The Historic Jaya Ganga — *built by King Dhatusena in the 5th century AD to carry the waters of the Kala Wewa to the ancient city tanks of Anuradhapura, 57 miles away, while feeding a number of village tanks in its course. This channel is also famous for the gentle gradient of 6 ins. per mile for the first 17 miles and an average of 1 ft. per mile throughout its length. Both the Kalawewa and the Jaya Ganga were restored in 1885 — 1888 by the British, but not to their fullest capacities. Now under the Mahaweli Diversion project, the Kala Wewa has been augmented and the Jaya Ganga improved to carry 1000 cusecs of water.*

IRRIGATION AND MULTI-PURPOSE DEVELOPMENT IN SRI LANKA

The history of our country dates back to the 6th century B.C. When the legendary Vijaya landed in Lanka, he is believed to have found an island occupied by certain tribes who had already developed a rudimentary system of irrigation. Tradition has it that Kuveni was spinning cotton on the bund of a small lake which was presumably part of this ancient system.

The development of an ancient civilization which was entirely dependent on an irrigation system that grew in size and complexity through the years is described in our written history. Many examples are available which demonstrate this systematic development of water and land resources throughout the so-called dry zone of our country over very long periods of time. The development of a water supply and irrigation system around the city of Anuradhapura may be taken as an example.

Ancient Irrigation Works

Anuradhapura had been set up as the capital city in the 3rd century B.C. with a comparatively small reservoir, the Basawakulame, built across a minor branch of the Malwatu Oya, supplying the city. (The Basawakulame incidentally is the oldest identified ancient irrigation reservoir in the country today). As the capital city grew, its water supply both for domestic consumption and for irrigation had to be augmented. This was achieved first, by the construction of the Tissa Wewa and the Nuwara Wewa on other small branches of the Malwatu Oya. Thereafter the Nuwara Wewa itself was augmented a few centuries later from the main Malwatu Oya by means of a diversion anicut and inlet channel. Still later the Nachchaduwa reservoir was constructed encompassing the diversion anicut and making use of the same inlet channel to further augment the Nuwara Wewa from this new storage reservoir. (*see front cover*).

This system, complex as it was, had functioned efficiently for about 500 years during which period Anuradhapura flourished as the capital city of the island kingdom. It was only in the 5th century A.D. that further augmentation was achieved no doubt to meet the needs of water supply to a bustling metropolis which has been estimated to have covered an area of forty square miles, the size of Greater London today. This augmentation of the city's water supply was achieved with the construction of twin-reservoirs, the Kalawewa—Balaluwewa across the perennial Kala Oya, (the basin adjacent to the Malwatu Oya), and the construction of a trans-basin diversion canal, the famous Jaya ganga which brought the impounded waters of the Kala Oya into the Malwatu Oya basin via Nachchaduwa and Nuwara Wewa. The Jaya Ganga was 57 miles in length and had an average gradient of only half a foot per mile for the first 17 miles and an average gradient of about one foot per mile throughout its whole length.

Twin Tanks

The construction of the Kalawewa across the perennial Kala Oya had been achieved by means of a simple technique which could be called the twin-reservoir technique.

There is evidence to show that the Balaluwewa had first been constructed on the left bank of the Kala Oya together with the massive stone spillway which serves both reservoirs, and the Kala Oya diverted into this reservoir in the first instance. Thereafter the massive Kala Oya embankment had been constructed on the right bank, and with the breaching of the small dividing bund the two reservoirs were united. Even today, when the water level in the reservoir sinks below a certain elevation, the formation of the two separate reservoirs can be clearly discerned.

The maximum population of the city of Anuradhapura at that time has been estimated at two million people. The domestic requirements of water for such a large population was met by the construction of numerous bathing ponds and separate wells for water for human consumption. This was made possible on account of the increase in the water table in locations close to the irrigation reservoirs and channels. The irrigation system itself at the high point of development and utilisation commanded an extent estimated at 10,000 acres for which the assured supply of irrigation water was available.

The continuous development of irrigation works had taken place in the dry zone from about the 5th century B.C. to about the 12th century A.D. inspite of interruptions on account of internal strife. The island kingdom with its capital at Anuradhapura was broken up into smaller kingdoms on many occasions. The capital itself was moved from Anuradhapura to Polonnaruwa in the 8th century A.D. This led to the development of irrigation works in the Polonnaruwa area and the golden age of Parakrama Bahu the Great (1153-1186 A.D.). This king was responsible for the restoration or construction of no less than 165 diversion dams, 3910 canals, 163 major tanks and 2376 minor tanks, a stupendous achievement by any standard.

The purely technical achievement in the construction of ancient irrigation systems is of the same rank as the construction of the pyramids in ancient Egypt. Thus the ancient irrigation system of Sri Lanka can rightly be described as one of the wonders of the ancient world.

Socio-Economic Aspects

The socio-economic aspect of this achievement of the ancient civilization is equally significant. The ancient irrigation system could not have been developed so systematically in stages, but for the generation of an increasing economic surplus, due to earlier irrigation development, a part of which was available for this development. Another part of this economic surplus had been invested in the construction of religious edifices, some of which are considerable technical achievements in themselves. Notable amongst these are the famous stupa, the Ruvanweliseya in Anuradhapura built by King Dutugemunu in the first century B.C., occupying a symbolic pride of place and the large number of Buddha statues, most of them carved in the living rock constructed by successive kings from the Anuradhapura period right down to the Polonnaruwa period. Of this, mention may be made of the Samadhi Buddha in Anuradhapura, the statue of the Sleeping Buddha in Polonnaruwa, the Awkana Buddha and the giant Situl Pawwa Buddha image. The decline of this so-called hydraulic civilisation after about the 12th and 13th centuries has been attributed to a variety of causes. These include internecine wars which had erupted in almost every reign from earliest times, foreign invasions and natural causes such as the advent of malaria which were aggravated by disruptions caused by war.

Trade and cultural exchanges had taken place between Lanka and various foreign nations including Greece and Rome in the West, and China in the East, in the time of the ancient civilization. The island was also subject to invasion from the neighbouring sub-continent, and in turn, had at times, invaded India Burma and Malaysia. It could therefore be said that Lanka had traded on terms of equality with various foreign powers during this period. In fact, in some instances Lanka was in a superior position in its foreign relations, for example in the 8th century when technologists from our country visited Kashmir in order to assist the King of that country in the construction of a reservoir.

The arrival of European powers starting with the Portuguese in the 15th century resulted in a different relationship between Sri Lanka and various foreign powers. This was the beginning of the colonial era which saw further rapid decline of the ancient irrigation systems. The Portuguese in the 16th and 17th centuries and after them the Dutch in the 17th and 18th centuries occupied the maritime provinces and engaged in trade especially in spices and precious materials. They established forts at strategic points along the coast,. especially on the Western seaboard. The Dutch also developed a system of canals based partly on existing Sri Lankan ones for transport of goods in the Western area. The development of Colombo resulted from the use of Colombo as a trading port by both the Portuguese and the Dutch, and the establishment of the Fort of Colombo as a base to attack the kingdom of Kotte. With the advent of the British in the late 18th century the focus on the Western seaboard was complete. Colombo was henceforth to be the model city of the British possession which covered the whole island with the fall of the Kandyan kingdom in 1815. At this stage, the dry zone had been virtually abandoned and the infrastructure of its ancient civilization swallowed up by the jungle.

The British Period

The British with their wonted enterprise explored the island thoroughly and rediscovered the ancient irrigation works of Lanka. This had long since been reduced to isolated reservoirs, small and large, by far the large majority of them in a state of disrepair, supporting the impoverished population in isolated villages. The remains of the ancient irrigation works excited the interest of individual British colonial administrators throughout the 19th century. This led to the investigation and partial restoration of some of these works, notably the Kala Wewa. Extensive surveys were also undertaken to map out the ancient irrigation systems, and eventually the complete topographical survey of the island was done, this being one of the notable achievements of the British period.

The British developed an extensive plantation economy supported by an useful infrastructure of roads and railways all centered around the plantation areas and leading to the Port of Colombo, which was also rapidly developed. The plantation sector was developed in the wet zone where the traditional village such as it was, began to be neglected. The traditional peasant in the plantation area was not employed in the plantations. Indentured labour was brought in from India to work in the plantation industry. According to the classical colonial pattern, existing feudal laws such as Rajakariya were adapted by the British to extract labour from the already impoverished peasantry for construction and maintenance of the roads and railways, and in due course for the restoration of the ancient irrigation works. Despite this, however, the country was now dependent on imported rice which was paid for with the produce from the plantations.

The Sinhala and Tamil dependent bourgeoisie were afforded the privilege of education in the British tradition and this resulted in the birth of an elite class, some of whom took pride in the ancient heritage of Lanka. The more enlightened colonial administrators were also interested in the achievements of the ancient civilization. Thus by the turn of the century there was sufficient interest in the systematic restoration of the ancient irrigation works to justify the setting up of a new Department of Irrigation in 1900 hived-off from the Public Work's Department. The Irrigation Department had its headquarters in Trincomalee from 1908 to 1931 when it was moved to Colombo. After the Malaria epidemic in the 1930s a new emphasis was placed on the further development of settlements based on the restored ancient irrigation works in the dry zone. The then Minister of Agriculture, Mr. D. S. Senanayake, commissioned the documentation of all the available data on the ancient irrigation works, and this monumental project was undertaken by Mr. R. L. Brohier whose three volumes remain the most comprehensive documentation on the subject today. The ancient major works that were restored were used to resettle new peasants in what were called major colonisation schemes. These included the Minneriya project which was especially famous because the Minneriya reservoir was the only major irrigation reservoir that had not been breached when rediscovered in British times. The Minneriya irrigation sluices had been built by Mahasena in the 3rd century A.D. and were reputed to have functioned continuously from that time. The Minipe anicut across the Mahaweli ganga built by Agga Bodhi I in the 5th century A.D. together with the Minipe irrigation canal, was also restored by the British and a major colonisation scheme was developed around it. During the 2nd World War the restoration of the Parakrama Samudra described as the great King Parakrama's 'Crowning Glory' was undertaken. The closing of the breach in the Topawewa, one of the three reservoirs that made up the Parakrama Samudra, was an epic achievement of the time (See box).

During the 2nd World War our sources of imported rice were cut off after the Japanese occupation of

(Continued on page 8)

RIVER CLOSURE

When a dam is built across a perennial river the last stage of construction is described as the river closure. In the case of a concrete dam the river may be allowed to flow over the incomplete concrete structure if necessary. In the case of an earthen embankment, this is obviously not possible. A temporary river diversion is therefore necessary through a diversion tunnel or sluice as the case may be. Such temporary river diversions are also used in the case of concrete dams. The diversion sluice or tunnel is ultimately closed by means of a steel drop-gate and then sealed up inside with a concrete plug.

