DEVELOPMENT OF UNDERDEVELOPMENT IN SOUTHERN SRI LANKA: DEESTABLISATION OF ANCIENT IRRIGATION ECOSYSTEMS BY THE IMPACT OF HYDRAULIC ENGINEERING

by

D.L.O. Mendis

1.0 Introduction

A paper titled 'The Need of the Hour: Non-depedent Implementation of Southern Area Plan' attracted the attention of our Chief Guest, His Excellency J.R. Jayawardena, last year. H.E. remarked that this paper contained severe criticism of some policies of his government. This was a reference to the Lunugamvehera project. H.E. added that his government welcomed criticism, and that he would ask the Minister in charge to set up a Commission of Inquiry into the project.

His Excellency's remarks, given wide publicity in the press, led to some discussions in a Sunday paper. The former M.P. for Tissamaharama wrote that he had opposed the project from the time it was first mooted in the early seventies. The Director of Irrigation wrote an article defending the project. It became necessary therefore to focus attention on the two real bases for criticism of Lunugamvehera, namely the ecosystem approach and the context of the proposed Southern Area Plan, rather than engage in contentious and futile debate. The article titled 'The Ancient Irrigation Ecosystems of Sri Lanka' reproduced as an Appendix, for reference, was an attempt to give publicity to the scientific systems approach to the study of the ancient irrigation works in our country.

More recently, representations have also been made by Mr. M.S.M. de Silva and the author, to the new President of Sri Lanka, His Excellency, R. Premadasa, in regard to certain aspects of development policy for irrigation and multi-purpose projects, which evoked an immediate response. H.E. appointed a Committee headed by Mr. N.G.R. de Silva, Director of Irrigation to report to him on the matter, and Members of Parliament were also kept informed. This was in keeping with President Premadasa's avowed policy of 'Open Government' announced immediately after he assumed office. This policy, if correctly implemented, will act as an antidote to previous strategies and policies which were heavily dependent on foreign aid and foreign expertise. As a result, decisions on vital issues were often taken behind closed doors in bureaucrats advised by technocrats, more often than not overawed by foreign so-called experts who really know much less about our own problems, and their likely solutions, than we do ourselves.

Such strategies and policies in the immediate past have taken us away from true economic sovereignty, which has been described as a situation where: "the people of a country control its economy and its destiny themselves, free from interference from abroad; they control its resources, its markets, its trade, its policies. They decide. They may..."

Mr. D.L.O. Mendis, a long-standing Fellow of the Institution, was President in 1986/87.

He had his early education at Royal College, Banadarwela where he was a Governor's Scholar, and at Royal College, Colombo, where he won a Hon. Cecil Pereira Memorial Scholarship.

He graduated BSc. Engineering (Hons.) in Civil Engineering in 1955, and was awarded a Commonwealth Scholarship for postgraduate studies in 1959, which he declined, preferring to serve as an engineer in Sri Lanka. However, in 1985 he obtained a MSc. in Agricultural Engineering from the Post-graduate Institute of Agriculture, Peradeniya.

His abiding interest is the ancient irrigation systems of Sri Lanka, on which he does continuing research. Prof. Joseph Needham F.R.S. has invited him to undertake a comparative study of the ancient hydraulic civilizations of Sri Lanka and China at the Needham Research Institute in Cambridge, as a Visiting Scholar in 1990.
decide to engage in certain forms of co-operation with other countries; or they may decide not to; but they decide". (Boorstein, 1969, quoted in Mendis, 1971, 76)

1.1 Janasaviya Programme

President Premedasa's Janasaviya programme also fits well into the concept of Open Government. It also attempts to liberate the poorest of the poor from the shackles of dependence, dominance and exploitation, and mobilise their productive capacities. To really succeed, this programme needs support from all segments of society, notably technocrats; but we technocrats must first be liberated from the immediate past experience of domination by expatriates. This may be easier said than done.

The JSP is also of interest on account of many features in common with the erstwhile DDC programme of 1972-77, which was started after the attempted insurrection of 1971, with a primary objective of creating new employment opportunities, especially for educated youth. That programme was thrown out lock, stock and barrel, by the new government in 1977, on the advice of some bureaucrats and technocrats who were desperately anxious to show their 'loyalty' to the new regime, in exchange for a few plums of office. Anything and anyone associated with the development effort under the previous government was roundly condemned. The DDC programme was a favourite whipping-boy. (Treasons, 1978, 74, quoted in Mendis, 1988, 47).

1.2 Poverty alleviation programme

If the DDC programme had been transformed to the JSP twelve years ago, the adverse impact on the poorest, of the removal of social welfare measures that had existed for decades, would have been somewhat cushioned. If that had happened, there may not have been need for a Poverty Alleviation Programme today. Poverty has been defined in absolute and relative terms as follows:

"The concept of poverty in essence means 'deprivation' which could be analysed in both absolute and relative terms. 'Absolute poverty' is normally defined in relation to a minimum specified standard of living in terms of nutritional norms or basic needs. 'Relative poverty' takes as point of reference the prevailing standards of the society and is thus closely related to the pattern of income inequality. Both aspects are relevant to the analysis of poverty". (Wickremasekera, 1985, 244).

Removal of social welfare measures has increased absolute poverty, while economic growth in the recent past has increased relative poverty. Both absolute and relative poverty may have contributed to some of the social upheavals in the country in the recent past. Some of those disruptions may have been avoided, many of them ameliorated to a greater or lesser extent, if those social welfare measures on which the lower segments of society depended so much had not been removed virtually overnight.

The following figures should give food for thought in this context:

<table>
<thead>
<tr>
<th>% of Sri Lanka GNP allocated to:</th>
<th>1977</th>
<th>1987</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rice Subsidy</td>
<td>5</td>
<td>0.7</td>
</tr>
<tr>
<td>Military Expenditure</td>
<td>0.07</td>
<td>5</td>
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</table>

Source: U.N. University, World Institute for Development Economics Research (WIDER), Helsinki, Finland.

2.0 Development vs. Underdevelopment

In a paper presented at an Institution day meeting on June 22, 1972, extensive quotations were made from the doctoral thesis of a Peruvian Industrial engineer turned economist, Fransisco Segasti. The title of his thesis was "Towards a Methodology for Planning Science and Technology in the Underdeveloped Countries", and the methodology was applied in the Andean Pact countries: Peru, Chile, Equador, Bolivia and Columbia, at that time. (Engineer, Special Issue, 1973).

Segasti said:

"Underdevelopment is a phenomenon in its own right, it cannot be adequately studied and interpreted as a 'stage' in a sequential development process or as an interval in a sequential development continuum along which all countries can be placed and through which they must proceed in order to become 'developed'. Underdevelopment is a part of the historical process of industrialisation on a world scale, which implies that both development and underdevelopment are two facets of the same process of expansion of capitalist society beginning in the XIX century. This process involved the creation and spread of modern technology and the establishment of an international division of labour with a few more advanced countries producing manufactured goods, and a large number of backward countries supplying raw materials and primary commodities. Underdevelopment and development evolved..."
simultaneously, they were and are functionally related, and they also interact and condition each other.

