lines and with poorer soil. The state

also on occasion reduced the size of the lots from 1 hectare per family. Fifty-five per cent of the land was found to be unsuitable for paddy cultivation in Middelewa (one of the settlements) by Siriwardhene (Peoples Bank Research Division, 1981, reported in Ascher and Healy, 1990: 106). Poor land coupled with bad weather led to crop failures and the landowners were led to lease their land to individuals outside the settlement. Field officials and farmers had poor communication. Originally farmers were told that the field officials would communicate their grievances to the higher authorities. However, officials who were not in touch with the farmers carried out the evaluation of field officials. Farmers reacted by ignoring official advice and wasting water. Settlement leaders who were elected were popularly understood to use their position for their own gain.

The Mahaweli project reduced the forested land by 250,000 acres. The government proposed to set up 700,000 acres of irrigated forests to offset this loss. It viewed this as an adequate response and discounted intangible ecological values such as soil preservation, water replenishment, climatic stabilisation or wildlife shelter. There is a significant threat to biodiversity —eight species of fish, four species of amphibians, nineteen species of reptiles, eight species of birds, three species of mammals and fifty-three species of trees are threatened with extinction (Goldsmith and Hildyard 1984). The senior environmental officer of the Mahaweli Economic Agency commented:

> Wildlife sanctuaries at Polonnaruwa, Seruwila, Allai and Somawathie have been logged.... People are killing elephants that get into their farms.... In the Mahaweli, we are in the process of eliminating the main natural habitat of the elephant. New ones have to be created away from dams and agricultural lands (Crossette 1987).

Wetland habitats along the banks of the Mahaweli were also disrupted along with groundwater sources. Several epidemics of malaria have broken out in the new settlements consequent to the rapid clearing of vast forest areas (Jayawardene 1995; Xinhua 1986, 1987).

The spending on the Mahaweli project benefited foreigners primarily. Fifty-five per cent of payments were made overseas. The employment provided by this project was limited to only 20,000 natives during construction. Most local payments were made to local contractors. These payments also increased the share of wealth held by the richest.[20] The debts incurred by the AMP and due over an extended period of time limits the pursuit of other development schemes without foreign loans and grants.

Quite apart from transferring technology, this project was harmful to the local technological infrastructure. Politicians treated these institutions as dispensable. Resources from institutions such as the State Engineering Corporation and Irrigation Department were siphoned off for the Mahaweli and to the war effort.

It has been argued using cost–benefit analysis that the AMP is a success. The benefits from hydropower and irrigation had exceeded the cost of the project by 1997 (Liyanagama 2000). Such analyses are useful in showing the benefits for hydropower and agriculture. However, considerations of sustainability or environmental costs such as deforestation, species loss, water quality, health costs, recovery costs once the reservoirs are silted up, opportunity costs that were lost in lieu of the project or social costs in terms of ethnic tensions or corruption[21] were not considered.

As an alternative, the government could have undertaken the renovation of over 7,400 small tanks capable of irrigating 251,000 acres at a unit cost of Rs 7,000–10,000 per acre instead of the Rs 25,000 per acre that was spent on the Mahaweli project (Wijesinghe 1981). These tanks had greater labour intensity and would have been less environmentally destructive and used local know-how. However, it would not have been as easy to obtain foreign aid for these ventures in the period 1970–90. Moreover, these projects offered fewer political benefits to local and foreign politicians, transnational companies and aid officials. Later, the Ministry of Finance acknowledged in the Public Investment Programme for 1985–89 (cited in Ascher and Healy [1990: 104]) that:

> The emphasis in the past has been on the expansion of irrigated agriculture through large-scale projects. The neglect of operation and the maintenance activities at the expense of new projects has resulted in the progressive deterioration of existing irrigation facilities and the wasteful uses of water. The cost of providing additional irrigated acreage is thus becoming progressively high.