At Uda Walawe the original design prepared by the American consultants envisaged a concrete structure across the river section. In the modified proposal taken up for construction, the river section was closed with an earthen embankment. Temporary river diversion was made through a massive river diversion sluice on the left bank of the river. Temporary river diversion was achieved when the river was at a comparatively low level at the beginning of the dry season, on June 11th 1967. Thereafter the river bed section which became exposed was carefully cleaned, and the earth embankment in this section was then commenced. This river closure operation went on till the end of September when the embankment reached a safe level. This part of the work was a race against time because the work in the river section had to be completed before the advent of the rainy season in October. The river closure at Walawe has been rightly described as an epic in engineering construction in Lanka in recent times, for which all credit goes to the workers and engineers of the River Valleys Development Board.

It is not widely known that a similar epic achievement, though on a considerably smaller scale, was the breach closure during the reconstruction of the Parakrama Samudra, back in 1942. The Eramudu Oya had breached the ancient embankment, leaving a considerable gap which had to be filled before the start of the North East Monsoon rains in October 1942. This was especially important because a similar attempt made in 1941 had resulted in a dramatic failure when early rains washed away the earth work in the river section. The engineer in charge of the work, Mr. M. M. Ismail, who was later to become intimately associated with development in the Gal Oya project, had to face a situation which few men would ever like to experience. At the height of construction activity he received an urgent telegram informing him that his eldest son was critically ill in far-away Sammanthurai. Knowing that the critical activity on the river closure could not be allowed to fail a second time and that his immediate presence at the site was essential, he had to make a heart-rending decision. He wired back asking his people to take the child to a good doctor. Shortly afterwards he received another telegram informing him that the child had expired. He wired back asking them to give the dead child a decent burial. The Eramudu Oya gap was duly closed and the vast area of Parakrama Samudra was filled once more after an interval of about 700 years.

THE GAL OYA PROJECT

The New York stock market crash in 1929 was followed by the great world-wide depression of the 1930s which led to the development of Keynesian Economic Theory. This theory had as its key concept the creation of new effective demand by increased development investment in a free-market economy. Two major projects were started by the Federal Government in the USA. In this period under Roosevelt's New Deal, the Tennessee Valley Authority and the Rural Electrification Programme were begun. Both were to be taken up after World War II as models for emulation in developing countries, including Sri Lanka, under the subtle influence of Bretton Woods through the World Bank. The Gal Oya Multi-Purpose Development Project was started in 1947—modelled on the TVA.

This was a considerable departure from previous practice in the development of river basins, where irrigation development had been based in the Dry Zone on the restoration of ancient irrigation systems. These ranged from very small village tanks to large reservoirs like Minneriya, Parakrama Samudra, Kala Wewa and Giant's Tank, together with massive river diversion structures and transbasin diversion canals including Minipe Anicut on the Mahaweli Ganga, Tekkam on the Aruvi Aru or Malwatu Oya, Elahera Headworks and the Angamedilla Anicut both on the Ambanganga, and canals like the Kala Wewa, Yodha Ela, the Minipe canal and Elahera canal. Many ancient irrigation works existed in the Gal Oya area including the massive Digavapi, one of the more famous of the large irrigation reservoirs. The ancient system had been partially restored in the form of the Pattipola Aru Irrigation Scheme which occupied the inland delta of the Gal Oya in the middle basin of the river, as well as other irrigation schemes dependent on restored ancient reservoirs like Thumpankani, Divulana, Chadayantalawa, Illunkuchenai, Nethai, Sagamam and Rufuskulam which were collectively described as Purana lands in the Gal Oya project, to distinguish them from the newly developed lands. The Pattipola Aru Scheme included several reservoirs such as Kondawattawana Kulam and Amparai Kulam and was described as "by far the largest paddy cultivation scheme in the island today, although from an engineering point of view it is the worst". The scheme commanded 33,000 acres but the area under paddy cultivation in 1948 was estimated to be only about 26,000 acres.

These purana lands were expected to benefit from the construction of the Gal Oya reservoir. This was the original conception of the Gal Oya project as credited to Mr. J. S. Kennedy, Director of Irrigation in 1936 who saw "the possibility of constructing a large reservoir, to be held up by a dam at Inginiyagala, primarily, to reduce flood damage in the flood season and shortage of irrigation supply in the other, in the Pattipola Aru Scheme". However the main emphasis was on the provision of irrigation facilities to 120,000 acres of new lands which could be double - cropped in an average year, and protected from all but phenomenal floods. The collection of engineering data for this project was completed by 1947 when a political decision was taken to set up the Gal Oya Multi-Purpose Development Project on the lines of the TVA.

For the purpose of preparing designs, specifications and estimates for the project, this data was made available to "The International Engineering Co. Inc. of Denver Colorado, USA, a subsidiary of the Morrison Knudsen International Co. Inc. who later secured the contract for the construction of the main dam". For the first time in Sri Lanka a major contract was awarded, on a cost plus fixed fee basis, in this case cost plus 11% of the agreed target estimate of dollars 10.5 million to be paid in US dollars. Subsequently, the target estimate was adjusted to approximately $11.6 million and the construction which was estimated to take 52 months was begun in March 1949 and completed in November 1951. The contractor therefore earned a substantial bonus. The original design for the spillway of the Gal Oya reservoir prepared by the US consultants was considerably increased by local technologists who were confident that a much larger design flood had to be provided for. This decision was amply justified when the phenomenal floods in December 1957 and January 1958 hit the valley. It has been said that "the expenses incurred by the taxpayer on this project were already prepaid by the sole activity of this reservoir during the flood". The effect of the reservoir on the Pattipola Aru Scheme and other Purana lands however had not been entirely as intended. Problems of waterlogging have arisen on account of ineffective drainage.

High Technology Dream

The expeditious completion of construction of the Headworks by the American contractor was held as an example to be emulated in the field of construction technology. However, it was not widely appreciated that this contract was executed on a cost plus basis so that the contractor could and did equip himself with all facilities including personal transport (jeeps, and cars) air-conditioned living quarters, a well equipped club house which boasted even a juke box, a refrigerated supply van which was reputed to have run virtually continuously between Colombo and Gal Oya bringing consumption goods like beer, during the course of the contract, and so on. Nevertheless, the image of US high technology was firmly implanted in the minds of our people at this time, so that high officials, consciously or sub-consciously thought in terms of the Gal Oya Headworks construction when dreaming of future projects.

The high technology approach to development demonstrated in the construction of the Headworks was imitated in the subsequent activity for provision of irrigation facilities. Between 1949/50 and 1965/66 the following items of expenditure were incurred which were manifestly excessive.

	Rs. m.
Roads and bridges ...	23.87
Office and other buildings, residential quarters ...	40.10
Motor vehicles	12.46
	76.43

These expenditures have to be compared with the total cost of the main dam equal to Rs. 40 million and the total cost of the irrigation system equal to approximately Rs. 75 million. In addition a total of over Rs. 52 million had been spent over the years on purchase of heavy machinery. Inappropriate technology was introduced in the process. For example jungle clearing was done using heavy anchor chains dragged by teams of powerful bull-dozers assisted by tree-dozers, an impressive spectacle no doubt, but extremely costly to the tax-payer: it cost the Director of Land Development "an average of no more than Rs. 200/- to clear and stump an acre of land" by labour-intensive methods in 1958, when "a private company secured a contract to clear and prepare 5,000 acres for the Board by mechanical methods for just over Rs. 2,000 per acre". Similarly, other advanced equipment was imported which were found to be superfluous. These included, the well-known Barber Greene plant for road paving and the Combine Harvester manufactured by the International Tractor Company.

Such imitative techniques used at Gal Oya were directly inspired by TVA and other developed world institutions. The use of these techniques amounted to a rejection of other techniques already available in the field of irrigation development in our country. Further, an unhealthy emphasis was given to the purely construction activities in Gal Oya on account of the splendour of the technological hardware used in the process, with an attendant reduction in emphasis on the most important aspect of the project namely, the human settlement. In fact, there were other examples of the imitative development technique which ended up as expensive failures. They include, "the Gal Oya Valley Food Production Company, which proved uneconomic (particularly, in its use of combine harvesters) and was abandoned after the 1957/59 floods".

The Gal Oya Development Board was created by the Gal Oya Development Board Act No. 51 of 1949 enacted on 24th November 1949, and commenced to function on 15th December 1949. Its operation was financed from a fund to which annual contributions were made by Government, in addition to revenues raised by the Board under the powers vested in it. On 31st March 1950, the Area of Authority of the Board was defined. This Area was divided into Developed and Undeveloped Areas, and the function of the Board was the multipurpose development of these arears.

The principal objective of the Gal Oya Development Board was "the establishment within its Area of Authority of the maximum number of families of Ceylon citizens that the area can carry at a reasonable standard of good and comfortable living conditions". In order to achieve this objective, "the Board was expected to provide irrigation facilities to individual allotments according to "the principle of peasant colonisation ....whilst at the same time encouraging the growth of collective agricultural and industrial undertakings among such peasant colonists". To achieve this the Board was empowered "to organize a system of planned cultivation of the most suitable crops arranging for such rotation as is deemed agriculturally necessary or advisable and for the profitable marketing of the produce". There was also provision for the supply of electric power.

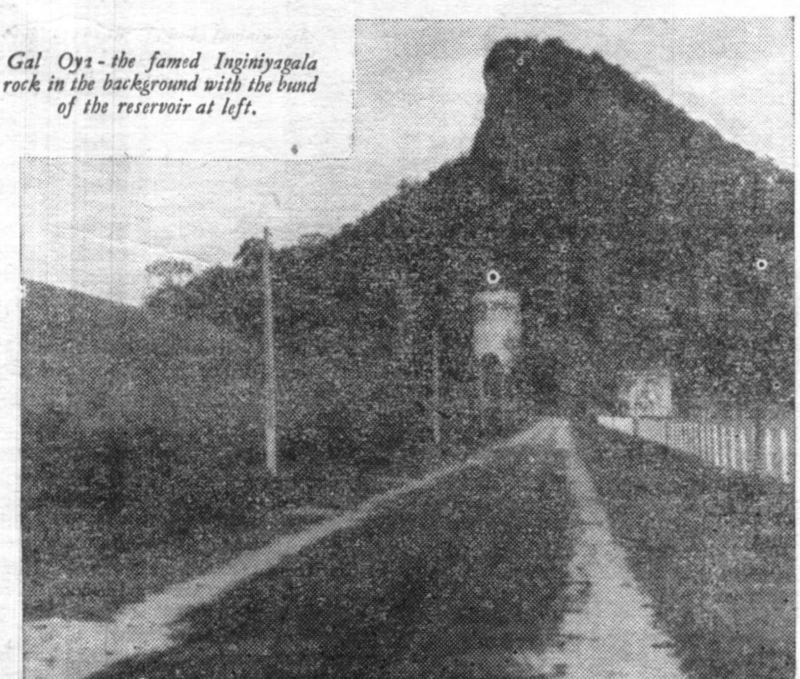
The first colonists "were settled in 1950/51 and consisted of 296 families displaced from villages taken up for development or from villages due to disappear beneath the waters of Senanayake Samudra". In the course of the next 15 years about 12,000 families in all were settled in new village units. The original allotments to each colonist family was 4 acres of irrigated paddy land and 3 acres of highland. This was reduced to 3 acres of paddy land and 2 acres of highland in 1953, and still later to 2 acres of paddy land and 1 acre of highland. The size of allotments in village expansion schemes for peasants from thickly populated localities within the Board's Area of Authority as well a some neighbouring villages in the Batticaloa district varied between 1 acre and about 3 acres.

