Dynamic Seafloor Channel Survey in Guyana

The Republic of Guyana, situated on the continent of South America, between 0Â°and 10Â°N latitude and 56Â° and 62Â°W longitude has as its northern boundary the Atlantic Ocean, forming an open seacoast of some 434 kilometres, intersected by the mouths of nine rivers. Fluid or â€˜sling-mudâ€™ is a special and dangerous feature of these estuaries.

The larger rivers are called the Essequibo, the Demerara and the Berbice rivers and the main ports of Guyana are Demerara and Berbice. Guyana experiences a semi-diurnal tide, or high waters twice per day. Common to all Guyanaâ€™s rivers are shallow estuaries. The minimum depth over each is locally called the riverâ€™s â€˜barâ€™ and these are usually several kilometres long (land to ocean). The controlling depths over these bars severely limit the draft of ships calling at Guyanaâ€™s ports. It is thought that the shallow estuaries are due to the interaction of discharge of fresh water from the rivers meeting the salt and muddy Atlantic waters at a critical angle. This is compounded by a unique system of huge migrating mud-banks, the average size of which vary from 32 to 64km long (E.W.), moving in a westerly direction. The body of water transports an enormous quantity of suspended silt, supplied, as it were, by these mud-banks which (100million m3/year, Delph Report 1962) move in a procession-like manner in an ever-westerly direction, creating an ever-dynamic ocean and river floor. These formations creep along the coast at an average speed of 1.3km/year so that the times for a complete cycle, from crest and back again, to pass any given point is about 25-30 years.

Sling-mud
The sling-mud found on these mud-banks normally attaches itself to the shore, in time becoming detached and migrating ever westwards and may be described as a semi-liquid mass of mobile mud varying in consistency from thin to thick custard. It has the ability not only of moving with the main bodies of mud-banks, but large quantities, millions of cubic meters, can become detached and wander out to sea, with no known predictable movements. These may indeed be called â€˜wanderersâ€™. Experiments show that the semi-liquid mud, the specific gravity of which is 1.213 or less, contains about 73.8% of water. When dried its typical analysis is as follows:

- insoluble residue (sand): 48.68
- silica (Si 02): 11.74
- alumna + ferric Oxide: 27.44
- lime (Ca0): nil
- magnesia (Mg0): 1.88
- combined water, organic matter and loss: 10.26.

Sling-mud Navigation
These â€˜wanderingâ€™ sling-mud masses, when superimposed on cyclic variation, i.e. the shipping channel in a river estuary, can alter navigable depth. If their presence is not known to a captain whose vessel has high water intake this may result in engine damage due to intake of sling-mud rather than water. Prior to the dredging of shipping channels Demerara & Berbice in the 1950s the bauxite vessel Key Holt ran aground on the Demerara Bar and was wrecked! In the 1960s, however, the Dutch cargo/passenger vessel Oranjestad became the first of many ships known to plough through this mud in the shipping channel by more than 10% negative draft as they made their way from sea to harbour and vice versa. This was contrary to normal minimum under-keel clearance of 10% draft of vessel. The vessel Booker Venture was designed trimmed by the bow by some two feet in order to plough through the soft mud on the Demerara bar. New captains to this area were then normally nervous about this negative draft, not least because of insurance clauses referring to â€˜vessel finding bottomâ€™!
During the period 1980-90 it was thought that dual-frequency echo sounders, (200k.c. and 30k.c.) gave the boundary between hard bottom and navigable mud. This was found to be not that accurate. Non-navigable mud was considered to be material with a specific gravity of more than 1.2. Today the Dutch dredging company Boskalis, with the modern help of DGPS, carries out spot checks with a special lead & line with which they claim weight/area will not go beyond 1.2 (up thrust on the weight). Thus ships with drafts of 9 metres, such as bulk carriers, at times navigate this dredged channel of the Berbice River 26 kilometres in length and with a bottom width of 80 metres in as much as 3 metres of sling-mud, without problem. Tests have show that in the dredged channel sling-mud can be suspended in the â€˜cutâ€™ channel, i.e. water above and below the sling-mud! Echo records also show at times the cut as a cone with the sling-mud above it, similar in appearance to an ice-cream cone.
Normal cross-sections of the long and narrow â€˜cigarâ€™ channel are done by echo sounder and GPS, after which a density-meter survey is done to determine the navigable depth and shades of grey from the echo sounder. The sounding of depths with the special lead-line is done at the edge, centre and edge of the cut at sections. The proper tidal time differences along the cut channel were major factors which when not used caused difficulties in the early days of this project, as well as the change in current direction from river to equatorial western direction, i.e. at approximate right-angle to the dredged channel. Pilots have now been advised of both this and tidal time differences, so navigation is good.
If it is known about and a ship has high water intake for its engines, sling-mud is but a nuisance. Many modern tankers do not have high water intakes! Settled sling-mud is a different matter. In cases of settled sling-mud attached to the shore it forms good sea defence barrier(s) but prohibits drainage through the sluices of adjoining land. In the shipping channel, agitation dredging is necessary to

discourage settlement of the sling-mud in the â€˜cutâ€™ channel (see photograph below) and to maintain a dredged depth.
In the instance of the dredging of basins alongside piers (wharves) in which the vessel will sit safely at low tide, any sling-mud present will find the lowest level, i.e. the basin. Settled sling-mud becomes mud, so that frequent use of the basin and periodic dredging are recommended. Migrating banks of sling-mud passing a river mouth are inhaled by the river and do cause much trouble for the harbour of the river. Little is known as to where these mud-banks terminate; they are not known on the island of Trinidad, which lies west of the Guyana coastline. Sling-mud, in Europe referred to as â€˜fluid mudâ€™ or â€˜navigable mudâ€™ was little known in the 1950/60s. Not so now, as ports such as Rotterdam also experience it.