A Comparison of Ancient and Modern Irrigation

The preceding historical examination is an attempt to understand the changing environmental and developmental sensibilities in Sri Lanka through colonial rule. The British brought with them values rooted in the Western Enlightenment, such as, concepts of modernity, the primacy of scientific and technological enterprise, efficiency, frugality, orderliness,

diligence, punctuality and rationality in decision making, liberated from the tradition, custom and group allegiances (Myrdal 1968 [Vol. 1]: 54–55). With these prejudices it would have been difficult for the Europeans to appreciate village agriculture with its superstitions, its lack of a drive towards 'development', or its accommodation of wildlife or group welfare over that of the individual. It would lead some of its engineers to dismiss village irrigation practices as 'inefficient' and to postulate that these were in fact only a primitive stage in tank development. Political independence did not change the basic ideology of 'development' in Sri Lanka. As Myrdal described it, these 'modernization ideals' became by the 1960s the 'official creed, almost a national religion'. Development planners such as politicians, economists, engineers, multilateral banks and foreign aid administrators have facilely dismissed traditional practices. In this section we compare several facets of ancient and modern irrigation practices.

Environmental Impact

The ancients, through a combination of myths, traditions and sensibilities, seemed to have largely sustainable practices. On the other hand, modern irrigation projects have caused long-term environmental harm. There was extensive clearing of forested lands and other environmental degradation for construction. The ecology of the river banks also suffered. Wildlife was hurt under modern practice. Many species were displaced and the dams inundated fertile lands. Rapid land settlement in deforested areas led to outbreaks of malaria (Jayawardene 1995).

Elephants and other wildlife lost their habitat and would wander into settlements. Forests were cleared in cavalier manner. It was assumed that new forest plantations would compensate for the clearing of old growth forests, and that reservations would be created and wildlife transferred to them without much dislocation. Environmental impact assessments were carried out as an afterthought. Finally, deforestation resulted in lesser water flow in the river, thus vitiating the power and irrigation potential of the project.

How were such oversights possible? The answer lies in many factors. There was the obvious incompetence. For instance, the chief resident engineer at Kotmale, Pat Sadler, would explain the bungling as, 'There's been a lot of geological studies done on the project in the past, but no-one appeared to have coordinated the results and drawn the appropriate conclusion.' Yet it was also the case that SKANSKA wanted the dam to

be built for its own financial benefit. Another reason is the use of contractors from abroad. Locals would likely have had less problems on account of their grasp of the background, ability to communicate with villagers and the imperatives of having to live within the community afterwards.

For the politicians elected for a six-year term, more contracts meant the ability to disburse more patronage in the form of jobs and contracts. On another level, many were blinded by political partisanship and by the collateral use of the Mahaweli project as a vehicle for the pursuit of a particular vision of Sri Lanka (one built around a Sinhala Buddhist peasantry) (Tennakoon 1988).

Along with the transfer of technology, Western values towards the environment, lifestyles and the social roles of women too are conveyed. For example, Bandarage (1988) argues that while the pre-colonial female could own land, the allocation in the Mahaweli scheme was to the man—a policy that would build in female dependence. The Mahaweli planners and foreign consultants who were almost all men were attempting to recreate the mythic male-headed nuclear family with a dependent housewife (ibid.). While in the pre-colonial village women had the support of the extended family, in the Mahaweli settlements women were isolated.

Veddahs (aboriginal people) would be evicted from their last remaining hunting and gathering grounds (Jones 1982). The prime minister advised protesting Veddahs that 'the jungle was for wild animals', adding that it was not government policy to let people live in the jungles and that the government wanted them to enjoy the 'fruits of progress' (AFP 1993).

Political Institutions

There was considerable autonomy and self-reliance at each village in the pre-colonial period. By contrast, decision making in colonial times was in the form of a global hierarchy with its apex in Britain. Decisions were made based on the bottom line or the revenue from the enterprise. After political independence, decision making remained centralised and removed from public discussion. A few politicians, a few technocrats and foreign agencies made decisions of consequence to millions of people relating to the Gal Oya and Mahaweli schemes. Politicians who were dependent on foreign aid acquiesced, thus not only centralising but also externalising decision making. There was no room for public discussion or the contributions of diverse viewpoints. In particular, donor countries insisted upon evaluation and decision making by Western agencies.