These two phenomena must therefore be understood as inter-dependent partial structures which form part of a single system. The key factor differentiating these structures is that the developed one by virtue of its endogenous capacity for growth, became dominant and the underdeveloped one, given the induced and passive character of its dynamics, became dominated and dependant.

The main characteristics of an underdeveloped country are that it is dominated, disarticulated, and incapable of covering the costs of a human status for the majority of its population. Domination implies that it has little control over its own destiny. External environmental factors, beyond the control of the underdeveloped country, are the main determinants of the direction taken by its economic, social and even political structures". (Segasti, 1971, quoted in Mendis, 1973, 7)

2.1 Development of Underdevelopment

Segasti was describing the 'development of underdevelopment' in third world countries, a concept that grew out of analyses made by the Latin American Structuralist School, in the fifties, of the actual experience of economic exploitation of those countries by multi-national corporations.

Segasti continued: "It is important to point out that developed countries have been continuously shifting their modes of domination over underdeveloped ones in response to changing conditions and to pressures from them. From the control of raw materials extracted from, and manufactured goods supplied to, the UDC through export-import trading measures, they moved to the control of industrial production facilities through direct investment, and are now shifting to the control of technological know-how required in manufacturing industries. This last form is often exercised through direct investment and also through licensing agreements, sales of patents, etc. The primary vehicle through which these various forms of domination have been and are exerted has been and is the international or multinational corporation". (Ibid, 7).

Sri Lanka being a very small country, its local markets are far too insignificant to interest any multinational corporation. Therefore, there was hardly any move by MNCs to set up manufacturing industries here, en masse. Nevertheless, we have tried to attract some of them to the Free Trade Zones where manufacture under tax protection and other benefits was the bait, and the slogan at the time was 'Let the Robber Barons come!'

The MNCs that responded to the call were construction companies and consulting firms, and they have been having a field day in this country in the recent past. Involvement of local engineers in our own development effort was reduced to a now low, in comparison with what had prevailed previously. In the process, the local construction industry was driven to the wall, and all but totally eliminated. The subject has been discussed and debated from time to time, and there is no mood to elaborate on it in this paper. (See, Engineer, Vol. XIV, 1986, No. 2).

The point that has to be stressed however, is that in the absence of local markets on a scale to match the manufacturing capacities of multi-national corporations engaged in industrial production, it has been in the field of construction that the developed-world countries have been able to intrude into the economy of this country in the recent past, and achieve a position of dominance.

Segasti says that the 'main characteristics of an underdeveloped country are that it is dominated, disarticulated, and incapable of covering the costs of a human status for a majority of its population'. It is also undeniable that our country has become severely disarticulated in the past ten or twelve years. Finally, the President's Poverty Alleviation Programme is an admission of the need for, and a brave attempt to do something positive about 'covering the costs of a human status for a majority' of the population. Thus according to Segasti's definition at least, we are an underdeveloped country. The question is whether this underdevelopment is increasing, whether we are an underdeveloping country?

3.0 Underdevelopment of Southern Sri Lanka

The underdevelopment of southern Sri Lanka, however, began much earlier than the present decade. The fundamental basis for this underdevelopment, in a conceptual sense, was the destabilisation, and in some cases, the destruction of ancient ecosystems by the impact of hydraulic engineering, introduced not by foreign MNCs or even by foreign experts, so-called, but by our own people. The principle vehicle for the introduction
of this destructive social force was a map produced in 1959, described as the "Map of Water Resources Development of Ceylon". This map has been revised and reprinted since it was first published. A copy probably hangs on the wall in every office of every important official in the Irrigation department and the Mahaweli Ministry, and is presumably used for conceptual planning and project identification for irrigation and multi-purpose projects in this country.

3.1 The 1959 Water Resources Development Map of Ceylon

This map shows the topography, the 100 foot contours, and the 103 river basins in the country. In a number of the larger river basins, large storage reservoirs are also shown, with the implied suggestion that they should be constructed in the future. The proposed capacity of each reservoir has been determined on the basis of the rainfall and runoff above the proposed dam site, in its own catchment only. The potential irrigable area below each reservoir, again within that river basin only, matches the proposed storage capacity of each reservoir. Thus what this map shows is a collection of within-basin reservoirs in the major river basins, without any consideration of trans-basin diversion.

3.2 Water resources development in ancient Sri Lanka

The first major trans-basin diversion irrigation and water supply project in Sri Lanka was the 57 mile long Jaya Ganga from the Kala Oya to the Walawata Oya basin. This ancient trans-basin canal was built, possible in the 3rd century, certainly no later than the 5th century, when the Kalawewa was constructed by King Dhatusena, to augment the water supply to the capital city Anuradhapura. Still later the Kalawewa itself was augmented in the 8th century, by means of a trans-basin diversion from the Nalanda Oya in the Mahaweli basin through the Ebbawela cut in the ridge separating the two basins.

Kalawewa was in a breached condition when discovered by the British. They repaired it in 1905, and with the restoration of the Jaya Ganga in 1935, the Anuradhapura city tanks were once again augmented, after an interval of some 700 years. Finally in 1957, a new concrete dam was built at Nalanda and a new regulator at Ebbawela, which enabled water from Mahaweli to augment Kalawewa, and hence flow to Anuradhapura, after an interval of several centuries.

It should be apparent from this brief sketch of past history, that the 1959 map, with its within-basin restricted concept of so-called water resources development, actually set the clock back some 1500 years. What is most amazing is that we are still apparently following this irrational and unscientific basis for water resources development in Sri Lanka in the last quarter of the 20th century.

3.3 Uda Walawe Project

The first major project picked out for full investigation on the basis of identification on the 1959 map, was the Uda Walawe reservoir. The following comments on the disadvantages of developing an isolated river basin were made in a critical paper on the designs for Uda Walawe headworks, more than 20 years ago:

"The original master plan drawn up after 1960, comprised the following reservoirs:
1. Upper Walawe reservoir or Samanala weva,
2. Katupath Oya reservoir,
3. Uda Walawe reservoir,
4. Chandrika weva,
5. Mau Oya reservoir,
6. Wel Oya reservoir

Subsequent planning has taken adequate note of the disadvantages of developing an isolated river basin. The water-shed is nature's boundary, but is not necessarily the ideal limit for planning a development pattern or for managing a developed system. Hence, the development of the Walawe basin will necessarily be linked with the development of adjacent and nearby river-basins, those to the west of the Walawe basin contributing excess run-off by means of trans-basin diversion and those to the east of the Walawe basin benefitting from this diversion.