The possibility of growing and processing sugar cane in the Gal Oya Valley had been suggested in the very early days of the project. In due course an extensive sugar project was launched in 1960 with full-scale planting, and commissioning of a sugar factory. Two years later a distillery was commissioned which used molasses produced by the sugar factory. The distillery produces rectified spirits which are the basis of Brandy, Rum and other products. The sugar complex has been described as "the most ruinous component of the entire Gal Oya Project". It is again evident here that an attempt had been made to imitate development in other parts of the world without reference to differing socio-economic conditions prevailing in this country. It has been pointed out that whereas in the existing (colonial) plantation industry the largest estate was about 4,000 acres in extent, an attempt had been made to set up a sugar cane estate 10,000 acres in extent under an autonomous authority. When this attempt was found to be a failure, outside expertise was sought in 1966 from the Parsons Corporation of Los Angeles, USA.

Apart from irrigated agriculture for paddy and sugar cane, other development activities were undertaken at Gal Oya. These included generation of hydro power for which an installed capacity of 10 m.w. was provided, and various industrial establishments which were meant to provide supporting services. These included a brick and tile factory, a woodworking complex including a saw mill and a carpentry workshop, a base workshop for repair and maintenance of mechanical plant and equipment, which also included a tyre retreading plant, and a large rice mill. The rice mill was located at Chavalakadai at the Southern end of the Batticaloa lagoon with the expectation that water transport would be used to move the milled rice to the railway at Batticaloa. A number of private rice mills were also established.

The creation of the Gal Oya Development Board was thus a new departure in administration in the country. The Gal Oya Development Board was wound-up when the Act which created it was superseded by the River Valleys Development Board Act of August 26th, 1965. All personnel, plant, equipment etc. of the Gal Oya Development Board were absorbed by the newly created River Valleys Development Board, but an Area of Authority of the new Board was never defined.

The failure of the Gal Oya Development Board to achieve its objectives was brought out by an evaluation committee appointed by the Minister of Land, Irrigation and Power, Mr. C. P. de Silva in November 1966, in order to "ascertain the economic and social returns of investments made, and provide guidance for future development projects of a similar kind".



Gal Oya - the famed Inginiyagala rock in the background with the bund of the reservoir at left.

Negative Returns

The evaluation committee discovered that the entire investment for development of undeveloped land yielded a negative return; specifically the development of new irrigated paddy lands, irrigated sugar cane, the industrial establishments including the rice mill, the woodworkng project, the brick and tile factory, the base workshop and the sugar cane factory were run at a loss and could not be made to yield a profit. Only the investment in providing improved irrigation facilities to existing Purana lands yielded a profit, which was estimated as a rate of return greater than 10%. This was due to the absence of expenditure on:—

(a) Infrastructure facilities such as roads, bridges and community centres.

(b) Administrative overheads of the development authority including residential quarters for officers.

It is thus seen that the Gal Oya project which was set up in the hope that a new approach to land development and settlement was being discovered and which therefore rudely abandoned earlier techniques, has in fact turned out to be a failure. To put this tragic misadventure into its proper perspective, it is necessary to appreciate the fundamental error in this approach to development which is of an imitative nature. What was successful in the Tennessee Valley Authority in the United States of America during Roosevelt's New Deal could not be transplanted in a newly independent colony which already had its own hoary traditions of irrigated agriculture in the traditional sector.

All quotations from: *Report of the Gal Oya Project Evaluation Committee, January* 1970, *Govt. Press.*

Burma and this resulted in a further impetus to achieve self-sufficiency in food. Emergency measures taken at this stage included a vigorous drive for the cultivation of a variety of so-called subsidiary food crops including non-irrigated grain crops like maize, and many varieties of yams. In this endeavour attention was paid to traditional sources of food which had long sustained the traditional sector, but had not been popular in the new urban sectors like Colombo, and in the plantation sector which had been made accustomed to imported commodities.

The Post-War Period

Immediately after the War, in the mid 1940s, the Irrigation Department was faced with a shortage of personnel, many of the British engineers being no longer available. Moreover with the achievement of political inde-

WALAWE BASIN DEVELOPMENT

The main stem of the Walawe Ganga rises in the Adams Peak range whilst other major tributaries, the Belihul Oya and the Weli Oya spring from the Horton Plains at elevations greater than 7,000 m.s.l. These branches fall rapidly over the southern escarpment to an upland platform between 1,500 and 2,000 m.s.l. where the site of the proposed Samanala Wewa project near Balangoda is located. The upland platform gives way to the lowland plain at the Kaltota scarp with a sharp drop of over 500 ft. which will be used for power development under Samanala Wewa. The famous Ukgal Kaltota anicut built by King Gajabahu at the foot of this scarp and restored in the late 19th century is about 500 feet above sea level. Below this anicut the Walawe Ganga traverses the lowland plain which covers about 500 sq. miles out of a total 954 sq. miles of this basin. The plain is bounded on the west by the Bulutota massif from which spring two tributaries, the Rakwana Ganga (known as the Timbulketiya Ganga in its lower reaches) and the Hulanda Oya. In the lower plain, the course of the Walawe Ganga approximates to the boundary between the Wet Zone to the West and the Dry Zone to the East.

Ancient Development

The one mile to 1 inch topographical survey reveals a dramatic picture of the remains of the ancient irrigation works in the southern area dry zone. In the Walawe basin the ancient storage system had consisted of a number of chains of small (village type) tanks, one feeding into the other along the tributaries of the river. It is conceivable that these tanks had been constructed over many years starting with the uppermost, the detention of the upper tanks already constructed being used to control the river during construction of the next lower tank. The concentration of small tanks in this area is the highest for any part of Sri Lanka, being about 1.4 tanks per sq. mile.

Apart from these small village tanks, a large reservoir had been built across a major tributary now called the Mau-ara which joins the main Walawe Ganga from the eastern bank about 25 miles from the sea. This is the famous Mahagama tank which had so impressed the engineer-historian Henry Parker at the end of the last century that he thought it may have been the original Parakrama Samudra of King Parakrama Bahu the Great. R. L. Brohier quotes a local tradition that this reservoir held the waters of a thousand tanks and mentions that in fact 440 small tanks were found in the 142 sq. miles catchment area of this reservoir, which works out to 3 tanks per square mile!

Another large storage reservoir across a perennial tributary had existed on the western bank of the Walawe Ganga.

Modern Development

Apart from storage tanks many river diversion structures and systems of channels had been built in the Walawe basin in ancient times of which the Ukgal Kaltota system commanding 2,000 acres has now been restored. A new structure called the Liyangastota anicut has also been built across the main river about 15 miles from the sea in modern times to divert the water along a 5-mile long channel to a new reservoir called the Ridyagama tank, commanding some 2,500 acres.

The International Engineering Co. of USA, which also designed the Galoya headworks, had prepared detailed plans and specifications for the construction of the Walawe dam and power plant located at Embilipitiya about 30 miles from the sea, but these proposals were not implemented. In 1954, an aerial survey of the land and water resources of the island were authorised as an aid project from Canada. Consequent to this survey, a "Report on a Reconnaissance Survey of the Resources of the Walawe Ganga basin, Ceylon" was published in July 1960. These investigations led to a master plan for the development of the basin which proposed the present Uda Walawe Reservoir located about 7 miles above the Embilipitiya site, and the Samanala Wewa about 5 miles above Ukgal Kaltota on the main river. There were also to be several small reservoirs on tributaries, namely the Katupath Oya (fore-bay reservoir for the Samanala Wewa Power Project), the Mau-ara, the Weli Oya and the Hulanda Oya. Of these only the Chandrika Wewa across the Hulanda Oya was built (by the Irrigation Department in 1964) to command 5,000 acres of new land.

Feasibility studies for Uda Walawe and Samanala Wewa were undertaken by Engineering Consultants Inc. of Denver, Colorado in 1963. Although they showed that the best benefits could be obtained by constructing both headworks simultaneously or in quick succession, and the next best benefits were to be had by first building Samanala Wewa and then following up with the Uda Walawe project, the Uda Walawe was built first. The ECI proposal for Uda Walawe was also considerably modified in the process. The new Uda Walawe headworks cost about Rs. 60 million compared to an estimated Rs. 80 million for the ECI proposal. The ECI preliminary estimate for Samanala Wewa was Rs. 120 million. Today's cost for a new proposal now being prepared jointly by the Central Engineering Consultancy Bureau with Soviet assistance is estimated to be about Rs. 250 million, excluding cost of plant.

The Walawe Project

The Walawe Project under the Uda Walawe reservoir was originally envisaged to benefit 60,000 acres of new land on both banks of the river. Initially, a-5 acre unit consisting of 2½ acres of irrigated land, 2 acres of highland and 1/2 an acre for a homestead was given to each settler. This was subsequently reduced to a total of 2½ acres per family, from which a net annual income of about Rs. 5,000 is said to be possible from two seasons cultivation.

Under the first phase of development 8,000 colonists have been settled and a total of 27,500 acres of new land brought under irrigated cultivation of paddy, cotton and subsidiary food crops, in the right bank area. A Youth Settlement Scheme has also been established where 2,000 acres have been earmarked for subsidiary food crops.

The 2nd phase of the project envisages development during 1977-81 of 15,000 acres under sugar cane, 15,000 acres under cotton and 3,000 acres under paddy, all in the left bank area. It is proposed to settle 6,000 farmer families during the 5-year period. The total estimated cost of the programme will be about Rs. 120 million. The first phase of the project already completed has cost nearly Rs. 600 million including the costs of headworks and both left bank and right bank main channels, and the whole right bank system.

The Walawe Project has already run into considerable difficulties. After the epic achievement of river closure virtually one year ahead of schedule in 1967 during construction of headworks, the rest of the development programme has moved comparatively slowly. The 27,500 acres developed in the right bank area as well as the 5,000 odd acres under Chandrika Wewa are yet faced with some irrigation difficulties which have to be solved. Extensive areas of the left bank with a large untapped potential has already been brazenly occupied by squatters. This includes land within the irrigable command of the left bank main channel that has already been constructed, as well as highland. Some land in the pendence in 1948, the drive for self-sufficiency in food was accelerated, and the Irrigation Department was accordingly earmarked for expansion. With a favourable external resources account, it was possible to think big, and the Irrigation Department was able to advertise abroad for specialised and technical personnel. A new Designs and Research Branch was set up in the Department under a Senior Designs and Research Engineer of the rank of Deputy Director. This branch was imaginatively conceived to undertake investigation and prepare implementation studies for the restoration of the ancient irrigation systems.

