Engineering problems of flood control and drainage in the low-lying lands of the wet zone in Sri Lanka

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The Wet Zone low-lying lands of our country are confined to the West and South Western sectors. The area is subject to an average annual rainfall of about 100-120 inches. The island's topography with the central massif results in rivers radiating towards the coast. The rivers debouching to the West and South western coasts carry about half the annual rainfall run-off. Since the island is skirted by a broad peneplain below the 100′ contour it is ideally located to form the flood plain. The flatness of the rivers in the coastal plain is readily evidenced by the several meanders and braiding. In general the river cross sections at bankful discharge can accommodate only 15% to 25% of the flood flows.

RIVER FLOODS

The large flood volume the rivers carry, has therefore to occupy the entire flood pain. It is this flood plain that we have intruded into for cultivation. The engineering problems of flood control and drainage are therefore inevitable in such methods of land utilisation.

The main problem is flooding. Take the case of the Gin Ganga as typical of the rivers in the Wet Zone with average annual rainfall 146 inches. The river rises at elevation of over 4000′ in the Deniyaya hills and has a catchment of 370 square miles. Of the total river length of 70 miles the last 7½ miles from Puhulduwa to Gintota the average bank elevation is only 3 or 4 foot above mean sea level. Thus any attempt to cultivate the land by the river bank is fraught with danger of floods. These floods can be caused by rain in the immediate neighbourhood or by heavy rains in the upper catchment, which comes down swiftly due to steep gradient. The simplest method of excluding floods from the higher reaches of the river is to protect the lower

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areas by levees or bunds. But this creates a series of other problems. Levees also prevent the natural drainage of the lower areas to the river. So regulated openings have to be left on the levees to permit the local drainage to return to the river channel. The openings have to be shut with rising river stages and opened as the river stages fall to permit the drainage of the lands protected by the levees.

PUMPING

But the problem gets complex if the river stages continue to maintain a high elevation. The drainage of the protected areas is no more possible by gravity and resource to mechanical evacuation is inevitable.

Pumping is an expensive method of flood evacuation. Heavy initial capital costs followed by recurrent operation and maintenance costs are the penalties faced in the gambit of flood plain occupancy.

FLOOD PROTECTION BUNDS

Levee height to prevent floods for all time are unattainable. No country could afford the resources for such undertakings. Thus in Ceylon the levee height for agriculture is kept at a frequency of once in 10 years for overtopping. In Gin Ganga scheme to be constructed under Chinese Aid the levee height is fixed at once in 20 years overtopping. In the other minor flood protection schemes such as Kiralakele, Bolgoda, Dedduwa, Rantotuwila, Bentota Right Bank, Madampe, Hikkaduwa and Madu Ganga, the levee height is kept at 3.5′ above M.S.L. corresponding to a frequency of 3-5 years.

CHANNEL IMPROVEMENT

Canals and drainage channels being overrun by water hyacinth and salvinia presents a recurrent maintenance problem which is time consuming and expensive. Their retarding effects of flood flows cause prolonged inundation and create serious difficulties at controlling structures.

Construction of coconut husk pits along river banks cause further retardation to discharge of flood waters. This is widely used in Goiyapana, Koggala and Dummelamodera Ela. Obstructions by fish kraals is prevalent in Hikkaduwa and Bolgoda. As these provide forms of livelihood, they have to be endured despite the necessity for removal.

IMPROVEMENT TO SEA OUTFALL

Most rivers in the area enter the sea through openings in the sand dunes. If the sand bar has built up due to poor river flow widespread flooding of long duration is inevitable, till the river flood reaches a level of 4 or 5 feet above sea level and automatically breaches the sand bar to produce a rapid drawdown. But the duration of this inundation will be critical and all or most of the paddy can be ruined.

Manual cutting of sand bar can be attempted only if the flooding is over 2½ feet above sea level. The best solution is protection of river mouth by groyne or jetty construction. For this to be successful, data collection of off shore currents, littoral drifts, wind directions etc., has to be monitored for a long period.

The engineer can then test out the alignment and shape of groyne on a scaled model to determine the best configuration. But in our country most constructions are ad hoc and no time is "lost" on such studies with the result that construction begins in the prototype itself. Some such outfall structures fortuitously succeeded as at Bolgoda and Goiyapana, but problems of sand bar inside the groyne pair are met with as at Iranavillu or Madu Ganga necessitating heavy recurrent expenditure on maintenance dredging to keep outfall free for speedy drainage.