The Uda Walawe reservoir project may thus be studied either in the context of a relatively isolated development of the Walawe basin itself, or in the context of a larger development pattern embracing at least that portion of the island which has been described as "South East Ceylon"." (Mendis, 1958, 132)

3.3.1 Location of Uda Walawe reservoir

At that time when the Uda Walawe headworks was being built, an attempt was being made to discuss a rational basis for water resources development. A fairly recent publication available at that time...
was used, which described the principles of water resources planning as follows:

1. Define the purpose of the engineering project. Formulate its useful end which makes the creation of the project a desirable objective.

2. Plan the project in accordance with its established purpose. Investigate alternative proposals, and select the project that will most effectively fulfill the purpose.

3. Design the project in the most efficient manner and in accordance with appropriate criteria of safety.

4. Construct the project according to its design, while applying suitable standards of workmanship.

5. Operate the project, thus bringing the useful end of the engineering planning into concrete existence." (Kuiper, 1963, quoted in Mendis, 1968, 134)

These principles were combined with another suggestion made by Szechowycz, that investigations for earth dams should include the alternative of eliminating concrete spillways, and utilizing the savings so achieved to increase the capacity of the reservoir by raising the dam. (Szechowycz, 1959, quoted in Mendis, 1968, 134).

Using this suggestion, and applying Kuiper's principles, it was argued that:

"the correct location for the Uda Walawe reservoir was a site about ten miles upstream of the present location, having the following characteristics:
- Catchment area: 400 Square miles
- Irrigation command: 100,000 acres
- Area of reservoir at F.S.L (400 M.S.L): 9,900 acres
- Estimated average annual yield: 770,000 acre feet

This reservoir would have functioned as an after bay reservoir for the Samanala wewa. Spillway would have been provided in a gap between hills as shown. The cost of the reservoir should therefore have been less than the cost of the reservoir already constructed". (Mendis, 1968, 135)

Thus, it had been argued as far back as 1968, that on the basis of scientific principles of water resources planning the correct location for Uda Walawe reservoir was somewhere near the existing ancient Ukgal Kaltota anicut. Today it is even more evident that this is the correct and only possible location that also fits into the Upper Transbasin Channel of the Southern Area Plan. It is also abundantly clear that there is no rational or scientific basis for the present location of Uda Walawe reservoir.

Professor Kuiper was invited to Sri Lanka in 1985 to lecture to engineers in Mahaweli on the principles of water resources planning. In a private meeting with him, the author discussed this problem of the absence of any scientific principle in the water resources planning allegedly practiced in Sri Lanka today, based as it is on the unscientific 1959 map. To this day no impression has been created on high-level technocrats who still use this map as a basis for project identification, from the initial stage of pre-feasibility studies. Professor Kuiper's visit was in vain.

3.3.2 Construction of Uda Walawe headworks

Construction of Uda Walawe headworks was completed in record time in 1968 after an epic river closure operation by the River Valleys Development Board in 1967. (Mendis, 1967, 67). The total cost of construction of Uda Walawe headworks was an incredibly low figure of about 40 million rupees for all the following works:

1. A rolled earth filled embankment containing 51 million cubic yards of earth, with rip-rap protection on the upstream face etc.
2. About 50,000 cubic yards of concrete including reinforced concrete.
3. Two reservoir power plants with a total installed capacity of 5.4 MW.
4. A radial gated spillway structure with 7 nos. gates each 43' 6" high by 34' wide, the largest installed in the country up to that time.
5. A river sluice structure for river diversion during river closure.

At today's prices all this would have cost about 4000 million rupees.

3.3.3 Downstream development and settlement under Uda Walawe

Downstream development work has been extremely slow, and fraught with problems. The original plan was to acquire all private lands and block them out together with crown lands lying within the irrigable command. An element of anarchy crept in however, and prevented this. Several studies have reported on this of which the following is a
typical example "in fact, the official land distribution never occurred. Once the land had been levelled and prepared, purena villagers, infuriated by the coming of outsiders, forcefully and disorderly occupied the land. Distribution occurred thus in an unorganised manner, with each family, whether purena or not, taking land where an opportunity was present and in as big a quantity as possible. Sometimes settlers were chosen from the land in which they first settled. The political context of the time did not allow radical measures to be taken to correct this situation and restart from scratch. Thus the status quo remained". (Drooy and Shammugaratnam, 1984, 85-86).

3.3.4 Water management

Another important issue that receives a great deal of attention is the problem of water management. Several studies have been done to understand this problem at Uda Walawe and elsewhere in Sri Lanka, by local and foreign consultants and researchers. Uda Walawe has acquired a reputation as one of the best examples of wasteful use of irrigation water anywhere in the island. An explanation for this, popular amongst some 'experts' is that the farmer over-uses precious irrigation water because it's given to him free of charge. Their solution therefore is to place a charge on water as an irrigation duty.

3.3.9 Rehabilitation of irrigation distribution system

Large sums of money are being spent from time to time on what is called rehabilitation of the distribution system at Uda Walawe, the first such programme having been started even before construction of the channels was completed. The most recent programme currently under implementation is financed by a loan of U.S. $ 15 million borrowed from the Asian Development Bank, and euphemistically described as 'aid'. This works out to a cost of about Rs. 40,000 per ha. for 12,000 ha., at current rates of exchange. It is incredible that such enormous sums of money are spent on so-called rehabilitation at regular intervals of perhaps 10 years, without the realisation dawning on high-level decision makers, who advice politicians, that there is something radically wrong somewhere.

3.4 The Ecosystem approach

Is there any connection between these three problems that seem to be outstanding features of the Uda Walawe project, namely, the interference with the original blocking out programme and alienation of land, by local people; the water management problem that very soon manifested itself in the irrigable area; and the need for rehabilitation of the channel system from time to time?

Indeed there is a connection, and the answer to all three problems is indicated in the title of this paper: Destabilisation of ancient irrigation ecosystems by the impact of hydraulic engineering. Referring to the Appendix titled Ancient Irrigation Ecosystems of Sri Lanka, it is seen that four types of ecosystems that had existed in the area when blocking out was attempted, were the following:

1. Rain-fed agriculture or haen govithan.
2. Seasonal or temporary river diversion and flood irrigation on river banks: a type of micro irrigation ecosystem.
3. Micro irrigation ecosystems dependant on permanent river diversion and channel systems on river banks.
4. Micro irrigation ecosystems based on small village tanks.

Many of these types of micro ecosystems had also been destroyed by submergence under the 9,000 acre waterspread of the Uda Walawe reservoir. A few of them had been functioning, but most had long been over-run by jungle and abandoned.

Destruction of functioning micro ecosystems by submergence when the Uda Walawe reservoir was impounded was in the nature of an eventuality that could not be avoided. Displaced persons living in the reservoir bed area would have accepted it with karmic resignation. Destruction of functioning micro ecosystems in the downstream development area by acquisition and re-blocking out was another matter. It could be, and was, resisted. Hence the beginning of anarchy in the area.