Meanwhile the influence of Anglo-American thinking in the immediate post-war era led to the launching of the Gal Oya Multipurpose Development Project. The origins of this project

upper catchment area which has been declared a Strict Natural Reserve has also been occupied, the attraction in this case, apart from rain-fed agriculture, being illicit gemming. The normal administrative processes have so far failed to contain these activities. On the other hand previous experience in the old colonization schemes suggests that squatters would ultimately be legally recognized by the authorities. An area where this view has encouraged much pioneering is the upper left bank of the Weli Oya where restoration of some ancient village tanks has been undertaken with much enthusiasm by 2nd and 3rd generation settlers spilling over from the Ukgal Kaltota Colonization Scheme.

Water Management Problems

Another aspect of the failure of Walawe is the shortage of water for cultivation in the right bank area, allegedly due to over-consumption caused by negligence and bad soil characteristics in some areas. The latter is said to be aggravated by tractor ploughing, as opposed to buffalo ploughing; this causes a hard pan to form which increases retentivity of water in the soils over the years. Given a particular pattern of soils, the overuse of water should be investigated through the water storage and distribution system in all its aspects. At Walawe as in all other major projects, the system consists of a large storage reservoir owned and maintained by the state through a bureaucratic infrastructure, together with a system of main and distributary channels for the control and distribution of this water for irrigation. The water is issued to each individually owned paddy lot through an individual pipe outlet. Water is issued in rotation to each paddy lot according to a distribution scheme decided upon by a group representing the cultivators and the bureaucracy, during each cultivation season. In practice, such a Water Management Programme for any given area has to be adjusted and modified to some extent, from time to time (to match the weather for example). A constant interaction between the peasant cultivators and the officials is necessary to achieve this, and success is never certain even when the physical features of the project are in perfect working order. Any physical shortcomings in the system naturally aggravate the problems.

At Walawe, the water management problem has assumed such enormous proportions that it is necessary to re-examine even the fundamental layout of the scheme. The project is based on a large storage reservoir together with two large main channels carrying this water on either bank of the river, distances of about 25 miles. This concept is in sharp contrast to the system that had existed in this area as evident in the remains of the ancient irrigation system, which had consisted of a large number of small storage tanks, a very few large reservoirs, and a few large diversion systems. Modern thinking suggests that the ancient system was wasteful of resources because these small tanks were comparatively shallow, so that the proportion of land submerged by the small tanks compared to the area of land cultivated was large in comparison with the corresponding ratio for the area submerged under the Walawe reservoir and the land benefitted by it. Furthermore, the loss of water through evaporation from the larger aggregate surface of the small tanks would have been greater than from the surface of the Uda Walawe reservoir.

The main channels have also been designed following the logic of the large-scale storage and distribution system. Each main channel intersects a number of natural streams or oyas which themselves carry much water during the rainy season and sometimes run dry during the rest of the year. If a small tank is constructed at each of these intersections some water may be diverted into the main channel during the wet season. Spillways are necessary to get rid of excess water. When the intersection is with a perennial river like the Timbulketiya Ganga, a comparatively large storage reservoir is necessary if proper use is to be made of the water in the tributary. In the case of the Hulanda oya, the Chandrika Wewa had already been constructed before the Walawe right bank channel was designed, and the intersection of this channel with the Hulanda Oya became a problem. If the Chandrika Wewa had not already been constructed it would have been located at or above the point of intersection. Such a possibility still exists for construction of a reservoir on the Timbulketiya Ganga which could provide supplementary water to the right bank main channel. If the right bank main channel had originally been designed on the basis that it would pick up water from the Timbulketiya Ganga and the Hulanda Oya, storage reservoirs would have been constructed in this fashion on these tributaries.

Another aspect of the water management problem that merits attention is the question of the individual pipe outlets to each colonist's allotment. This design attempts to make each peasant cultivator independent of all the others and dependent only on the system as a whole. However, in the traditional irrigation systems in all parts of the country, another method is widely practised. In this method water is allowed to flow from one individually owned allotment to another, so that an interdependence arises amongst the peasant cultivators. That no attempt has ever been made to incorporate this system in the design of the modern irrigation schemes shows that traditional peasant cultivators are not consulted when such schemes are set up.

All these are aspects of a concept which may be described as a centralised large-scale multipurpose project, of a type which began at Gal Oya. The technological roots of the failure of the Gal Oya project have been unearthed. A similar enquiry into the Walawe project is imminent.

Reservoir Location

Another feature of the Walawe Project that may give rise to serious problems in the future is the very location of the massive Uda Walawe reservoir covering 10,000 acres at highest water level. The rationale behind the location of this reservoir, is the old concept of a balance between the water available from the drainage area above the reservoir and the area of irrigable land lying below it. This concept had been used in the Irrigation Department in the 1950s to locate reservoirs in many of the 103 river basins in the country. These are shown on a map of the hydrological resources of the island published by the Irrigation Department in 1959.

The use of this concept to locate the Uda Walawe reservoir needs now to be critically examined. To the West of the Walawe Ganga lies the wet zone where virtually all the rivers are perennial (as seen in the use of the word Ganga). To the East lies the dry zone where the non-perennial rivers are given the name Oya or Ara (with the single exception of the Menik Ganga) all the way to the eastern seaboard and northwards to the Mahaweli Ganga itself.

There seems to be no question that in the future, population pressure in the densely populated south-western sector of the wet zone will have to be relieved by developing the now sparsely populated lands in the south-eastern area, as envisaged in the Southern Area Development Plan. (See Box on page 12). At this stage (which is already almost upon us) the Walawe reservoir will stand out as a serious obstruction to this proposal for a rational development of the southern area of the country. However, it is better to face this as an objective reality and to learn the necessary lessons from it than to avoid facing the issue and inadvertently repeat the same mistake in the future.

could be traced to the mid 30s when the-then Director of Irrigation, Kennedy, had identified a suitable site for a large reservoir on the Galoya river at Inginiyagala in the Eastern province. Kennedy had also identified another suitable site for a large reservoir on the Amban Ganga, the main branch of the Mahaweli in its lower reaches, by the construction of a dam across a large gap in the Sudu Kande range, known as the Sudu Kande Gap. This project had been pigeon-holed at that time because it would have made the Parakrama Samudra superfluous, since its bed fell within the area of command of the proposed Sudukande reservoir.

Inspite of setting up of the Designs and Research branch in the Irrigation Department and the recruitment of a number of foreign engineers at this time, the Gal Oya project was undertaken with American assistance because the decision-makers at this time were influenced by the Tennessee Valley Authority project in the U.S.A. The Gal Oya Project therefore was launched in the image of the TVA project(see pg.6,7). Meanwhile expatriate engineers in the Irrigation Department were in charge of restoration works on many of the large ancient Irrigation projects, notably Kantalai Augmentation Scheme, Allai Extension Scheme, Mioya Scheme and the Elahera Diversion Project.

Some of the expatriate engineers, particularly the Indians, used labour-intensive techniques in their work. This was not an altogether unmixed blessing because there was more than an occasional whisper of abuses and misappropriations, for which expatriate and local counterparts were equally responsible when huge amounts of money were paid out on checkroll.

The grandiose approach to development demonstrated at Galoya inevitably caught the imagination of our people, no doubt as intended by far-seeing promoters in other parts of the world. European manufacturing organisations that were desperately trying to re-establish themselves in world markets after the War, were able to negotiate new deals for supply of plant and equipment for our development projects. In one instance, light tanks manufactured by a British firm during World War II, were converted into tractors which were sold to us. Some of these deals were propped up, with such inducements as the training of our technical personnel for short periods in manufacturing establishments abroad. In due course our people were able to direct their natural mechanical bent to the operation of capital-intensive technological hardware and prove that "our operators and mechanics were equal to the best in the world". (A fact more apparent today, being proved by the massive exodus of these personnel to the Arab world.)

This emphasis on technological hardware for construction resulted in a subtle change of emphasis in our major irrigation projects from the most vital aspect: namely, the human settlement and the development of the living community (which was the emphasis in the pioneer days of Senanayake), to the more glamorous aspect of heavy construction. Subsequent research and investigation into the Gal Oya project have revealed the extent to which this disproportion had occurred in the implementation of that project. This problem is still very much with us, and the inquiry itself is still not complete, but it seems likely that these mistakes will not be repeated in the Mahaweli Development Project, at least on the same scale. After the construction of the GalOya headworks and main canals, there had been some discussions about the prospect of using the same technology for construction of a similar large project in the Walawe basin for which the designs had been prepared by the same foreign consultants who had designed the Gal Oya headworks. However, although a surplus of heavy construction equipment was demonstrably available and manifestly evident in the Gal Oya valley, no attempt was made to use this plant and equipment in the Walawe in the mid 50s. Perhaps the image of the Gal Oya magic still haunted the imagination of decision-making politicians and bureaucrats who were consciously or unconsciously expecting the new project to be launched with new equipment! Whatever the reason, the Walawe project was postponed and actually launched only 10 years later, in the mid 60s when, ironically enough some of the old Gal Oya equipment was used again after reconditioning.

After 1956

The significant political changes in the mid 50s resulted in new attitudes to development. New construction agencies from East European countries were soon seen vying with their West European and American rivals to break into new markets in our country. Thus in the late 50s and early 60s there was an influx of technologies from some of the East European countries. Nationalisation of the oil industry in the early 60s resulted in the withdrawal of the U.S. Agency for International Development from our country on account of the infamous Hickenlooper amendment.

This further encouraged the "transfer of technology" to the socialist countries. Thus the stage was set for the start of the Walawe project for irrigation, power and flood control, and the Maskeliya Reservoir project for power and flood control by East European agencies.

The catastrophic floods of December 1975 were also of great significance during this period, when a number of major ancient reservoirs were breached. A large amount of resources had to be diverted in succeeding years for so-called flood damage repairs. An interesting aspect of this work was the construction of a large number of circuit bungalows in many major projects at this time.

The Designs and Research branch in the Irrigation Department did very useful work throughout the 50s, but for various reasons it was not entrusted with the responsibility for continuing development. Largely responsible was the influx of foreign technical assistance for river basin development. This technical assistance was often so packaged that the counterpart function assigned to local experts was of a secondary nature. In any case the very concept of development of separate river basins enforced an unnecessary spatial restriction which the original Designs and Research branch of the Irrigation Department was not faced with, since they could think in terms of the whole island's resources of land and water. No doubt inspired by the restricted basinwise approach, the Irrigation Department put out a map in 1959 illustrating the possibility of the construction of a large number of reservoirs in many of the 103 separate river basins in the island. Each one of these proposals illustrates the principle of a land—water balance in the given river basin combined with the existing topography, as given in the one inch to one mile topographical survey of the island. The admitted approximation of such proposals based on contours 100 feet apart is not the point at issue, but rather the unnecessary restriction to a single basin in such resource planning.

Technical assistance from U.S.S.R. was available for the investigation of the water and land resources of the Malwatu Oya or Aruvi Aru basin, and the Kelani river basin, in the late 50s and early 60s. At about the same time technical assistance from U.S.A. was used to study the Mahaweli Ganga basin and the Walawe Ganga basin. Another U.S. study was done on the three river basins of the South Western wet zone, namely the Kalu, Gin and Nilwala gangas.