Technology

Ancient technological practices are now ignored. Yet these technical skills were successful in building irrigation works of some sophistication that were in harmony with the environment and used locally available resources.

During colonial rule the British supplanted indigenous technology with their own. Technological decision making moved from the village to the urban centres where the irrigation departments were located. British technology developed in a different milieu. They did attempt to adapt this technology to Sri Lanka. Yet, far from trying to build sustainability, it was in the imperial interest to build dependence. Much of the new infrastructure had to be imported from England.

In the post-colonial period, the technological decision making was further removed from the irrigation department to transnational corporations. These corporations were not sensitive to local needs and resources. As a result, where indigenous techniques were based on local raw materials, labour-intensive techniques and elephants, modern construction uses capital-intensive techniques, largely foreign raw-material and heavy machinery.

During the latter period of British rule and the post-colonial period there was considerable development of technological capability in government entities such as the Irrigation Department. There was a growing base of skills in the universities. Indeed, one of the first major projects under the Mahaweli scheme, the construction of the Polgolla barrage in the mid-1970s, was largely in local hands. Yet in the planning and execution of projects such as the Accelerated Mahaweli Project with foreign funding, local technological infrastructure was ignored.

Reliance on foreign technologists for the AMP led politicians to downgrade their regard for local technological infrastructure (Thurairajah 1985). Resources from the State Engineering Corporation and Irrigation Department were siphoned off for the construction without due credit, and indeed, these agencies would come close to bankruptcy.

Foreign Aid

Pre-modern irrigation works cost less as local materials and labour were used. Foreign borrowing and grants have funded most irrigation works in modern times. While it appears that foreign aid should help, in the case of the Mahaweli project there were serious shortcomings. The foreign

governments insisted upon the hiring of transnational corporations on the basis of their parochial needs. These corporations chose to use expensive heavy machinery and save labour in a country with high unemployment. The technological choices made resulted in 55 per cent of the payments being made overseas—resulting in a net outflow of cash. Governments elected to office for a period of five years benefit from heavy cash inflow and are not hurt politically by a mounting long-term debt. They would thus carelessly continue to borrow, resulting in the current debt, which was around five times the GNP in 1992.

Centralisation of decision making makes only a few officials party to major decisions. Transnational corporations were in a position to offer phenomenal bribes to these few officials to cover up any misdeeds and to circumvent oversight. Moreover, the lender countries do not have adequate oversight. In such a climate, contracting corporations find bribery of Third World officials to be not only useful for facilitating their work, but also a means to bypass local regulations and to cover up their corruption. Local officials in turn support censorship and are known to use threat of violence to suppress any leaks regarding their misdeeds.

Was the rising population in Sri Lanka the major cause of the problems of modern practice? While this question deserves a detailed examination, what is clear is that modern technologies have not helped and would have led to problems even if conditions were stable.

The question is really not whether ancient or modern practices are better, but which is more appropriate. This article offers evidence for many advantages of the ancient system. Given the favourable evaluation of ancient practices, would it be sensible to revive those technical practices? Is it viable to recreate the ancient style of life? The answer is clearly not only negative, but also that it would be inappropriate to present conditions. Our point in comparing the two is to point out that, indeed, there are alternatives to the 'Western' model and that in this particular case the alternative was better. This was a point lost on imperial Britain even when it professed a policy of benign paternalism and on contemporary development planners.

This examination of contemporary irrigation and water management practices makes clear the many shortcomings of modern practices. Acknowledgement of these shortcomings by policy makers, engineers and water managers can lead to improved practices. Thus, reflection on the practice of contemporary large-scale projects is useful and can lead to rectifying some aspects. A deeper reflection is also needed to address

some of the blind spots of contemporary practice. In this regard, it is useful to examine pre-modern irrigation systems for the lesson that they offer.