SALT WATER INTRUSION BY TIDE

By its poor elevation close to river estuaries all low-lying drainage and minor flood control projects are subjected to salt water intrusion from tides, which travel up the rivers. This landward movement of saline water is prevented by salt water exclusion bunds and regulators. Thus low-lying lands in the coastal areas have to be protected from both salt water and river flood. Drainage and reclamation of such lands are therefore termed salt water exclusion and minor flood protection schemes.

Our coastline is subject to semi-diurnal tides. There are 2 nearly equal high waters and 2 nearly equal low stores each lunar day. The average difference between the high water and low water is about 18 inches. The high water level and low water level varies daily. The highest high tide and lowest low tide occur shortly after full and new moon. They are called spring tides and neap tides. The lowest high water and the highest low water occur shortly after the first quarter and third quarter of the moon and called neap tides. The springs and neaps also change from month to month.

There are tide tables that predict these values. However for purpose of regulation of control structures in our drainage schemes, operation is based purely on observation. A careless operator may close the gates too late and saline water could enter protected areas, since land elevations are very low and drains and canals have bed levels below sea level. This danger is very real and is aggravated by the fact that salinity wedge could move upstream whilst the non-saline drainage water is actually moving downstream. For instance in Bentota river the bed is very deep in places 30 feet below sea level near the Colombo-Galle Road bridge. The depth of salt water entry inland is thus very high and the distance penetrated is about 18 miles. Lands near Pitigala Ganga have been affected by salt water.

CONSTRUCTIONS IN RIVER CHANNEL

In the present program for development of the paddy lands on the 2 banks of the Bentota river the reduction of the sill level at the Road and rail bridge is provided for. In some of the bridge spans the rock is at about 6 inches below sea level and it is proposed to lower this to—4 feet below mean sea level to accelerate the drawdown of flood levels. Similar action has already been taken at Madampe bridge in Ambalangoda and by blasting the reef at Nilwala Ganga and Kelani Ganga Estuaries. But once this is done saline intrusion up river necessarily increases and preventive action by careful regulator operation is imperative.

FOUNDATION DIFFICULTIES

A serious construction difficulty is the bad foundation conditions one meets in these soils. Structures have to be founded on piles or rafts. If insufficient piles or too short piles are used, the structure settles down unevenly. Piling is an arduous and expensive operation. Flood protection and salt water exclusion bunds when founded on such soils, settle down, necessitating continuous maintenance.

LAND SUBSIDENCE

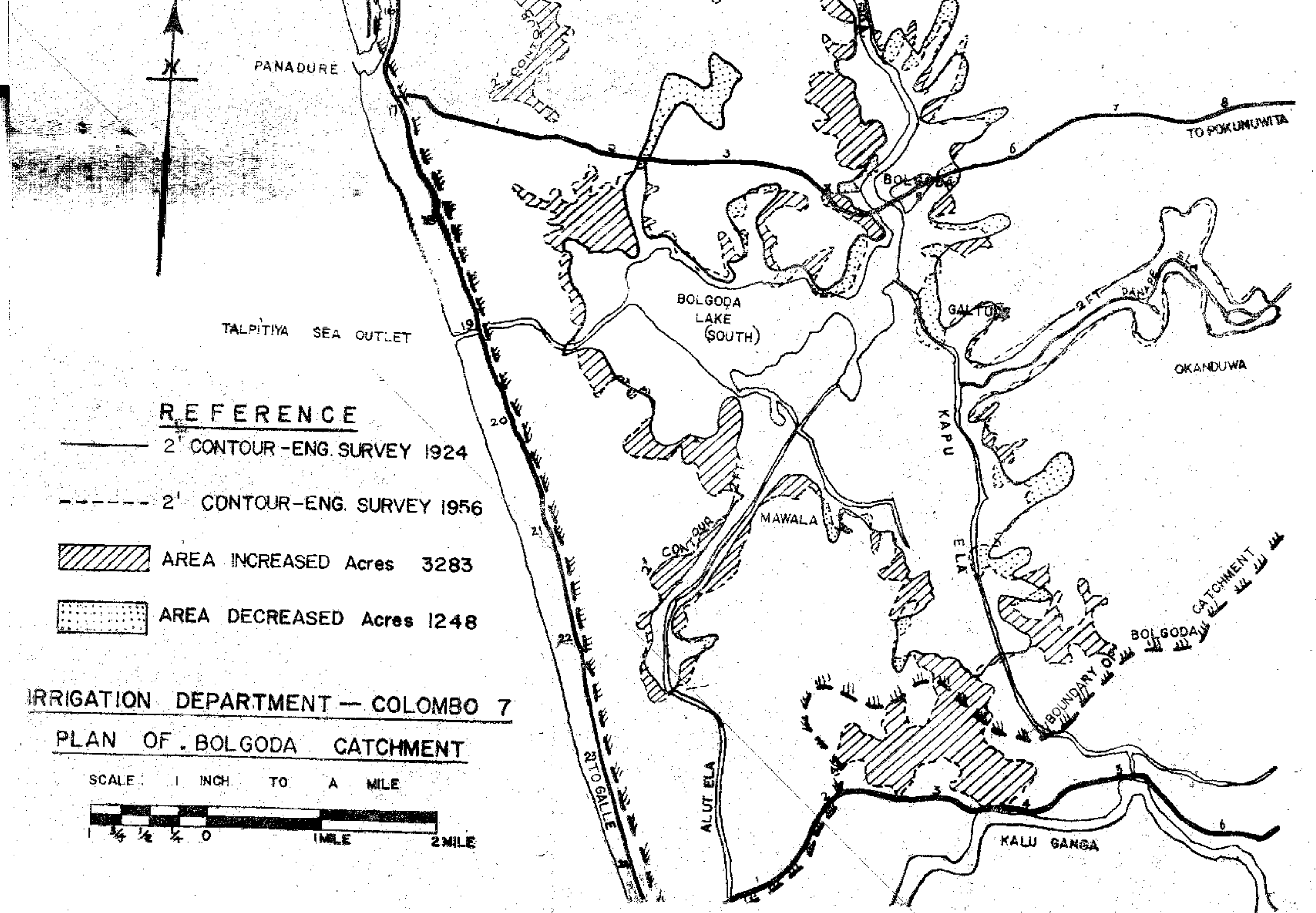
Another problem in the reclamation of these lands is land subsidence caused by improved drainage of boggy or peaty soils. This is due to soil shrinkage by oxidation and compaction. When the water table is lowered, air enters the soil pores. Oxidation of organic soil by action of aerobic bacteria occurs Co_2 produced escapes into the air. As the water table drops the upper soil layers compact the lower soil layers. If animals, men or machines are used this compaction is increased by reducing voids. An average of one inch subsidence per year on peaty soil has been observed in Europe and the U.S.A. If pumping is resorted to the subsidence will increase. Here again there is a constraint. But in Sri Lanka the land use is for paddy, a water loving plant, hence the lowering of the water table for drainage is within very narrow limits. In the crash food production program undertaken this year (1975) large scale deployment of pumps is envisaged.