3.4.1 Irrigation ecosystems vs. hydraulic engineering

They key to understanding this conflict in the Uda Walawe downstream development area is to understand the difference between ancient irrigation ecosystems, and the modern system of blocking out of farmer allotments; and the difference between the ancient system of irrigation and distribution of water, and the modern system of provision of irrigation facilities. Brohier, long ago, documented the Ancient System of Irrigation and
Distribution of water, as shown in Figure 1. This illustrates how water was used for irrigation, many times over, in a micro irrigation system. It is essentially the infrastructure of a water management system where the farmers are interdependent. This was the system that may have prevailed in the Uda Walawe downstream area before blocking out was attempted in recent times. It is the channel system that was used in the ancient irrigation micro ecosystems.

The modern system of blocking out and provision of irrigation facilities follows a different principle altogether; indeed it follows a different socio-political philosophy. Here, every farmer is treated as an independent individual entrepreneur, and each farm allotment is provided with an individual pipe outlet from a field channel. The waste water from each allotment falls into a drainage channel, and all drainage channel water is taken away without being reused in the immediate vicinity. (See Figure 2).

From a socio-economic perspective, the modern system is representative of capitalist relations of production, whereas the ancient system is representative of pre-capitalist relations of production. In trying to introduce the modern system where the ancient system obtained, we are assuming the transformation of the traditional goviya practising subsistence farming, into an agricultural entrepreneur in a capitalist system.

Many studies by social scientists in both the older so-called colonisation schemes, and in the newer settlement programmes under Gal oya, Walawe and Mahaweli, have shown that in a short time a majority of the colonists or settlers have been reduced to penury, while a small minority prospered. The majority were transformed into agricultural wage labour, and the minority into petite capitalists. The physical layout of the irrigation channel system and the blocking out pattern favours the latter at the cost of the former.

The ancient system of irrigation and distribution of water; on the other hand, conforms to a more egalitarian agricultural economy, at farm level.

3.4.2. Need for inter-disciplinary study

Due to division of labour, in this case intellectual labour, social scientists are often unaware of the work of natural scientists, and vice versa. Engineers, more often than not wrapped up in the intoxicating awareness of their own importance in the development effort of a poor third world country, are seldom aware of either. Recently, economists and ecologists, sociologists and physicists, have met in New Mexico, U.S.A, in an unprecedented inter-disciplinary brainstorming session, in a deliberate attempt to learn from each other's techniques. Since some of the participants were Nobel Laureates, their example may well be followed by others, in the not too distant future. (Scientific American, December 1988, 81).

Here in southern Sri Lanka there is a ready-made real-life situation calling for such an inter-disciplinary research effort, to try to understand the root causes of the present social upheavals. According to the necessarily preliminary findings presented in this paper, the development of underdevelopment in the area in recent times is due to the impact of hydraulic engineering on ancient irrigation ecosystems. In the Walawe basin this impact has destabilised existing micro ecosystems with resultant destabilisation of the social system as well.

3.5 Remedial measures at Walawe

It may be argued that the intention at Walawe was to create a new macro irrigation ecosystem consisting of a large storage reservoir commanding a number of micro ecosystems in its command area. (See Appendix). However, to achieve such an objective, major changes in the design and layout of the irrigation infrastructure will be necessary.

3.5.1 Inappropriate technology and imitative development

On the right bank main channel, the syphon crossing across the Timbelkettiya gange must be replaced with a level crossing. The syphon was built here for no better reason than that it was the practise recommended by the U.S. Bureau of Reclamation. (Transactions, 1968, II, 179). This is a good example of imitative development and an example of underdevelopment, due to transfer of inappropriate technology.

Another example of this type of inappropriate technology transfer in the recent past, reported at last year's Annual Sessions, is the use of relief valves in the design of the channel lining in Mahaweli System B: "The writer is of opinion that the design could have been changed entirely to incorporate a system of collector drains with manholes thus eliminating the need for such a large number of relief valves which necessarily
require individual attention. The canal lining can be built on a sand blanket as is usual". (Ranatunga, 1988, 27).

Of course the use of a sand blanket with open-jointed pipes to draw off the water under the lining would have been cheaper and easier to build and (more important) to maintain. Use of the relief valves may well result in the need for a costly 'rehabilitation project' in the System B area in the future, thus nullifying the effect of the costly lined channels.

3.5.2 Chandrika wawa

Another major change that will be necessary will be to retrace the R.B. main channel at a higher contour around the Chandrika wawa. This was first commented on in a paper presented in 1977, as follows:

"At Walawe a further problem has arisen on account of construction of the Chandrika wawa across the Hulanda oya before the design of the Uda Walawe reservoir and R.B. main channel was finalised. This channel now intercepts the Hulanda oya at Chandrika wawa at a higher bed level than the F.S.L. of the wawa. The channel has therefore been dropped into the wawa and picked up on the other side with a considerable loss of command". (Mendis 1977, 55).

3.5.3 The ancient system of irrigation and distribution of water

Finally, and most important of all, the layout of the distribution channel system will have to be changed bringing it closer to the ancient system of irrigation and distribution of water, shown in Figure 1. The Late Mr. M.M. Ismail, an experienced field engineer who called himself a farmer in the later stages of his life, understood this method very well, because he had practical experience of its application. He said: "The most economic water management method is effected by means of a laying down field channels 'on the contour' in echelon, to enable any waste or drainage from the upper row of fields to be re-used immediately by the lower strip of fields. A one cusec channel will deliver 3" irrigation to eight allotments of 24 acres in three days. Hence, one cusec flow commands 48 acres. 120 days of overall irrigation gives 48 inches or 4 acre feet to one acre. Allowing 0.25 inches daily, evapo-transpiration loss is 30 inches in 120 days. The balance of 18 inches is theoretically available to the lower strip of paddy allotments. Making allowance for deep percolation, it is found in certain parts of Gal oya valley that a 3½ months paddy crop is raised with 3 feet of water per acre of Yala crop (April - August)." (Transactions, 1983, 144).

The system described here is the ancient system of irrigation and distribution of water in which water flows from one farmer's allotment to another, so that farmers are interdependent on each other. This is in contrast to the present system of blocking out, where each allotment is given its full supply of irrigation water from its own individual pipe outlet, and each farmer is therefore treated as an individual entrepreneur, as previously described.

When Ismail presented the suggestions quoted above, the response of a high-level technocrat, in a position of responsibility to advise politicians, was as follows:

"There has been mention of re-use of water in irrigation systems. This is already in practise though it is not apparent to a casual observer.

For example, when water was issued to 'H' area most of the drainage water was collected into the Rajangana reservoir from where further irrigation was practised. Mahaweli diversions are not issued direct to Rajangana and all the benefit that it gets from the Mahaweli diversion is from return flow in System H. Similarly the drainage from Minneriya and Giritale schemes are being used at the Gal amunu anicut". (Transactions, 1983, 149).

It is quite obvious that this is a misleading statement, quite beside the point in reference to Ismail's remarks about the need to re-use irrigation water from one farmer's allotment to the adjacent allotment.