Indigenous irrigation technologies evolved to suit the local environment and people, and hence are still likely to retain some seeds of compatibility. In addition, these technological practices yield lessons for the present. The technology and practices of colonial sectors that to some extent have been adapted is also a valuable legacy. There is a need to understand the basis of these different technologies and to research, innovate, synthesise and develop water management practices that can be rooted in the indigenous, that harnesses the colonial, and that when useful, grafts on the foreign.

NOTES

1. For instance, the author of the *Rajavaliya*, an ancient Pali document, dismisses the significance of monarchs after the twelfth century, saying: 'Because the fertility of the land was decreased the kings who followed were no longer of such consequence as those who went before' (Gunasekera 1954).
2. Documented at the permanent Mahaweli exhibition (Mahaweli Kendraya), Colombo.
3. Following the rehabilitation, Kennedy (1933) assessed that of the 800,000 acres under paddy cultivation, the major works irrigated 160,000 acres, the village tanks and *ela*s (canals) accounted for 370,000 acres, and 270,000 acres were supplied directly by rainfall. The British discovered when restoring the small tanks that some needed canal irrigation while most could function independently (Bastiampillai 1967). Also, Brohier (1934) refers to the feeding of some small tanks in the Kalawewa region.
4. This is an oversimplification. There is evidence for some village tanks having been fed by larger tanks and canals (Bastiampillai 1967; Brohier 1934; Roberts 1967). On the other hand, there are a large number of independent village tanks surviving.
5. The large-scale irrigation works were supported by a specialised administration, which have been recorded as the *dolos-maha-vatan* (Roberts 1967; Siriweera 1972). Roberts concludes that Leach has underestimated the degree of the king's authority, and overestimated the power and freedom of the local chieftains, yet grants Leach's contention that the administration was decentralised.
6. Brohier (1934) reports that at Timbolketiya in southern Sri Lanka, 'a local tradition asserts that Pandikulama held the waters of a thousand tanks. Apparently long before the large tank was built, the system of water storage was confined to chains of little tanks'.
7. As opposed to this, the recent Samanalawewa Dam project was chosen to give the shortest distance between the abutments and to reduce construction costs even though there was geological evidence of a crack. The result has been massive disaster (Yapa 1992) with the entire scheme rendered useless by seepage through the crack.