However the capacities of pumps have been intentionally kept on the low side allowing inundation and pondage in the fields to allowable depths. An allowance for initial subsidence of newly reclaimed land can be estimated between 25% to 35% of the designed depth of drain below existing land level.

In Bolgoda Scheme, I was fortunate in tracking a contour plan done by the Survey Department in 1924. On superimposing the 2' contour traced by the Survey Department in 1956, the area below has increased by 3283 acres and decreased by 1248 acres in other places, giving a nett increase of 1935 acres land below 2' M.S.L. contour. The decrease in area has been caused by land fill for urban expansion. The increase is obviously due to subsidence since drainage improvements commenced with Bolgoda Flood Bunds and locks at Kepu Ela and Waras Ganga (see plan)

I think this is very pertinent to emphasise at this stage when we are about to introduce pumped drainage to Bolgoda and other schemes. It is very safe to forecast that pump capacities will have to be increased as the years progress and general land elevation drops.

In conclusion I think it opportune to mention the problem of man made saline intrusion that goes unabated in Madampe scheme. The coral stone excavation close to the coastline induces heavy saline seepage due to pumping continuously for several weeks. The pumped water always flows landwards and turn the lands and inland waters increasinly brackish. The lands that are physically lost by abandoned pits and the lands turning saline now equal or exceed the areas being annually reclaimed from marsh. Since the foreshore coral and the reef are equally subject to this attack the entire coastline and low-lying land in Madampe area is in peril of being overrun by the sea.


PANADURE
TALPITIYA SEA OUTLET
BOLGODA LAKE (SOUTH)
BOLGODA
GALTUDU
TO POKUNUWITA
PANAPE ELA
2 FT
OKANDUWA
KAPU ELA
MAWALA
2' CONTOUR
ALUT ELA
BOUNDARY OF BOLGODA CATCHMENT
KALU GANGA
TO GALLE
REFERENCE
2' CONTOUR-ENG. SURVEY 1924
2' CONTOUR-ENG. SURVEY 1956
AREA INCREASED Acres 3283
AREA DECREASED Acres 1248
IRRIGATION DEPARTMENT — COLOMBO 7
PLAN OF . BOLGODA CATCHMENT
SCALE : 1 INCH TO A MILE
1 3/4 1/2 1/4 0 1MILE 2MILE

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