3.5.4 How technocrats can mislead politicians

This type of statement made by persons in positions of technical and administrative authority is available in the printed record of discussions in the various Transactions of this Institution of which further examples will be given. It is an unfortunate fact that such statements from such persons, have a certain ex cathedra aura of truth, whereas the reality is the exact opposite. It does not require much imagination to see how politicians have been mislead down the years by such advice, with resultant development of underdevelopment.

In regard to the particular case under discussion, the Uda Walawe Project, it should be apparent by
now that the achievement of a stable macro irrigation ecosystem below the Uda Walawe reservoir is unlikely in the extreme, unless there is a radical change in thinking at the highest levels of policy making in respect of irrigation projects, which does not appear at all likely at present.

If this is the gloomy forecast for the future in Walawe, what of the Lunugamvehera project, the cause celebre which attracted attention of His Excellency President Jayawardene last year? And what of the proposed Southern Area Plan which was first discussed some 25 years ago, and has been cleverly kept out of sight of political leaders by bureaucrats and technocrats who advised successive governments on irrigation policy throughout that period?

4.0 Lunugamvehera

Lunugamvehera was shown on the 1959 map described as the Lower Kirindi Oya reservoir. The location and capacity was such that there was a within-basin balance of water and land. There was sufficient storage capacity in the reservoir, and runoff from the catchment above, to match the area of land under command. However, there was no soil survey of the land under command, since soil surveys had not come into common usage at that time.

Lunugamvehera caught the fancy of some technocrats who no doubt felt that what was shown on a map described as the Water Resources Development Map of Ceylon must necessarily be a sound project. Moreover, it conformed to Brohier's 4 stage theory which had been used to justify Uda Walawe earlier. (See Appendix).

4.1 Hurathgamuva alternative

The proposal was opposed by technocrats in the Planning Ministry who were keen to see the Southern Area Plan accepted. The Planning Ministry directed that the proposed Lunugamvehera project should be re-examined in the light of the proposed Southern Area Plan, and this fact was placed on record in this Institution in 1971 for the first time. (Mendis, 1971, 84, also quoted in Mendis, 1988, 51). If this direction was followed, an alternative site for a storage reservoir at Hurathgamuva, about 10 miles upstream of the Lunugamvehera site should have been investigated. This, as we know, was never done.

In the paper presented at these Sessions in 1977, the following remarks were made about a reservoir at the alternative Hurathgamuva site: "This reservoir would command the same lands that would be benifitted by the proposed Lunugamvehera weva. It is a matter for regret that, without meeting these arguments for construction of the Hurathgamuva reservoir rather than the Lunugamvehera weva, foreign expertise has now been sought to justify the latter project ....... It is in this context that the recent request to a foreign organisation to undertake a feasibility study of the proposed Lunugamvehera project should be viewed. It leaves a bad taste in the mouth when a project which has been criticised by local technologists for sound reasons, is offered to a foreign agency for investigations. It is well known that foreign financing agencies are ever willing to lend us money for development projects, provided certain minimum benefits are shown, whatever the long-term consequences may be - witness the Uda Walawe reservoir. And the terms of reference for such investigations will never be comprehensive enough to cover all aspects and all possibilities of the long-term perspective - witness the E.C.I. study for the Three Basins" (Mendis, 1977, 57).

4.2 The 1977 Committee appointed by the Minister

This paper was presented in October, 1977 just three months after the new government had come into power with an unprecedented 5/6th majority. The new Minister had been asked to make a policy decision, a few weeks after taking office, on the Lunugamvehera project. He appointed a five-member Committee of engineers to report to him on the pros and cons of Lunugamvehera and Hurathgamuva. Three members of the Committee, Messers A. Maheswaran (Chairman), D. Ladduwahetty, and T. Palamakumbura, recommended construction of Lunugamvehera. Mr. M.S.N. de Silva in a dissenting Report, recommended that Hurathgamuva be investigated and constructed. Mr. D.L.O. Mendis reiterated to the other members what he had always stated, ever since he first brought the Southern Area Plan to the attention of engineers at these annual Sessions, in 1971, that the Hurathgamuva weva fitted into the Plan and the Lunugamvehera weva did not. The Committee's Report to the Minister was submitted without his signature.

4.3 Construction of Lunugamvehera headworks

The Minister gave his approval for construction of Lunugamvehera. He said later that he had been guided by Napoleon, who had advised that a general
could afford to lose a battle, or even a war, but not to lose time. When he first made this
pronouncement at a meeting, an engineer remarked that History would absolve the Minister, but not
the technocrats who had created the fait accompli situation which had given the Minister no choice.
His arm had been virtually twisted to give the decision.

What happened thereafter is really a sorry saga. All kinds of problems arose during construction so
that the project which was started in 1978 was not completed till 1986. Thus the construction period
was 8 years, double the original estimated period of 4 years. As for costs, this is said to have
increased 4 times over the original construction estimate by the time the project was finally completed.

All this makes dismal reading, but it is only the beginning of the sad and tragic story of
Lunugamwehera which will surely be recognized in the future as a model of its type illustrating the
destabilisation and destruction of ancient irrigation ecosystems by the impact of hydraulic engineering.

4.4 What lies ahead at Lunugamwehera?

The following information will give an indication of what may lie ahead: (See Figure 3).

1. The medium scale ancient reservoirs lying downstream of Lunugamwehera, Tissa weva, Debaha
weva, and Wirawila weva are supplied with excess water, perhaps due to subsurface flow from
Lunugamwehera weva, and there is insufficient land below these ancients reservoirs to benefit from
this excess water.

2. The promised supply of irrigation water from Lunugamwehera right bank channel to Badagiriya tank
has not materialised. Settlers under Badagiriya who had been experiencing water shortages from the
time they were first settled about 30 years ago, are now asking that they be resettled
below Lunugamwehera.

3. About 1500 families who had been settled in micro ecosystems of types 1, 2, 3 and 4, (see Appendix)
that now lie submerged undār Lunugamwehera weva, and were uprooted and resettled
are now becoming something of an embarrassment to local authorities.

4. Local people are well aware that the alternative site about 10 miles upstream of
Lunugamwehera, at Hurathgamuvu should have been investigated, and such investigations would have
taken no more than about 6 months to one year, because of easy access to the site. They also know
that if it had been investigated, it would have been much easier to build a dam at Hurathgamuvu
than at Lunugamwehera which had various foundation problems that apparently took the engineers by
surprise. Time of construction at Hurathgamuvu would have been about 2 or 3 years, and that
reservoir would have commanded a far greater extent of irrigable land than Lunugamwehera, with re-use
of water in the irrigable area.

5. Local people also know that ancient ecosystems in what is now the bed of Lunugamwehera, that had
supported some 1500 families, would have been given a better assured supply of irrigation water from
the Kirindi oya, after supply to the new lands settled under Hurathgamuvu. They well know the
benefits of this type of re-use of irrigation water under ancient irrigation ecosystems, and the
ancient system or irrigation and distribution of water, described in this paper.