8. A decade later the British reintroduced compulsory state service in a manner similar to *rajakariya*, calling it the Ordinance No. 16 of 1844 for 'the preservation and improvement of roads, rivers, lakes of this island'. However, the motivation was probably more for road construction that benefited the planters who controlled the legislature, than to maintain village agriculture. Tennent was the primary architect of British policies (de Silva 1981). This compulsory labour, the new dog, gun (3 shillings), poll (3 shillings) and land taxes along with the anger arising from the dispossession of lands by the 'wastelands ordinance' led to a peasant rebellion. This rebellion was put down by the skilful manipulation of chieftains by Governor Torrington and the colonial secretary, Emerson Tennent, along with martial rule, destruction of villages suspected of aiding the rebels, and the arrival of British troops who happened to be fortunately available from neighbouring India (House of Commons 1851). Emerson Tennent was removed from office by Earl Gray by a letter dated 3 December 1850, ostensibly for his rivalry with the government agent of the western province (ibid.: 371), but more likely on account of his conduct during the 1848 rebellion (Gooneratne 1965).
9. The 'sea of Senanayake', D.S. Senanayake was prime minister at that time. This name, of course, has undertones from the Parakrama Samudraya, the tank constructed during the reign of Parakrama Bahu in the twelfth century.
10. The earliest riots against Tamils were perpetrated by Agriculture and Irrigation Department workers in the settlement area (Vittachi 1958). After 1983 there were massacres of Tamils, Sinhalaese and Muslims.
11. A World Bank mission would suggest the settlement policy was simple. 'On the one hand are the large areas of underutilized areas; on the other are thousands of families living in congested areas. Settlement of this population on the idle lands holds out bright hopes of giving them a better life, while simultaneously adding directly to the wealth of the nation.' Their only reservation about the choice of colonists was that middle-class individuals who were better educated, skilled and equipped were ineligible as were private corporations (Caine 1953: 384).
12. The ballot was given to Ceylonese who could read, write and talk in English to elect ministers to a few portfolios such as agriculture.
13. Data of water consumption in western US and (West) Pakistan was used by the United States Operations Mission along with archaic formulas for estimating water consumption (Iriyagolle 1978). These basic errors were not discovered for ten years. The net result was that it was assumed that 15,000 to 27,500 cubic metres of water can irrigate 1 hectare of paddy and that 364,000 hectares could be irrigated instead of the more reasonable 141,000 hectares. By comparison the Sri Lanka Irrigation Department used 27,500 cubic metres in 1969 as the water requirement in the Deduru Oya irrigation project, and a Russian study done in 1961 for the Kelani Ganga irrigation project estimated a water consumption of 37,000 cubic metres per hectare of paddy. Thus, the Mahaweli plans lacked reliable empirical data which would have been necessary even for a minor irrigation project, and erred systematically on the side that suited the government. Furthermore, the estimates do not account for the consumption of water by settlers for household uses.
14. These figures were taken out of context from the 'Agricultural Development Proposals 1966–70' of the Ministry of Agriculture of 1966. This study only recommended the stabilisation of the area under cultivation, not expansion.

15. In the case of the subsequent Samanalawewa project, Pearce (1994) reports that the construction lobby in the United Kingdom was able to overcome the objections of the Overseas Development Administration who believed the project to be of doubtful value at the outset. It has since proven to be a liability for Sri Lanka as there was a leak from the reservoir.
16. A ritual where the king gets into the paddy field to plough and to demonstrate, maybe for political purposes, the adage that 'with the mud washed off, the farmer is fit to be king'. The new prime minister, J.R. Jayawardene, decided to revive this custom.
17. The price of oil, which was $35 at that time, was to fall to $15 later. A high price of oil led to overvaluation of the hydroelectricity to be produced.
18. This experience is not restricted to Sri Lanka. SKANSKA has operations in many countries. In Peru it was commissioned to build a $350-million hydroelectric project in the Andes in which the cost escalated to $1,900 million (*Engineering News Record* 1981). In Indonesia they contracted to build a hydroelectric plant in Mrica that too had cost overruns and unsatisfactory engineering that led the government to abandon the project. SKANSKA, however, persuaded the Swedish government to give foreign aid to the Indonesian government so as to continue with their work (Sherwell 1984).
19. Also see submission by Professor L.W. Mediwake to the World Commission on Dams and Development at http://www.dams.org/kbase/submissions/showsub.php?rec=ENV017, and a review by the British Aid Agency, DfID at http://www.dfid.gov.uk/policieandpriorities/files/asia/ev_s392.htm.
20. For instance, the richest 10 per cent had 30 per cent of the total national income in 1973 and in 1983 their share was 41 per cent (Ivan 1989).
21. Few of the charges of corruption have been investigated and documented. For example, Ostrovsky and Hoy (1990: 68) charged that funds intended for the Mahaweli project were used to purchase weapons and for military training.

REFERENCES

Abbay, R. (1877), 'The Restoration of the Ancient System of Tank Irrigation in Ceylon', *Nature,* 16(11), pp. 509–12.

Agence France Presse (AFP) (1993), 'Sri Lankan Aboriginal Chief Fights Lone Battle Against Time', 8 November.

Alexis, L. (1986), 'Sri Lanka's Mahaweli Project: The Damnation of Paradise', in E. Goldsmith and N. Hildyard, eds, *The Social and Environmental Costs of Large Dams*, Vol. 2. Cornwall: Wadebridge Ecological Centre, pp. 276–90.