The Mahaweli basin investigations were undertaken by the United States Operations Mission (USOM) in 1958, and a report submitted in 1961. Shortly afterwards the United States Aid Mission was pulled out following nationalisation of United States' oil companies, and no further action seems to have been taken on the USOM report. However, in 1964 a new agreement was entered into by Government with the United Nations Development Programme for a comprehensive study of the Mahaweli Ganga basin and the adjacent river basins. This project was to be called the UNDP/FAO Study. The UNDP/FAO team in collaboration with Sri Lanka specialists prepared a Master Plan for development of water and land resources in the Mahaweli and adjacent river basins in the North-eastern and North-western parts of the island. The Mahaweli Development Plan is now under implementation in stages. None of the other investigations mentioned above have yet been taken up for implementation.

The U.S. study of the Kaluganga, Ginganga and Nilwalaganga basins was undertaken by Engineering Consultants Inc. (ECI) of Denver Colorado. Their proposals envisaged the construction of several large reservoirs in the upper reaches of these rivers. One of these proposed reservoirs called the Jasmine Complex would impound the waters of major tributaries of all three rivers in a single large reservoir. The terms of reference of this investigation precluded further inquiries into the prospect of diverting the impounded waters outside the three basins to the extensive arid lands in the South-eastern part of the country. The scale of these proposals was such that massive investments were necessary for construction of headworks for these projects, and the benefits that would ensue in terms of flood control and controlled issue of water for irrigation in the three basins alone could not justify the proposals. Further benefits could be achieved from development of hydro-power with further marginal investments, but even this could not justify the colossal scale of these proposals.

Colorado's ECI was also commissioned in 1964 to prepare feasibility studies for the Walawe basin, for the construction of two large reservoirs, the Samanala Wewa in the uppermost region, primarily for development of hydro-power, and the Uda Walawe reservoir in the middle basin, primarily for irrigation. The ECI study pointed out that the construction of both the reservoirs undertaken simultaneously or in quick succession would give the best returns on the investments. In the alternative the Samanala Wewa reservoir in the uppermost reaches should be constructed first, since the benefits from hydro-power generation would be available early to justify these investments and generate a surplus which could be used for the subsequent construction of the Uda Walawe reservoir lower down.

However, the Uda Walawe reservoir was constructed first, river closure being achieved in late 1967 and the reservoir filling completely by the end of 1968. The construction of the Samanala Wewa project which in 1964 was estimated to cost less than Rs. 200 million by ECI is now about to be undertaken at a cost of approximately Rs. 500 million, with technical assistance from the U.S.S.R.

The Uda Walawe headworks were constructed according to designs prepared jointly by the Irrigation Department and Techno Export, Czechoslovakia. Local expertise was used to a considerable extent, sub-contracts for construction being executed by Ceylon Development Engineering Company Ltd., and the River Valleys Development Board. The RVDB used some of the equipment inherited from the construction of Gal Oya, after major overhauling. These included heavy earth-moving equipment and the giant stone-crusher reputed to be the largest in South-East Asia. Construction of headworks was completed by the end of 1968.

At this stage it was expected that the provision of irrigation facilities to 60,000 acres of new lands would be completed in about five years. However, nine years after, only the right bank area amounting to 27,500 acres has been developed (See Box). A major problem at Walawe seems to be overconsumption of irrigation water in the area already developed. As a result some doubts have arisen about the availability of water for development of the full potential in the left bank area.

Better utilisation of irrigation water must always be a major objective of everybody involved in the project including farmers, officials and agricultural research workers. Farmers and officials must work out and implement realistic water management programmes, whilst agricultural research workers must continuously try to develop new varieties of grain with greater drought resistance needing less irrigation water. Nevertheless further development in this area must be tied up with the development of the entire Southern area of the island.

All-Island Development

Brohier has divided the whole island into three broad regions for his study of the ancient irrigation works of Sri Lanka. These are the North-eastern region, the North-western region, and the Southern region. Whilst broadly following this division, it is useful to add the Northern region including the Jaffna Peninsula, as a fourth region, in considering the irrigation and multipurpose development in Sri Lanka.

A proposal for long-term development in the Southern region called the Southern Area Development Plan has already been outlined (See Box). It has been emphasised that any new project in this area should fit into the framework of this larger proposal. In this context it is significant that steps are now being taken to construct a reservoir across the lower Kirindi Oya called the Lunuganvehera Wewa. The embankment for this reservoir is located about 10 miles from the sea, on the basis of a single basin balance of water and land resources according to the method used in the Irrigation Department in the late 50s, as described above. This proposal does not fit into the proposed Southern Area Development Plan and could therefore turn out to be a misuse of resources which may be better utilised. For example, a suitable reservoir could be constructed in the upper Kirindi Oya basin at the intersection of the proposed upper trans-basin diversion canal with the Kirindi Oya. This reservoir could provide storage water for the very lands proposed to be benefitted by the Lunuganvehera Wewa.

The Mahaweli Development project has been planned on a long-term basis with multipurpose objectives. The primary objective is the assurance of irrigation water for 650,000 acres of new land (only some of which are rain-fed) as well as 250,000 acres of existing irrigated lands. The project has not been confined to a single river basin. Diversion of water from one basin to another by means of tunnels, as well as open canals is a significant part of the project. The other basins that will ultimately benefit from this project are, Maduru Oya, Kantalai, Pankulam Ara, Yan Oya, Ma Oya, Per Aru, Kanakarayan Aru, Pali Aru, Parangi Aru, Malwatu Oya and Kala Oya. Such trans-basin diversion is also being done from one branch to another within the Mahaweli river basin itself. Wherever possible hydro-power is generated in the process of such diversion. Thus a comprehensive development plan for the North Eastern and part of the North Western regions has been drawn up and is being implemented in stages (See Box).

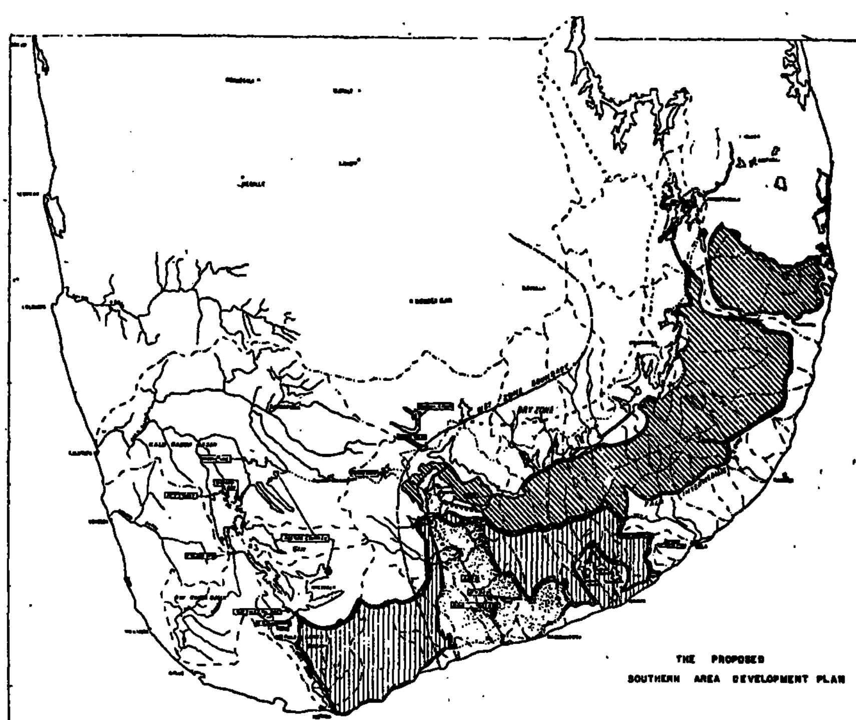
SOUTHERN AREA PLAN

With the implementation of Stage I of the Mahaweli Diversion Project, it has been announced that the diversion of the Kelani Ganga to the thirsting lands of the North-Western region would be undertaken next. This leaves the Southern area of Sri Lanka as the third large region for multipurpose development planning. It is not widely known that an outline of a Multipurpose Development Project for the Southern area has already been prepared by a few national technologists. The proposed development plan for the southern area of Sri Lanka incorporates the feasibility studies carried out by ECI for the three basins of the South West Wet Zone, the Kalu, Gin and Nilwala basins.

This proposal envisages the diversion of excess water from the South West wet zone to the extensive lands in the South Eastern dry zone, which area does not have sufficient rainfall for irrigated agriculture for two seasons of the year. The complete project will depend on construction of large storage reservoirs in the "three basins" as proposed by ECI together with an upper and lower diversion canal flowing from west to east, and crossing a number of river basins in the process. At each crossing a new reservoir will be located which will impound the flow in that river together with the extra flow from the trans-basin diversion from the wet zone. The upper trans-basin diversion canal will traverse successively the basins of the Walawe Ganga, Malala Oya, Kirindi Oya, Menik Ganga, Kumbukkan Oya, Heda Oya and Wila Oya, and will ultimately fall into the Gal Oya itself, above the existing Gal Oya reservoir at Inginiyagala. The lower trans-basin diversion canal will end up in the Kumbukkan Oya basin. According to this proposal it will be necessary to conserve the upper catchment areas of all the above river basins and for this purpose it is proposed to have a broad forest reserve located immediately above the upper trans-basin diversion canal. A corridor forest reserve will connect this proposed reserve with the existing national park and sanctuary in Yala, so that the fauna in this area may ultimately be made to move to the new reservations. This will become necessary in the distant future when the lower basins of the Menik ganga, the Kumbukkan Oya and the Wila Oya are taken up for development.

The implementation of this proposal will necessarily be in stages. At each stage it will be necessary to go through the usual steps including detailed investigation, feasibility studies and implementation programmes. However, it will be possible and in fact desirable to take up the construction of the smaller reservoirs along the upper diversion canal at the first stage. Each of these reservoirs will store water barely sufficient for irrigation for one season for all the land lying below it in its own basin. Subsequent construction of the large reservoirs of the wet zone "three basins" will provide the additional water which can then be transferred to these existing reservoirs by constructing the trans-basin diversion canals in stages. This development proposal will necessarily span a large period of time perhaps running into centuries. There is no need to be discouraged by this; in fact it should be a source of encouragement to have such a long-term plan available even in outline for the future. We have only to look back on the development of the ancient irrigation system over several centuries as illustrated by the story of the water supply to Anuradhapura from the 5th century B.C. to the 8th century A.D. for further assurance and inspiration.

Officials from the Asian Development Bank evinced interest in the proposal, but was ultimately brought to the attention of Chinese experts in 1972. Subsequently the Chinese government agreed to provide technical assistance for a limited project in the Gin Ganga basin which would provide flood control benefits to existing lands in the lower reaches of that basin. This project is now under implementation. It may be considered as a step in the total development plan for the Southern region, outlined above.