5.0 The Southern Area Plan

It is well known that there was a vast system of trans-basin and intra-basin channels, connecting
large reservoirs in the ancient Raja rate of Sri Lanka. Brohier first documented this in his
historic paper to the Royal Asiatic Society in 1935, referred to in the Appendix. (Brohier,
1937). Nicholas did further research and showed that there was an intricate systems of channels
connecting the basins of the Mahaweli gange, Amben
gange, Kala oya, Modaragama ala, Malwatu oya and
Yan oya, in ancient times. (Nicholas 1960, quoted
in Mendis, 1966, 28).

This author has pointed out the significance of the fact that in most instances the channels were
built before the reservoirs which they supplied, and in some cases, the supply channel was
consolidated by a reservoir. The following examples were referred to in the 1977 paper:
Vasabha built the Elahera channel in the 1st century, and Mahesan built the Minneriya weva (which it supplied) in the 3rd century. Aggabodhi I built the Minneriya-Kantalai yoda weva, and his successor Aggabodhi II built the Kantalai weva. The Nuwara weva was first supplied by means of a diversion channel from an anicut across the Malwatu oya until the Nachchaduwa weva was built submerging this diversion anicut, to consolidate supply to the Nuwara weva, much later.

5.1 1977 Discussions: Step by step development

In a like manner, the recommended strategy for implementation of the Southern Area Plan was to construct the upper trans-basin channel first, and build the storage reservoirs in the southwestern wet zone later: “This proposal for step by step development follows the same logic used in the development of the ancient irrigation systems. It provides a long-term framework within which to plan the development of the Southern area. The ultimate step in this macro development plan will be the diversion of excess water from the southwestern wet zone basins of the Nilwala ganga, Gin ganga and Kalu ganga. Here again, the initial step will be river diversion by anicut and canal, followed later by the construction of storage reservoirs in the wet zone to consolidate the diversion system with storage of water at the source. The development of hydro-power from the diverted water will not be excluded by this systematic development in stages.

This proposal, described as the Southern Area Plan, originally due to Mr. M.S.M. de Silva, has already been presented in outline to this Institution in 1971”. (Mendis, 1977, 57).

5.1.1 A red herring: Southern area vs. Mahaweli

A response to this during discussions, was the following comment:

“He said that Mr. Mendis had advocated the ancient system of step by step development with the first step being anicut diversion, for an irrigation project. However, he said the problem today was that we cannot wait that long for such step by step development because we wanted quick development and so the example of the Nachchaduwa system was not appropriate today. For example the present government was not prepared to wait 30 years for the entire Mahaweli development and they wanted to develop 900,000 acres in 5 years. This could not be done with labour-intensive technology..........................

In regard to the proposed Southern Area Plan he said that it certainly was a good idea to divert excess water from the wet zone to the dry zone and this in fact was being done in the Mahaweli project. However (he said) that the southern area canals will ultimately depend on large storage reservoirs constructed in the wet zone. Therefore he said it will take a lot of time, energy and money and a great deal of investigations as well, quite apart from the question of political priorities and policy decisions made by governments and not by technocrats to implement this project. However (he said) that if the government decides to stop the Mahaweli project and go to the southern area they would have to do so”. (Transactions, 1978, 75).

The author responded to these comments with the following:

“In regard to the Southern Area Plan depending on large reservoirs and... observations that if they were asked to stop Mahaweli and go to the south they would do so, Mr. Mendis was very sorry to hear these words ......... He said that the Southern Area Plan was not meant as an alternative to the Mahaweli. It was a part of the total development plan for the country and there was no intention of dividing the country into parcels .... It was important that while the Mahaweli project was being implemented even in the brief period of 5 or 6 years rather than 30, that we should still promote other concepts and think of other projects. The proposed Southern Area Plan was one such concept and it covered a whole region. This was better than picking out a little bit of one river basin to suit a particular electorate or a particular M.P. After all Mr. Mendis said, Sri Lanka is only a small island of 25,000 sq. miles, and we should plan our water and human resources for the whole country”. (Transactions, 1978, 76).

5.2 Another red herring: the land will not be there

Five years after these remarks had been made at the 1977 Annual Sessions, a Seminar on Agriculture and Community Development was held during the 1982 Annual Sessions, at which the same speaker made the following significant remarks: “In his opinion, the question of further projects after the present Mahaweli programme is completed may not arise. For one thing, the land will not be there for such purposes and secondly the required national food and other agricultural products from
irrigated cultivation would all be grown within the projects that have already been taken up". (Transactions, 1983, 130)

In other words, there is no need for the proposed Southern Area Plan!

A similar sentiment was expressed in a publication in 1984, which said: "This has brought about a physical limit to the extension of peasant resettlement. After the much publicised Mahaweli project Sri Lanka will not be left with any major river basins or vast stretches of uncultivated but potentially arable land for future development". (Dvroye and Shamugaratnam, 1984, 113).

These statements that 'the land will not be there' and that 'Sri Lanka will not be left with any major river basins or vast stretches of uncultivated but potentially arable land' are misleading to the extent that they could be labelled mischievous, in the context of denying recognition of the Southern Area Plan that was identified some 25 years ago. Perhaps such statements give a clue as to why this plan has been denied political recognition throughout this long period.

This same attitude has recently been adopted by foreign consultants who had been engaged to study the water resources of the Kelani ganga basin. They had the audacity to state that there was no possibility of diverting excess water from the Kelani ganga in the southwest wet zone to the southeast dry zone, because all the potentially irrigable land in the SEDZ was given over to National Parks and other reservations.

5.3 The price of underdevelopment - money spent on the south

One final comment: when the question of neglect of the southern area by successive governments, misled by bureaucrats and technocrats, and foreign consultants is discussed, one response is to draw attention to the large sums of money that have been 'spent' on Uda Walawe and Lunugamvehera projects, as if this is an indication of development. The whole thrust of this paper is to show the exact opposite that money spent on hydraulic engineering which destroys ecosystems is money devoted not to development but to underdevelopment, for which technocrats who advise politicians must be held squarely responsible.

5.4 Blood on our hands.

It can be argued that there is a direct link between the anarchy that disrupted the alienation of land in Walawe in the early seventies, and the widespread unrest and civil commotion that has erupted in the south in more recent times. Both have roots in the destabilisation and destruction of ancient irrigation ecosystems, although the present conflict between so-called subversives and security forces obviously has other roots. Nevertheless, when innocent civilians are "caught in the cross-fire" as reported in the press from time to time, some of the blood of these innocents must lie on the hands of technocrats responsible for destruction and destabilisation of the ancient irrigation ecosystems.