Ameer Ali, A.C.M. (1972), 'Rice and Irrigation in 19th Century Sri Lanka', *Ceylon Journal of Historical and Social Studies*, 2(1), pp. 50–59.

Arumugam, S. (1969), *Water Resources of Ceylon: Utilization and Development*. Colombo: Water Resources Board.

Ascher, W. and R. Healy (1990), *Natural Resource Policy-making in Developing Countries*. Durham: Duke University Press.

Baldwin, M.F., ed. (1991), *Natural Resources of Sri Lanka: Conditions and Trends*. Colombo: Natural Resources, Energy and Science Authority of Sri Lanka.

Bandarage, A. (1988), 'Women and Capitalist Development in Sri Lanka, 1977–87', *Bulletin of Concerned Asian Scholars*, 20(2), pp. 57–81.

Bastiampillai, B. (1967), 'The Revival of Irrigation Enterprise in Ceylon, 1870 to 1890', *Ceylon Journal of Historical and Social Studies*, 10(1&2), pp. 1–26.

Brohier, R.L. (1934), *Ancient Irrigation Works in Ceylon*. Colombo: Government Publications Bureau.

———. (1956), *The Ancient Irrigation Works in Ceylon: 50th Jubilee Souvenir*. Colombo: Institution of Engineers, Ceylon.

Caine, S. (1953), *Economic Development of Sri Lanka* (International Bank for Reconstruction and Development Mission Report). Baltimore: Johns Hopkins Press.

Central Bank of Sri Lanka (1985), *Review of the Economy*. Colombo: Government of Sri Lanka.

Chandler, William U. (1984), *The Myth of TVA: Conservation and Development in the Tennessee Valley, 1933–1983*. Cambridge, MA: Ballinger Publishing.

Codrington, H.W. (1938), *Ancient Land Tenure and Revenue in Ceylon*. Colombo: Ceylon Government Press.

Crossette, Barbara (1987), 'Pinnawela Journal; Small Place Squeezes in for Elephant', *New York Times*, 20 June.

Deraniyagala, S.U. (1992), *The Prehistory of Sri Lanka: An Ecological Perspective*. Colombo: Archaeological Survey Department of Sri Lanka.

De Silva, K.M. (1981), *A History of Sri Lanka*. London: C. Hurst.

De Zoysa, L. (1881), 'Notes on the Origin of the Veddas with Specimens of their Songs and Charms', *Royal Asiatic Society (Colombo Branch)*, 7(24), pp. 93–115.

D'Oyly, John A. (1975 [1835]), *Sketch of the Constitution of the Kandyan Kingdom, 1774–1824*. Dehiwala, Sri Lanka: Tisara Prakasakayo.

D'Souza, Rohan (2003), 'Canal Irrigation and the Conundrum of Flood Protection: The Failure of the Orissa Scheme of 1863 in Eastern India', *Studies in History*, 19(1), pp. 41–68.

Engineering News Record (1981), 'Peru Banking on Irrigation Scheme', 25 June.

Farmer, B.H., ed. (1977), *Green Revolution? Technology and Change in Rice-growing Areas of Tamil Nadu and Sri Lanka*. Boulder, CO: Westview Press.

Food and Agriculture Organisation (FAO) (1969), *Mahaweli Ganga Irrigation and Hydropower Survey*. Rome: FAO.

Goldsmith, E. (1982), 'Traditional Agriculture in Sri Lanka', *Ecologist*, 12(15), pp. 214–15.

Goldsmith, E. and N. Hildyard (1984), *The Social and Environmental Costs of Large Dams*. San Francisco: Sierra Club.

Gooneratne, Yasmine (1965), 'Nineteenth Century Histories of Ceylon', *Ceylon Journal of Historical and Social Studies*, 8(1&2), pp. 106–18.

Gunasekera, B., ed. (1954), *Rajavaliya* (*Or a Historical Narrative from Vijaya to Vimala Dharmasuriya II*). Colombo: Ceylon Government Press.