In the North Western area a possibility for diverting excess water from the Kelani Ganga has been mentioned. Meanwhile, basin development projects have also been undertaken, most of them based on restoration of ancient reservoirs, chiefly in the Daduru Oya, Mee Oya and Kala Oya basins. One of these projects that has been undertaken with foreign technical assistance is the Inginimitiya Reservoir Project on the Mee Oya, where investigations have been completed recently with technical assistance from Japan. In the Kala Oya basin, the new Rajangane Reservoir was designed by the Irrigation Department, and constructed by the Ceylon Development Engineering Co. Ltd., without any foreign assistance in 1965. This reservoir has a massive concrete spillway, incorporating 32 radial gates for flood control.

The Northern region has unique characteristics. It has an extensive water-bearing limestone formation covered with a comparatively thin layer of soil, in the Jaffna peniusula as well as in the northen mainland area. Groundwater is tapped for irrigation of subsidiary food crops including chillies, onions, and potatoes, from a number of irrigation wells. A long-term proposal for converting three lagoons into fresh water reservoirs is also being implemented. This Scheme depends on the overflow from the Iranamadu reservoir across the Kanakarayan Aru. (See Box)

Institutions

The structure of institutions dealing with irrigation and multipurpose development projects has been changed in recent times. After 1970 the old Irrigation Department was considerably reduced in size and its responsibility for maintenance of irrigation works was handed over to the newly created Territorial Civil Engineering Organisation. The Irrigation Department remained a smaller but specialised and centralised organisation with an overview of the water and land resources of the whole island. Thus the responsibility for initiating future irrigation and multipurpose development planning is still vested in this Department.

In the late 60s the implementation of the first stage of the Mahaweli Development project was started. Since large investments were necessary, which were obtained as long-term loans from the World Bank, foreign Consulting and Contracting organisations were attracted once more to our country. In fact the terms of World Bank loans usually specify a pre-qualification by the World Bank itself. As a result a foreign Consulting organisation was engaged for the implementation of Project I, the Polgolla Complex. At this time World Bank projects were being negotiated which were viewed with much scepticism by local scientists

(Continued on page 16)

THE NORTHERN REGION, GROUNDWATER AND LIFT IRRIGATION

The Jaffna peninsula and the coastal strip of the mainland especially in the North-Western part of the island has its own unique characteristics on account of land formation and climate. In this region an extensive limestone formation exists, which has a potential for retaining groundwater and which is covered by a comparatively thin soil layer ranging from about a few feet to a maximum of about 30 ft. in thickness near Tellippalai in the Jaffna peninsula. Groundwater exploitation for irrigation from surface wells has been practised from time immemorial using both manpower and draught-power especially in the Jaffna peninsula. In recent times, the use of power-driven pumps has considerably increased the use of groundwater especially for irrigation of subsidiary food crops. Labour-intensive cultivation of chillies, onions and potatoes has made a very useful contribution to domestic production. Self-sufficiency in all three commodities has now been achieved. As a result, the rate of depletion of the groundwater in certain areas has given some cause for alarm. An organisation was therefore set up early in 1965 for systematic observation of water levels and testing of sample water in over 400 selected wells known as observation wells. This work is directed by the Hydrological Branch of the Irrigation Department. Deep-well drilling has also been undertaken by this branch, the first deep wells being drilled at Kondachchi, south of Mannar and at Vanathawillu, north of Puttalam in 1964. It has been shown that there is an adequate storage for groundwater in the subterranean limestone formation which can be economically tapped for irrigation by deep tube wells. The surface water in the Mahaweli Development area will be approximately doubled when the Mahaweli Scheme is completed and there will be a corresponding benefit to ground water in the northern region described here, as a result. The systematic exploitation of groundwater should therefore be considered a significant resource for agricultural development in the future.

In the Jaffna peninsula, the amount of local rainfall has upto now determined the useful potential of groundwater for irrigation because this rainfall was the only available replenishment. However, the possibility of introducing new fresh water sources from the mainland to benefit the subterranean watertable in the Jaffna peninsula has been discussed from a long time past. There are 3 seawater lagoons which can be converted to fresh water over a very long period of time. These are the Elephant Pass Lagoon, to the east of the Elephant Pass; the Vadamarachchi Lagoon extending in a north-westerly direction along the peninsula with a sea outfall about 13 miles north of Jaffna; and the South Lagoon with a sea outfall about 4 miles south-east of Jaffna. The Elephant Pass Lagoon has an area of about 19,000 acres and an average depth of about 4 ft. The excess waters from the Iranamadu flow down the Kanakarayan Aru into the Elephant Pass Lagoon. The possibility of converting this lagoon to fresh water had first been discussed nearly a 100 years ago and taken up as a project about 50 years ago after completion of the Iranamadu Tank across the Kanagarayan Aru with a storage of about 82,000 acre feet, in 1922. The lagoon has to be kept free of salt intrusion from the sea. This takes place from the south eastern end during the north east monsoon through the sand bar at Chundikulam, and during the south west monsoon through the bridge at Elephant Pass. If these two locations are effectively sealed off, the Elephant Pass Lagoon Fresh Water project could become a reality.

The Vadamarachchi Lagoon has an area of about 7,300 acres and an average depth of about 5 ft. The Thondamanaar Barrage was constructed in 1948 to prevent intrusion of seawater from the north western end of the lagoon. Unfortunately, the project has not yet resulted in an appreciable storage of fresh water by repeated dilution and leaching of the salt in the lagoon, for various reasons. One reason given is that the intrusion of salt water promotes the fishing industry and is therefore welcomed by some people. The South lagoon has an area of 6,400 acres and an average depth of about 5 ft. A saltwater exclusion structure has been constructed near the sea outfall. The fresh water for this project has to come from local rainfall.

There are also several natural wells or "kerni" in the peninsula region which hold freshwater. By far, the best known of these is the so called tidal well, Puttur, usually known as Nilawarai. This well has been found to be 164 ft. 6 in. deep. It has a surface area of about 50 ft x 40 ft. and contains freshwater of the highest potable quality to a depth of 50 ft. Pumping tests were carried out in 1946 to determine the potential for irrigation from this well, and a project for cultivation of subsidiary food crops of 250 acres has been functioning since 1950.

MAHAWELI GANGA DEVELOPMENT

The main stem of the Mahaweli ganga rises in the Hatton Plateau in a region with an annual rainfall of nearly 200 inches. It is joined by the Kotmale Oya which springs in the Horton Plains, 7000 feet above sea level, and flows in a northerly direction down to Kandy. After encircling Kandy, it changes direction to enter the Dumbara valley and flows southward for several miles. It then swings eastward, breaks through the Rantambe gorge near Randenigala and finally turns northward once again. Down the Dumbara valley it picks up the waters of many tributaries notably the Ma Oya and Hulu Ganga flowing southward, whilst the Uva region contributes the waters of the Kurundu Oya, the Uma Oya, the Badulu Oya and the Loggal Oya which all flow in a northerly direction to join the main river. Beyond Randenigala, the river flows down to the sea across the vast plain of the North-eastern dry zone in a general northerly direction. The river has changed its course many times over the years in the middle reaches of this plain. Nevertheless in ancient times the main river had been successfully diverted for irrigation by means of massive diversion anicuts and canals, at three known locations in this plain. References also exist in the written records of other possible diversions which have not been identified. Some tributary streams join the main river in its middle reaches from the Western or left bank side. The most important of these is the Amban Ganga which is a sizeable river at the point of its confluence with the Mahaweli Ganga. Major tributaries of the Amban Ganga are the Kalu Ganga and the Sudu Ganga. The Nalanda Oya is a comparatively small stream which falls into the Amban Ganga but is of some importance on account of diversion of its waters to the adjacent Kala Oya. There are no large tributaries joining the river from its right bank in the dry zone area. Thirty miles from the sea the Mahaweli Ganga gives rise to a single large distributary, the Verugal Aru, which branches off in an easterly direction to the sea. The main delta of the river has five separate outlets which fall into Koddiar Bay, South of Trincomalee.

The Mahaweli basin area of 4030 square miles, out of the island's 25,000 square miles, is estimated to carry an average of seven million acre feet of water each year representing approximately one-fourth of the total average discharge of all rivers in Sri Lanka.

In ancient times a comprehensive diversion network of anicuts and canals had been constructed in the Mahaweli basin. Two of these diversion systems led water directly to the storage reservoirs, (Minneriya - Giritale and Parakrama Samudra) whilst all the others diverted irrigation water through subsidiary networks of small channels and village tanks to the fields. The traces of most of the smaller channels have long been obscured, but the remains of the small tanks are everywhere evident. The centre of development in the pre-Christian era had been the capital city of Anuradhapura on the banks of the Malwatu Oya and the water resources of this basin had been developed at that time to supply the city. Extensive development in the adjacent Mahaweli basin came in the post-Christian period. A continuous scheme of development can be seen, indicating that there was an accumulation of knowledge from the experience of the past which was used over and over again in the development of these works.

It is quite clear that the ancients had not developed a technology for diverting a perennial river through a tunnel or massive sluice, in order to construct a permanent dam across such a perennial river. Instead, they had used the twin-tank technique for such construction best illustrated by the Kala Wewa-Balalu Wewa. On the other hand they had completely mastered the technology of construction of stone dams across these rivers, and these structures were used for diverting the flow in the river into a man-made canal. At least in one instance, in the case of the diversion dam and canal across the Malwatu Oya which augmented the Nuwara Wewa, a reservoir (Nachchaduwa) was subsequently constructed which encompassed the diversion anicut. Thus it can be argued that an adequate technology was available to harness all available water resources for irrigation without the type of large-scale temporary river diversion that is used in modern times.

Modern Development

The Master Plan prepared in the period 1965 to 1968 by the UNDP/FAO team in collaboration with Sri Lanka specialists envisaged the multipurpose development of the land and water resources in the Mahaweli basin and adjacent river basin at an estimated cost of Rs. 6,700 million at that time (1968). The plan was to be implemented in 30 years (by 1998). According to this plan 4.7 million acre feet out of the total 7.0 million acre feet of the flow in the Mahaweli Ganga could be utilised for irrigation in an area of 900,000 acres. An additional 0.9 million acre feet of water available in the development area would also be used making a total of 5.6 million acre feet. Of the 900,000 acres to be benefitted about 250,000 acres are presently irrigated but are not assured of irrigation water supplies for two seasons every year, whilst about 650,000 acres will be new lands (some of it presently under rain-fed cultivation). This figure should be compared with the total of 925,000 acres served with irrigation facilities under major projects at the present time. Of the 900,000 acres, 422,000 acres lie in the Mahaweli basin and the balance 478,000 acres lie in adjacent river basins, Maduru Oya, Kantalai, Pankulan Aru, Yan Oya, Ma Oya, Per Aru, Kanakarayan Aru, Pai Aru, Parangi Aru, Malwatu Oya, and Kala Oya.