6.0 Conclusion: Warning for the Future

All this should be a warning to other technocrats (for example those in the Mahaweli project) who are engaged on project formulation, and advice politicians on priorities for feasibility studies. In the present order of things, these studies originate from projects identified on the 1959 map, and are undertaken by foreign consultants who come in on some credit line. These consultants are almost necessarily ignorant about the ancient irrigation ecosystems of Sri Lanka, and are not at all concerned about the basis for their terms of reference - the 1959 map on which projects have been identified, which as we have seen is unscientific and irrational.

The UNDP/FAO studies in the mid sixties also fall into this generalisation. The proposed Moragahakanda reservoir and the proposed NCP canal identified at that time, should be re-examined in terms of rational, scientific principles of water resources development planning, as a matter of urgency.

If this is not done, there is grave danger that the underdevelopment of Southern Sri Lanka by the impact of hydraulic engineering that we are experiencing, may well be repeated in the NCP in the future. The consequence of this will be perpetuation of the ethnic conflict, permanent division of this small country on ethnic lines, and possible permanent occupation and annexation by our big neighbour, now in temporary occupation of about 25% of our land.

Construction of Lunugamvehera was manoeuvred by shortsighted technocrats who did not investigate
the Hurathgamuva alternative, and virtually forced the Minister into giving his approval for a defective proposal, to 'save time'. Now, Moragahakanda may be taken up for construction on a similar basis, to 'save time' on investigation of an alternative proposal for a reservoir in the Kalu ganga basin in the NCP. Thus history tends to repeat itself.

References


19. Transactions of the IESL (1983), pages 144-149


ANCIENT SYSTEM OF IRRIGATION AND DISTRIBUTION OF WATER

SPILL OR WANNA

CHENA AND HIGH LAND CULTIVATION

PADDY FIELDS

PICK UP WEIR

CHENA AND HIGH LAND CULTIVATION AND VILLAGE SETTLEMENT

PADDY FIELDS

PICK UP WEIR
APPENDIX
THE ANCIENT IRRIGATION ECOSYSTEMS OF SRI LANKA

R.L. Brohier's study, Ancient Irrigation Works in Ceylon, published in 1934 remains the best source of reference for a serious study of the subject. A less well-known paper was presented by Brohier on the Interrelation of Groups of Reservoirs and Channels in the Raja Rata, in 1935 and published in 1937 in the Journal of the Royal Asiatic Society, Ceylon Branch. Among the many members and distinguished visitors present at that meeting of the R.A.S. the only one still with us is His Excellency J.R. Jayewardene.

In 1956 Brohier was President of the Engineering Association of Ceylon in its 50th year, when it became the Institution of Engineers, Ceylon, by Royal Charter. In an article in the Jubilee Souvenir, Brohier presented a theory for the evolution and development of the ancient irrigation systems in four stages. These were:

1. Rain-fed tanks from which water was baled out at leisure.
2. Small village tanks similar to ones still in existence.
3. Large storage reservoirs each of which submerged a number of small village tanks and
4. River diversion works which augmented the large reservoirs by means of diversion channels.

Map

In December 1957 all the large ancient reservoirs were breached by cyclonic rainfall and consequent unprecedented floods, and the beds of all these reservoirs lay revealed shortly after. There was no evidence to confirm the theory that these large reservoirs had submerged small village works built previously, but this significant fact escaped notice at the time, and was not commented on.

The Uda Walawe reservoir was taken up for construction in the sixties after full investigations had been done by foreign consultants. Even while construction work on the dam was going on in 1967, it was pointed out by some engineers that the correct location for a large reservoir in the middle basin of the Walawe ganga should have been a site about 15 miles upstream of the Uda Walawe site. (See figure)

Headworks

These engineers who were working on construction of the Uda Walawe headworks were intrigued by the intricate system of small village tanks, one leading into the next down the tributary streams of the main river, that had been built in ancient times in the Walawe basin. It was difficult to believe that these chains of small tanks represented a stage in the evolution and development of ancient irrigation systems and that therefore they should one day be replaced by one or more large reservoirs like the Uda Walawe reservoir.

However, the remains of an ancient large reservoir in the lowest reaches of the Mawara the main tributary on the left bank of the Walawe was an enigma. The famous British Engineer Parker had thought that this may have been one of the three Seas of Parekrama referred to in the chronicles. Brohier has recorded a tradition that this ancient reservoir had held the waters of a thousand tanks and stated that some 440 small tanks had been found in its catchment area in recent times.

It is easy to see that the ancient Magama
Weva is the prototype on which Brohier constructed his four-stage theory. Unfortunately, it is just one of its type so far discovered, and it is extremely unlikely that there are any others that have escaped discovery at this stage when the country has been extensively surveyed and mapped. The enigma of the chains of small tanks in the tributary streams of the Walawe-ganga may be explained in terms of the soils in the Walawe basin. The poorly drained paddy soils lie in the valley bottoms of the tributary streams, so the system of chains of small tanks were built to make use of these soils for irrigated paddy cultivation. Irrigation water was released from each tank to its fields lying below. Drainage water from each patch of fields replenished the tank lying immediately below. Both surface and sub-surface flow ensured maximum re-use of water for irrigation under this intricate system.

The soils of the valley and slopes are more permeable, not so suitable for irrigated paddy cultivation, and quite unsuitable for a large channel distributary system. Herein lies the key to the many problems faced by settlers under Uda Walawe, described somewhat grandiloquently by local and foreign experts as water management problems. These experts often blame the farmers, implicitly or explicitly for wasting water. In turn, farmers tend to disregard the advice of these experts, confirming Galbraith's shrewd observation that farmers rightly disregard the gratuitous advice of those who do not themselves have to depend on the results of following such advice for their livelihood.

After the Uda Walawe reservoir headworks were constructed in record time in 1968, the downstream development work proceeded very sluggishly in comparison. Today, 20 years later, the original acreage planned for development has not been achieved, but expenditure has been incurred on rehabilitation work instead. The main problem is the aforementioned water management problem.

Meanwhile another great reservoir shown on the 1957 Water-Resources Development map, the Lower Kirindi Oya reservoir or Lunugamvehera weva, was taken up for investigation in the early seventies, and later constructed. An alternative location for a large reservoir, the Huratgama weva site was not investigated. It is quite evident that the only possible justification for the location of the Lunugamvehera weva as shown on the 1957 map, was that it submerged a number of small village tanks and thereby conformed to the 3rd stage in Brohier's 4 stage theory.

**Evolution**

An alternative theory for the evolution and development of irrigation systems was presented at a Seminar on Science and Technology in ancient Sri Lanka, organised by the Sri Lanka Association for the Advancement of Science in 1983. The 7 stages are:

1. Rain-fed agriculture
2. Seasonal or temporary river diversion irrigation.
3. Permanent river diversion irrigation.
4. Development of contour channels equipped with weirs and spillways.
5. Invention of the sorowa (sluice) with its bisokotuwa (access tower).
6. Construction of storage reservoirs equipped with sluices, and
7. Damming a perennial river.