Gunawardana. R.A.L.H. (1971), 'Irrigation and Hydraulic Society in Medieval Ceylon'. *Past and Present*, 53, pp. 3–27.

Hardiman, David (1998), 'Well Irrigation in Gujarat: Systems of Use, Hierarchies of Control', *Economic and Political Weekly* (Bombay), 20 June, pp. 1533–43.

House of Commons (1851), *Report of Select Committee on Ceylon*. London: House of Commons.

Indrapala, K. (1971), 'The Collapse of the Rajarata Civilization and the Drift to the Southwest', in K. Indrapal, ed., *Ceylon Studies Seminar*. Peradeniya: University of Ceylon, pp. vii–ix.

Iriyagolle, Gamini (1978), *The Truth about the Mahaweli*. Nugegoda, Sri Lanka: Gamini Iriyagolle.

Ivan, Victor (1989), *Sri Lanka in Crisis*. Ratmalana, Sri Lanka: Sarvodaya Publishers.

Jayawardene, Ruwani (1995), 'Healthcare Management in the Mahaweli Project', in H.P. Muller and S.T. Hettige, eds, *The Blurring of a Vision: The Mahaweli*. Ratmalana, Sri Lanka: Sarvodaya Publishers, pp. 205–20.

Jones, C. (1982), 'Harnessing Sri Lanka's Nile: A Nation Braces for a Flood of its Own Making', *Christian Science Monitor*, 25 March.

Karunatilake, H.N.S. (1988), *The Accelerated Mahaweli Programme and its Impact*. Colombo: Centre for Demographic and Socio-economic Studies.

Kennedy, J.S. (1933), 'Evolution of Scientific Development of Village Irrigation Works', in *Transactions of the Engineering Association of Ceylon.* Colombo: Engineering Association of Ceylon, pp. 229–92.

Knox, Robert (1681), *An Historical Relation of the Island of Ceylon*. London: Robert Chiswell.

Leach, E.A. (1959), 'Hydraulic Society of Ceylon', *Past and Present*, 15, pp. 2–26.

——— (1961), *Pul Eliya: A Village in Ceylon*. Cambridge: Cambridge University Press.

Liyanagama, B.S. (2000), 'Mahaweli Hydropower is Sri Lanka's Key to Development', *Journal of the Institute of Engineers, Sri Lanka*, 32(2), pp. 61–69.

MacFadden, C.F. (1954), 'The Gal Oya Project: Ceylon's Little TVA', *Geographical Review*, 44(2): 272–81.

Mendis, D.L.O. (1990), 'Lessons from Sri Lanka's Ancient Irrigation Ecosystems'. Proceedings of International Commission on Irrigation and Drainage, 15th Congress, April/May.

——— (1999), *Destruction of Cultural Heritage in the Name of Development*. Ratmalana, Sri Lanka: Sarvodaya Publishers.

——— (2002), *Water Heritage of Sri Lanka*. Ratmalana, Sri Lanka: Sarvodaya Publishers.

Ministry of Lands, Land Development and Mahaweli Development (1979), *Mahaweli, Projects and Programme: Review of Progress under the Accelerated Programme of Mahaweli Development*. Colombo: Ministry of Lands, Land Development and Mahaweli Development.

Ministry of Mahaweli Development (2001), *Mahaweli Projects and Programmes*. Colombo: Ministry of Mahaweli Development.

Mosse, David (2003), *The Rule of Water: Statecraft, Ecology and Collective Action in South India*. New Delhi: Oxford University Press.

Myrdal, G. (1968), *Asian Drama, An inquiry into the Poverty of Nations*. New York: Pantheon.

Obeysekere, Gananath (1967), *Land Tenure in Village Ceylon*. Cambridge: Cambridge University Press.

Ostrovsky, Victor and Claire Hoy (1990), *By Way of Deception*. New York: St Martin's Press.

Parker, Henry (1909), *Ancient Ceylon*. London: Lusacs.