This Master Plan has been designed to make maximum use of the existing large and medium-scale ancient storage reservoirs in the development area. These reservoirs which presently provide irrigation water for considerable extents of land will be given an assured supply which will come from a number of large storage reservoirs constructed on the main river and on major tributaries; but in the first instance the benefit of an assured water supply to about 132,000 acres of existing lands under major and medium-scale irrigation projects has been achieved by a new diversion from the main river at Polgolla. As the project is implemented many of the smaller village tanks lying in the project area and at present supporting a fairly extensive minor irrigation system will become redundant. Many of these small tanks will therefore be breached and their tank-bed areas brought under cultivation.

With the proposed construction of several large reservoirs the Master Plan envisages the installation of several new hydro-power plants with a total installed capacity of over 500 megawatts for production of about 2000 million KWH of energy annually. With the construction of these reservoirs flood control will also be achieved in various reaches of the river that are now subject to flooding. The construction of the Kotmale Oya reservoir will protect the Gampola-Peradeniya area from floods. Construction of the Randenigala reservoir and Victoria reservoir on the main river will ensure flood control in the Minipe project area and further down the river. Construction of the Bowatenna reservoir and Moragahakande reservoir on the Amban Ganga will ensure flood control in the Minneriya-Polonnaruwa area.

In a project of this scale, which has to be implemented over a long period of time, the estimated cost will be subject to upward revision from time to time. This has been the experience both at Galoya and at Walawe. The original estimate of Rs. 6700 million in 1968 has now increased to about Rs. 10,000 million representing an almost 50% escalation in about 10 years.

In view of the large extent of the scheme and the large investment cost, the implementation plan has been divided into three phases. Each phase in turn will be divided into several stages. Each stage will be defined and described in terms of the extents and acres to be benefitted. For example Phase I of the project is divided into three stages in which Stage I benefits 132,000 acres of existing land, Stage II will benefit 71,000 acres of new land in the Kala Oya basin on which some 28,000 families will be settled, and Stage III will benefit 20,000 acres of new land in the Kantalai and Kaudulla schemes.

The major engineering features of each phase have also been identified as projects. Thus Project I of Phase I is described as the Polgolla Complex, the Suduganga Training Works, the Bowatenna Complex and the Elahera Headworks and Main Canal Construction. The construction of

Project I is now being completed. Items of work in the Polgolla complex are the Polgolla diversion concrete dam 565 feet long with a maximum height of 55 feet, incorporating 10 gates each 21 feet high and 40 feet long; the Polgolla Diversion Tunnel 26,450 feet long and 19 ft. 6 in. diameter to carry 2,000 cusecs; the Ukuwela Plant with two 20 megawatt units giving 235.25 million KWH annually. The Bowatenna complex includes the Bowatenna concrete dam 771 feet long with a maximum height of 103 feet incorporating six radial gates each 32 feet long and 37 feet high and the Bowatenna Diversion Tunnel 22,468 feet long and 13 feet diameter carrying 1,000 cusecs of water. The Suduganga Training Works consists of widening and deepening the Dhunoya into which the water from the Ukuwela Power Plan will be discharged. The Dhunoya falls into the Suduganga which will also be improved to carry 2,000 cusecs. The reconstruction of the Elahera Headworks includes raising the height of the existing anicut and construction of a new head sluice. The main Elahera - Minneri - Yodaela has also to be widened to carry a new maximum discharge of 2,000 cusecs.

Stage I is now being completed and an assured water supply is now available to existing lands under the following major and medium scale ancient reservoirs as follows:—

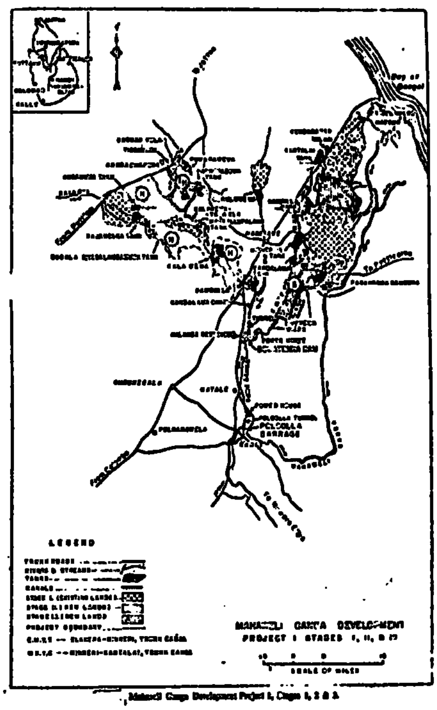
	Acres
Mahaweli Basin	
Kaudulla	10,200
Elahera	4,500
Minneriya	12,000
Giritale	4,500
Parakrama Samudra ...	19,000
Gal Amuna	3,500
Village Tanks	6,065
Kala Oya Basin	
Kandalama	3,500
Kalawewa	13,500
Maha Illuppallama	380
Kattiyawa	504
Rajangana	13,300
Siyambalangamuwa	1,500
Malwatu Oya Basin	
Nachchaduwa	5,337
Nuwara Wewa	2,399
Tissa Wewa	1,028
Basawakulama	921
Yan Oya Basin	
Hurulu Wewa	8,000
Total...	132,000

Work on Stage II of Phase I commenced in 1974 according to schedule and should be completed in 1979. In this stage 57,000 acres of new lands will be developed below Kala Wewa and 14,000 acres below Kandalama, and 28,000 families will be settled. Stage III just started consists of the development of 9,000 acres of new land under Kantalai and 11,000 acres of new land under Kaudulla. This work should also be completed by 1979, when all work on phase I would be completed.

Phase II of the project envisages construction of storage reservoirs on the Mahaweli Ganga and on the Amban Ganga. These are Victoria Falls Reservoir and Randenigala Reservoir on the Mahaweli and the Moragahakande Reservoir on the Ambanganga. Full investigation studies and implementation reports have first to be prepared after which construction will commence. It is expected that as much control as possible will be exercised by the new institutions like the Central Engineering Consultancy Bureau on the execution of the feasibility studies even though they may be partly financed by the foreign agencies. After the feasibility studies are completed it will be necessary to negotiate financial assistance from lending agencies like the World Bank for implementation of these projects.

The last phase of the project will be the construction of other reservoirs including the Kotmale Oya reservoir. The main objective of the Mahaweli project is the development of 900,000 acres of land with an assured supply of water for cultivation. Since about 650,000 acres will be new lands which will be settled on the basis of 2½ acres per family, it will be seen that some 260,000 families representing perhaps 1 million people will thus be settled over the next 30 years. Looked at in these terms this is a vast human settlement programme for which attention should be focussed not merely on the visible infrastructure but on the less tangible aspects as well. It is therefore heartening to note that the Mahaweli Development Board has virtually from its inception paid attention to the vital importance of the settlement aspect. The failures of Galoya and the impending failures of Walawe should be kept foremost in mind when the Mahaweli Master Plan is being implemented. Attention may be drawn in particular to two aspects. Firstly a change in the pattern of the infrastructure for providing irrigation facilities compared to the traditional techniques to which the village cultivator is accustomed. Secondly the need to diversify the activities of the settlers into various industries so that the living community will have other prospects to offer future generations who will find that new land and water resources are no longer available. In this context the need to systematically intensify cultivation techniques is also evident.

The first point mentioned above may be explained further. In traditional agricultural communities a great deal of co-operative effort is used during particular periods such as during land preparation and harvesting of the crop. In some village schemes, the very provision of irrigation water from one liyadde to another makes for this type of co-operation between neighbours. In the layout of the colonization schemes, on the other hand, the need for such co-operation is not built into the project. Theoretically each individual farmer can function independently of all the others obtaining his requirements of agricultural inputs, credit facilities etc. from the respective state organisations and harvesting and selling



his produce in like manner. In practice such a transformation may not be possible for a new settler accustomed to old ways.

In regard to the second point it may be mentioned that the Mahaweli Development Board obtained the services of a firm of Japanese consultants to report on possibilities for development of new industries in the development area. It should be stressed that such consultancy services should be used only as a guideline and not as a gospel. No foreign organisation can possibly comprehend our socio-economic environment to such a degree as to be able to prepare a new small-scale industrial project that will be easily and readily acceptable to our peasant cultivators and their children. It is necessary that this type of industrialisation which has been demonstrated in the Development Council (D.D.C.) programme should be the objective in the Mahaweli development area. Other types of new industrial projects which are set up by transfer of technology generally in urban centres may have a place in the new towns in the development area, but this will merely employ wage labour as they do in other towns. In this area State Corporations may well embark on new projects where suitable raw materials are available. It need hardly be mentioned that appropriate technology should be used even on such projects. The possibilities for such appropriate technologies for manufacture of cement and cement products, paper and paper products, ceramics, wood charcoal etc. should be investigated. The processing of agricultural produce and their preservation should also be the basis for new industrial projects using appropriate technology.

and technologists. Two of these projects were specially severely criticised, namely the proposal to instal a 50 Megawatt Gas Turbine, and the proposal called the Highways Project to allegedly "modernise the road system" in a chosen area. In an unprecedented expression of national feeling many scientists and technologists were openly critical of official Government policy in regard to foreign-financed projects at this stage. When the Government changed in 1970 there was a significant change in attitudes in many development projects. In the Mahaweli Development Board for the first time an engineer was appointed as Chairman and a greater responsibility was placed with local scientists and technologists for the execution of the work.

The Mahaweli Development Board grew in stages with the expansion of the project itself. In the process, an Engineering Studies Organisation (ESO) was set up in this Board in 1967, initially to review the UNDP/FAO reports. Later the ESO was able to undertake necessary engineering studies for this project. The ESO was manned largely by personnel from the Irrigation Department led by the late Mr. H. de. S. Manamperi, who at one time was simultaneously Chairman of the Mahaweli Development Board and Director of Irrigation. The ESO has proved once again the capability in designs and planning of Sri Lankans in this field of irrigation and multipurpose development.

Sri Lankan engineers and technologists are highly-thought of in the emerging countries of Africa especially in the field of irrigation. We have contributed considerably towards the development of many of these African states through the so-called 'brain drain'. It has been mentioned that another factor that we have more recently started contributing to this development is the 'brawn drain'; the large numbers of skilled and trained workers who have followed the engineers and technologists to Africa. Apparently we are losing one of our precious resources, namely our manpower, because we do not know how to value and use it. The irony of this situation is that at the same time we are accepting technical assistance from other countries for development of our irrigation and multipurpose projects. Such technical assistance in the form of vehicles and equipment may be absolutely necessary, but often the human component that is also included is not considered. To aggravate the situation the so-called counterpart Sri Lanka technologist who often works with foreign "experts" finds that for the same work there is a difference in tangible rewards in a proportion greater than 1 : 10. Thus the vicious circle of the brain drain is promoted.

The example of the work done by the Engineering Studies Organisation led to the setting up of the Central Engineering Consulting Bureau (CECB) in the Ministry of Irrigation, Power and Highways under the Industrial Corporations Act in 1973. This organisation, as its name suggests is vested with responsibility for providing consultancy services for large projects.