Arising from this 7 stage theory, six different ecosystems have been identified in ancient Sri Lanka, of which five are irrigation ecosystems.

These are:

1. Rain-fed agriculture or han govithana as described by Ray Wijewardena at the recent meeting of the SLAAS.
2. Seasonal or temporary river diversion and flood irrigation on river banks. As a micro ecosystem this is still practised in Sri Lanka, but the best known example of this type is the ancient Nile river irrigation system, on a very large scale.
3. Micro ecosystems dependent on permanent river diversion and development of contour channels and channel systems for irrigation. Many examples of these described as anicut irrigation schemes are available in Sri Lanka.
4. Micro ecosystems based on small village tanks. Some 30,000 of these are said to have existed in ancient times. 20,000 of
them in the ancient Ruhunu Rata, according to the chronicles.

5. Macro ecosystems, each consisting of a large storage reservoir commanding several micro ecosystems in its command area. These could be any of the previous micro ecosystems type. Each micro ecosystem would be strengthened and made more stable by the so-called drought-resisting capability of the large reservoir.

6. A complex of macro ecosystems made up of a number of inter-connected large storage reservoirs and channels. Brohier had mapped these complexes in the ancient Raja Rata, and described them in his historic lecture at the Royal Asiatic Society in 1935. It is significant that such complexes do not seem to have existed in the southern area in ancient times.

As Brohier has documented in his classic study, many colonial administrators including Governors, Government Agents and Engineers, had taken a keen interest in restoring some of these ancient irrigation works on a place-mal basis. It does not seem that any of them had ever really understood the basis on which the ancient irrigation ecosystems had evolved down the ages, despite the considerable efforts many of them had put in to investigate the remains of these systems.

In 1923 heavy rains in the dry zone of the ancient Raja Rata gave rise to floods which triggered off a series of breaches of small village tanks, and finally washed away part of the railway embankment near Medawachchiya with loss of life and much damage to property. Thereafter, the Irrigation Department launched a study of the small village irrigation works, and ten years later, J.S. Kennedy, later to be a famous Director of Irrigation, published a landmark paper in the proceedings of the Engineering Association of Ceylon. This paper titled Evolution of Scientific Development of Village Irrigation Works in Ceylon was republished and used as a Handbook in the Irrigation Department for the next 25 years. Kennedy made a statement in this paper which was to have far-reaching consequences. He said: "The village tanks, like the village cattle, are far too numerous for efficiency".

Evaporation losses from the surface areas of a number of small tanks was greater than the losses from the smaller surface area of a single equivalent large reservoir. Moreover, the area of land submerged by a number of small tanks was greater than the area submerged by a single large tank of equivalent capacity. Thus the small tank is inefficient from the viewpoint of the irrigation engineer who is concerned primarily with hydraulic considerations.

There are other aspects to the small village tank, viewed as the heart of a micro ecosystem, but unfortunately, these other aspects often escape the attention of the hydraulic engineer concerned primarily with the storage and distribution of water. Therefore the conviction grew over the years amongst irrigation engineers, that the small tank was inefficient and had to be replaced some day by larger reservoirs. Brohier placed the seal of his undoubted authority on this view, with the publication of his 4 stage theory in 1956.

It is a sobering thought that had the concepts of ecosystem development been known and understood at that time, Brohier himself may have identified the six types of ecosystems seen in ancient Sri Lanka, and perhaps presented them in the course of his classic lecture at the Royal Asiatic Society in 1935. The restoration and reconstruction of Sri Lanka's ancient hydraulic civilization would undoubtedly have proceeded differently if that had happened. The 1957 map would not have been published, and the two large projects in the south, Uda Walawe and Lunugamvehera would never have been built in their present locations.

After world war II the gigantic Senanayake Samudra was built in the Gal Oya valley. Here the existing 35,000 acre Pattipola area irrigation scheme consisted of a number of micro ecosystems. The new reservoir commanded all these micro ecosystems as well as a large tract of new land that was provided with new irrigation facilities. Some of the water management problems in this scheme, like those in Uda Walawe, may also perhaps be better understood, and resolved, if the new micro ecosystems could be identified.

Reservoir

The new Uda Walawe scheme, supposedly similar to the Gal Oya project - was really not similar at all. The large Uda Walawe reservoir...
submerged a number of abandoned micro ecosystems under its 9000 acre watershed. The root of the so-called water management problems at Uda Walawe lies in the very concept of the project, of a large new reservoir submerging a number of small village works.

If Uda Walawe was a mistake, Lunugamvehera was a blunder of an even higher order of magnitude. Here, a number of existing micro ecosystems were submerged by the new reservoir, without creating an effective new macro ecosystem. The micro ecosystems that were submerged were of all four types described, hen gali'wa, temporary river diversion, permanent river diversion and the small village tank ecosystem. Some of these micro ecosystems were actually functioning, others were abandoned in the jungle. All of them were destroyed with the removal of forest cover in the reservoir bed area, and the impounding of the reservoir.

If the alternative proposal of constructing a medium-scale reservoir at the upper site at Hurathgama, about 15 miles above Lunugamvehera dam-site had been adopted, a beautiful new macro ecosystem would have been created, eventually. The existing micro ecosystems in the command area would have been strengthened and stabilised. Some (not all) of the abandoned micro ecosystems in the jungle in the command area would have been restored, and stable new human settlements created around them. Particularly from the ecological and economic standpoints, this would have been a far superior project to Lunugamvehera. It is very difficult to understand why the alternative site at Hurathgama had not even been subject to a preliminary investigation, whilst the Lunugamvehera project was investigated over a decade or more, in the face of reasoned criticism of that site, and finally, constructed at great cost. The costs of this project will not be limited to the initial costs of construction of Lunugamvehera, and costs for provision of irrigation facilities in the years ahead. The social cost of destruction of ecosystems will have to be studied and evaluated in the years to come.

Conclusion

This analysis of the ancient irrigation systems as giving rise to six different types of ecosystems is a corollary to the 7 stage theory for the evolution and development of irrigation systems. That theory was first presented at an S.L.A.A.S. Seminar on Science and Technology in Ancient Sri Lanka, in 1983. It has since been discussed at meetings of the Institution of Engineers, Sri Lanka, as well as at international conferences both in Sri Lanka and abroad. As a direct result, Professor Joseph Needham, F.R.S., who had republished Broli's 4 stage theory in his monumental classic 'Science and Civilization, in China' has invited the author to undertake research at the Needham Research Institute in Cambridge.

The analysis of the six different ecosystems in ancient Sri Lanka has been set out in a paper submitted to the International Commission for Irrigation and Drainage, for a seminar to be held in 1990. It is considered important to discuss the issues involved in a wider context than in Sri Lanka alone. Meanwhile further study goes on and it is also hoped that this will be published in a new series to be called the History of Engineering in Sri Lanka, by the Institution of Engineers, Sri Lanka.

(Extracted from the Island, January 23, 1989)