Pearce, F. (1994), 'Britain's Other Dam Scandal', *New Scientist*, 26 February.

Peebles, Patrick (1990), 'Colonization and Ethnic Conflict in the Dry Zone of Sri Lanka', *Journal of Asian Studies*, 49(1), pp. 30–55.

Peiris, Ralph (1964), 'The Effects of Technological Change on the Population of Gal Oya Valley', *Ceylon Journal of Historical and Social Studies*, 10(10), pp. 163–92.

Ponnambalam, Satchi (1980), *Dependent Capitalism in Crisis: The Sri Lankan Economy, 1948–1980*. London: Zed Books.

Public Campaign on Environment and Development (1992), *Citizens' Report on the Environment and Development in Sri Lanka*. Rio de Janeiro: UNCED.

Roberts, Michael (1967), 'Paddy Lands Irrigation Ordinances and the Revival of Traditional Irrigation Customs, 1856–1871', *Ceylon Journal of Historical and Social Studies*, 10(1&2), pp. 114–30.

Samath, Feizal (1987), 'World Bank Criticises Sri Lanka's Biggest Project', Reuters, 30 June.

Sherwell, Chris (1984), 'How the Carrot and the Stick Saved a 1,240 m Project', *Financial Times*, 5 March.

Siriweera, W.I. (1972), 'Land Tenure and Revenue in Mediaeval Ceylon A.D. 1000–1500', *Ceylon Journal of Historical and Social Studies*, 2(1), pp. 1–49.

——— (1994), *A Study of the Economic History of Pre-modern Sri Lanka*. New Delhi: Vikas Publishing House.

Somasekeram, T. (1988), *National Atlas of Sri Lanka*. Colombo: Survey Department.

Tennakoon, N. Serena (1988), 'Rituals of Development: The Accelerated Mahaveli Development Program of Sri Lanka', *American Ethnologist*, 5(2), pp. 294–310.

Tennent, J.E. (1860), *Ceylon: An Account of the Island, Physical, Historical and Topographical with Notices of its Natural History, Antiquities and Productions*. London: Longman, Green, Longman and Roberts.

Thurairajah, A. (1985), 'How Local Engineers could have Benefited from Mahaweli Construction', *Economic Review*, 11(4&5), pp. 34–35.

Tippetts Abbett McCarthy Stratton (TAMS) (1980), *Environmental Assessment: Accelerated Mahaweli Development Program*. New York: TAMS.

Toynbee, Arnold (1946), *A Study of History* (Somervell's abridgement). London: Oxford University Press.

Uphoff, Norman Thomas (1992), *Learning from Gal Oya: Possibilities for Participatory Development and Post-Newtonian Social Science*. Ithaca: Cornell University Press.

United Nations Development Programme (UNDP) and Food and Agriculture Organisation (FAO), Mahaveli Ganga Irrigation and Hydropower Survey, FAO/SF55/CEY=7. Rome: FAO.

Vittachi, Tarzie (1958), *Emergency '58: The Story of the Ceylon Race Riots*. London: Andre Deutsch.

Webb, James (2002), *Tropical Pioneers: Human Agency and Ecological Change in the Highlands of Sri Lanka, 1800–1900*. Athens, Ohio: Ohio University Press.

Wijesinghe, Mallory E. (1981), *Sri Lanka's Development Thrust*. Colombo: Aitken Spence.

Wittfogel, Karl August (1957), *Oriental Despotism*. New Haven: Yale University Press.

World Commission on Dams and Development (WCDD) (2000), *Dams and Development: A New Framework for Decision-Making*. London: Earthscan, available at http://www.damsreport.org.

Xinhua (1986), 'Malaria Cases Increase in Sri Lanka', 21 August.

——— (1987), 'Malaria Rampant in Sri Lanka', 23 February.

Yapa, K.A.S. (1992), 'Sri Lanka's Samanalawewa Dam Fails', *World Rivers Review*, 7(4), p. 6.