In the field of consultancy the Engineering Studies Organisation succeeded in being recognised by the Asian Development Bank for the preparation of proposals for the hydropower aspect of the Bowatenne Complex. This is the first time that a local consultancy organisation has achieved such a breakthrough. The Central Engineering Consultancy Bureau is at present engaged in preparation of proposals for the Samanala Wewa Power Project jointly with experts from Techpron Export, USSR, the project being financed by the Soviet government. The CECB has also prepared a technical report on the Canyon Power Project which has been accepted by the Asian Development Bank, and are now negotiating with a Netherlands organisation that is interested in financing Full Investigation Studies for the proposed Randenigala and Moragaha-

FOREIGN EXPERTISE

The River Valleys Development Board was set up in August 1965 as the successor to the Galoya Development Board shortly after work on the Walawe project was started. A considerable amount of plant and equipment and a large number of personnel were transferred to Walawe from Galoya and a new base workshop set up at Walawe. Construction of the Uda Walawe headworks in 1966 and 1967 also saw the arrival of a great amount of new construction equipment. After river closure was successfully completed in September 1967 it was apparent that there was a surplus of heavy construction equipment of a particular type in Walawe. A decision was therefore taken by the Board to set up a new Heavy Construction Division with the object of undertaking construction contracts outside the Walawe project as well. It was clearly stated that first priority was to be given to construction development work in the Walawe project. The Heavy Construction Division made an immediate impact on a problem which even at that time was reaching major proportions, namely the utilization of the large numbers of employees in the Board's service. Outside contracts were undertaken all over the island. These included such important projects as construction of the Ella-Wellawaya road, and the new Maskeliya roads to replace those submerged by the Moussakelle Reservoir; earthwork on the Railway extension at the Cement Factory, Puttalam; the restoration of the Nagadipa Mahawewa and the Muruthavala Wewa. (The latter, a medium-scale reservoir in the wet zone near Tangalle, with an earth embankment about 100 feet high is now called the Rajapakse Samudra.) This work was appropriate for the men and machines that had been engaged on the dramatic river closure operations at Walawe in 1967. The Walawe headworks construction had also been carefully planned using the best planning techniques available such as network analysis, which was a comparatively new technique at the time. These techniques were also used in planning the outside contracts.

Alas, in late 1968 the Ministry of Planning and Economic Affairs obtained the services of an expert to advise the Plan Implementations Division on planning techniques. In due course this expert advised that the Heavy Construction Division should be disbanded and all the men and machines sent back to Walawe. After a somewhat drawnout struggle with the local engineers who were opposed to this proposal, the expert's view prevailed. The Heavy Construction Division was therefore wound up in late 1969. Thereafter there was such a surplus of personnel at Walawe that it was said that skilled men were asked to clock in at the workshop and then leave the premises, as there was no room for all the men to work together! After several years, the foreign expert duly returned to his homeland and in 1975 the R.V.D.B. decided to undertake outside construction contracts once again, although development work at Walawe was still far from complete. Today a new outside Contracts Division is once more functioning effectively in the R.V.D.B. and has undertaken construction work on the Lower Uva Development Project including construction of Muthukandiya Reservoir; construction of Dambulu-Oya reservoir project; restoration of minor tanks and construction of roads in Medawachchiya area; construction of the Ambewela-Pattipola road; construction of buildings for the State Fertilizer Manufacturing Corporation at Sapugaskande and construction of access roads at Samanala Wewa.

kande Reservoirs in Phase II of the Mahaweli Development Scheme. The CECB has absorbed many of the personnel of the original E.S.O. If the E.S.O. (which is part of the Mahaweli Development Board) winds up, the CECB will become the sole organization in the country for undertaking consultancy work on irrigation and multipurpose projects.

In construction work, the State Engineering Corporation in the public sector was the first to gain recognition by a financing agency, in this case the World Bank. The State Development and Construction Corporation has also since followed this lead. In the private sector, the Ceylon Development Engineering Co. Ltd. has blazed a trail in the field of construction work for irrigation and multipurpose development projects, and is now recognised for such work by both the World Bank and the Asian Development Bank.

In this context the possibility now exists for Sri Lankan Agencies to undertake designs and consulting in foreign countries as well. Although it may sound ironical that foreign agencies are doing the same type of work in our country, this follows from the nature of these contracts, where the financing agency has the say in the choice of consultant and contractor. Therefore, it may be easier for Sri Lanka organisations which have been recognised as prequalified for consultancy and construction work to seek such work abroad. This may serve the further purpose of channelling the 'brain-drain' and the 'brawn drain' to some useful purpose which seems to be a more practical approach than any attempt to stem these drains.

Conclusion

Today, it is being increasingly realized how critical water will be to the quest for self-sufficiency in food. The severe droughts that have affected every continent in recent years has brought the attention of almost every country to bear, as

HYDRO - POWER DEVELOPMENT

The hydro-power potential in Sri Lanka was first assessed in an ECAFE study, as 1000 M.W. A study prepared in 1949 and mentioned in a World Bank Report in 1952, gives a total of 500 megawatts made up of 13 individual projects located on the major rivers Kelani Ganga, Mahaweli Ganga, Walawe Ganga and Kalu Ganga. The United Nations expert Mr. Pfeiffer gave an increased estimate of 1400 megawatts in 1957 by identifying a total of 30 new projects. However, both these estimates concentrated on large projects.

Development of hydro-power in the upper Kelani basin originally proposed by Wimalasurendra in 1918, was started in 1928, but this project at Norton Bridge was not completed until 1948 when the 25 M.W. Norton plant was commissioned. At this time a proposal was prepared for systematic development of hydro-power resources in the Kehelgamuwa Oya and the Maskeli Oya, upper reaches of the Kelani Ganga. Simultaneously, a proposal was made to set up a fertilizer plant in this region to utilise the large amount of power that would be available from the proposed Seven Virgins project, but the World Bank mission in 1952 turned down this proposal. Foreign experts who advised the Planning Secretariat, also turned down the proposal for electrification of railways before the 10-year plan was published in 1959 so that this Plan proposed "modernising" the railways by doing away with the steam engines and introducing diesel traction.

Utilisation of hydro-power potential of the upper Kelani Ganga is now nearing completion, but the original proposal was broken down into a number of smaller projects. The total firm energy available in the complex is 1005 million KWH.

A further 170 million KWH approximately will be available when a further 30 MW is installed in the proposed Canyon Power Plant.

Under the Mahaweli Multi-purpose Development Project the hydro-power potential has been estimated by the UNDP/FAO study as follows:

No. River	*Installed MW*	*Firm Energy 10 KWH*
1. Mahaweli Ganga Cascade ...	342.5	1339.2
2. Kotmale Oya Cascade ...	207.2	784.7
3. Amban Ganga Cascade ...	161.9	638.4
4. Uma Oya Cascade	126.6	468.6
5. Badulu Oya & Loggal Oya Cascade	48.5	143.5
6. Other tributaries ...	36.2	119.9
Total Potential ...	922.9	3494.2

At present the Ukuwela Power Plant with 40 M.W. of installed power giving 170 million KWH of firm energy has been commissioned, and construction of the Bowatenna Power Plant has just commenced. This project is of interest because the designs have been prepared by the Engineering Studies Organisation of the Mahaweli Board and the construction contract has been awarded to the Ceylon Development Engineering Company Limited, the first instance when a power project has been undertaken without any foreign expertise. Under Stage II of the Mahaweli project, power plants will be installed at Kotmale Reservoir, Victoria Falls Reservoir, Randenigala Reservoir and Moragahakande Reservoir.

In the Walawe Ganga, the Samanala Wewa power project has now been started with technical assistance from the Soviet Union. The project should be completed by 1981, with an installed capacity of 120 M.W. giving 400 million KWH of firm energy. The Samanala Wewa power project will be the first hydro power plant that will benefit from both monsoons, and will thus add a much needed stability to our national power system. A considerable power potential will also be available in the proposed Southern area project. This will be chiefly in the Jasmine Reservoir complex and the Kukule Reservoir in the Kalu Ganga Basin.

In British times a number of small power plants had been set up in the plantation sector. The power generated from these small power plants, was consumed in the immediate vicinity, so that there was no need for expensive transmission lines. Unfortunately a project for electrification of the plantation sector financed by the Asian Development Bank was started recently, as a result of which some of these small power plants have been scrapped. After the increase in petroleum prices, new thinking has resulted in an effort to stop this possible waste. A proposal has also been recently outlined by the Chairman, Electricity Board, to set up a number of small-scale reservoirs with much less initial capital cost than for the larger projects, in all our major river basins. Incidentally these reservoirs will provide hydro-energy over and above that which is presently estimated to be available from the large projects in these river basins.

Small scale power plants can be also installed in irrigation sluices in the large reservoirs. This has been done at Uda Walawe where these reservoir power plants have an installed capacity of 6 M.W. At Gal Oya, a conventional power plant sited below the Senanayake Samudra has an installed capacity of 10 M.W.

Many foreign Governments have shown interest in providing technical assistance for small scale hydro-power projects. An offer was made by the Chinese Government for such assistance for a small-scale power plant located at Dhuvili Ella above Ukgal Kaltota on the Walawe Ganga and preliminary investigations have already been done. Incidentally, at Ukgal Kaltota, the Circuit Bungalow is provided with electricity from a generator driven by a very small water wheel designed and constructed by a local Irrigation Engineer more than 20 years ago.

never before, on the problems of water conservation. Not only in Sri Lanka but in most parts of the world, the earliest civilizations emerged where soils were richest and water most available, and became extinct when irrigation fell into neglect, when watersheds had been deforested, and when soil erosion and silting destroyed the very basis of agriculture.

In Sri Lanka, the heritage of our ancient civilization is known to have depended on an irrigation system that had achieved a multipurpose objective comprising irrigation, drainage, flood control and conservation. Modern irrigation and multipurpose development projects tend to concentrate on irrigation, flood control and hydro-power production with only secondary emphasis on drainage, and an almost complete absence of attention on conservation. The modern multipurpose development project is characterised by large initial capital investments on a reservoir and channel system. Subsequent investments on land development and settlements are usually spread out over a comparatively longer period of time. The benefits from such projects are also spread out over a comparatively long period. In spite of a considerable investment in the post-independence era, the output of our domestic agricultural sector has been slow in making a significant impact on our food production.

In the colonization schemes which were started in the immediate pre-war period and gathered much momentum after World War II, adequate attention was paid at least at the beginning, to the human settlement aspect. With the start of the Gal Oya project, attention was focussed on the efficiency of the investment in economic terms. Unfortunately this particular project has not measured up to the desired criteria for such an investment. The same appears to be true for the Walawe Project.

Much hope now rests on the Mahaweli Project. Here unlike at Galoya and Walawe attention is once more focussed on the human settlement aspect of the project. During Stage II, which is now underway a total of 71,000 acres of new lands are to be settled with 26,000 families representing about 150,000 people. Since purana villages and the old type colonization schemes are also found in the development area, the settlement in the new areas involves the integration of new and old. It is heartening to note that the authorities are making every effort to approach their task with courage and humility. There is both the will to succeed and a willingness to learn from the people.