

THE HOOGLHY RIVER SURVEY

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Introduction

On a recent trip abroad under a Fellowship of the United Nations Technical Assistance Administration we had the rare opportunity and privilege of visiting a number of hydrographic organizations in the United States of America, the United Kingdom and some leading countries of Western Europe. In becoming acquainted with them we became increasingly aware that our own parent organization, the Hooghly River Survey, was not widely known and that a desire and need for information regarding it existed in the hydrographic surveying world.

The best possible opportunity for this purpose was presented when Rear Admiral Robert W. Knox, the President of the Directing Committee of the International Hydrographic Bureau, invited us, during our visit to that organization, to contribute an article regarding the Hooghly River Survey to the International Hydrographic Review. We therefore wish to thank Admiral Knox and his associates for this opportunity.

History

The Hooghly River Survey, which is a marine service under the Commissioners for the Port of Calcutta, has a history dating back to the advent of the British in India. Nearly 300 years ago the Directors of the East India Company, with a view to ensuring the safe passage of ships to Calcutta through the river Hooghly, decided that a hydrographic survey of the river as well as training of pilots was necessary. Towards this end a 60-ton pinnace, the *Diligence*, was built in England and was sent to India with her complement which had orders to 'Take notice of the channels and depths of the river Ganges and the entrance thereto'.

Thus came into existence a joint service of river surveyors and pilots. In 1833 additions to the surveying fleet were made in the form of a brig, a schooner, an anchor vessel and four rowboats. In 1863 the surveyors were separated from the pilots. With the formation of the Calcutta Port Trust in 1870 responsibility for the river immediately up and down stream of Calcutta port was made over to them. Finally in 1881 the present organization of the Service was arrived at when Captain E. W. Petley, with 6 other officers, were transferred to form the Hooghly River Survey.

Functions

The river Hooghly is one of the mouths in the great Ganges delta. It is formed by the confluence of two offshoots from the Ganges, the rivers Bhagirathi and Jalengi. The confluence is at the holy town of Nabadwip, and from here the distance downstream is about 90 nautical miles to Calcutta, about 168 miles to Saugor, or where the Hooghly meets the sea, and about 212 miles to the sandheads, which is about the end of the sandbanks deposited by the river. The jurisdiction of the Port Commissioners at present commences at a distance of 1 mile upstream into each river (Bhagirathi and Jalengi) from the confluence and extends to the sandheads — 40 miles from Saugor into the Bay of Bengal (officially lat. $20^{\circ}57'25''$ N. long. $88^{\circ}01'40''$ E).

The river is navigable by deep-drafted ocean freighters up to Calcutta from the sea, a distance of 122 miles of pilotage. From Calcutta it is further navigable up to its headwaters by small shallow-drafted craft. Consequently the Hooghly River Survey Service is charged with the vital and heavy responsibility of charting all the river areas within the jurisdiction of the Port Commissioners.

From time to time the Service has to undertake hydrographic surveys of the various tributaries of the river Hooghly to aid river valley projects, inland navigation schemes or watershed area investigations. In addition, the running of river and tidal stations, tide and current testing, and collection of other hydrological data are duties of this department.

Work

The river between Bansbaria (about 30 nautical miles upstream from Calcutta) and the sea has been triangulated by the Service and permanently marked. The stretch upstream of Bansbaria has been triangulated with third-order accuracy, but the triangulation stations or survey marks here are not of a long-enduring type. Some major tributaries have also been similarly triangulated a few miles upstream from their entrance into the river Hooghly. All triangulation has been connected with the main triangulation net carried out by the Survey of India.

The channels between Calcutta and Hooghly Point — a distance of 34 miles — is surveyed every two weeks. This extraordinary frequency of channel surveys has been found advisable from experience over many decades due to the unstable channel depths. Downstream of Hooghly Point all the bars, including the sea bar 20 miles into the Bay of Bengal, are surveyed with an equal frequency. It may be interesting to note that there are no less than fourteen bars in the navigational channels between Calcutta and the open sea.

The river has two distinct channel regimes, which are seasonal : (a) *Freshets* : when the ebb current bolstered by the fresh-water discharge due to the monsoon rains, etc. has preponderance over the flood currents. During this season, from June to October, the channels are in the alignments with the axis of the ebb current; and (b) *Dry season* : when the discharge of the river becomes negligible and the flood current helped by the strong

landward winds gains strength. The dry season is from November to May, of which the last three months see the strongest flood currents. This change in the predominating current causes channels to shift laterally and take up alignments dictated by the influence of the flood currents.

To record the state of the river at these two periods, "bank to bank" surveys are carried out biannually in June and December from about 10 miles upstream from Calcutta to Diamond Harbour which is 40 miles downstream.

Below Diamond Harbour, however, the estuary fans out and the waters are too exposed for surveying except in calm weather which is available only in winter. Thus this area is not surveyed biannually but only once a year, between November and February.

Adequate permanent horizontal control exists between Diamond Harbour and the sea at Saugor for the annual survey to be carried out without any special effort in that direction. However, from Saugor the survey is carried out about 25 miles into the Bay of Bengal, in order to chart regularly the seaward approaches. So far no electronic control for the survey of this large offshore area is available. Therefore the control required for surveying by visual means is extended by means of "floating triangulation" The distance between two triangulation stations on the two banks of the river mouth has been accurately calculated. This is used as the baseline, and floating buoys or markers are laid to form suitable figures for the triangulation scheme. All the buoys are laid with a very heavy mooring and with the shortest possible scope of riding chain.

When a certain area is adequately covered with such buoys, sextant angles are observed from and to all of them and the triangles are closed. After the necessary work the positions of all the buoys are plotted and are used to carry out the survey of that limited area. When the area which is adequately controlled by the first set of buoys is surveyed, some of them are removed and relaid further seaward to give good figures continuing from the last line of buoys of the first set. Again angles are observed, positions are computed, plotted and used to survey the next area. This process is repeated to extend the survey. To check the work, the triangulation and survey first proceed down the westward channel, and upon reaching its seaward limit the survey is taken across to the eastern channel and brought up landwards. Finally when again in sight of land, the work is checked with the original base and the survey is adjusted as required. It is not within the scope of this note to further elaborate on this technique of surveying offshore areas, but suffice it to say that short of adequate electronic control it has proved to be sufficiently accurate and suitable for the job.

Using the same technique and also some dead reckoning below the outward limit of the usefulness of the former, the survey of a much larger area including the sandheads of the river Hooghly is carried out every 10 years by the Survey. It takes from five to six seasons to complete and it is carried out on a scale of 2 inches to a nautical mile, but is finally printed after reduction on a scale of $\frac{1}{2}$ inch to a nautical mile. This sandheads survey is incorporated in the Admiralty charts as well as the nautical charts of all nations of this area.

Officers are also required to carry out special daily surveys to assist in the extensive dredging carried out in the river and port. Similarly the mapping and supervision of the foreshore areas to guard against adverse effects on the river regime due to unwise riverside constructions, tide and current testing, maintenance of river stations, visual tide gauges and tide recorders, semaphores, etc., also fall within the purview of the Survey Service.

In recent years major river improvement schemes have been undertaken by the port authorities. The responsibility of the diverse work in this connection — on the hydraulic models as well as the site of the constructions — has naturally devolved upon the Survey.

Officer training

The Service is necessarily officered by men with a marine background, the usual source of recruitment being the Government of India's training ship *Dufferin* or from ex-cadets of this training ship with some sea experience.

Upon joining officers are trained for five years while they also assist in surveying operations. Officers who have passed all the three technical examinations are considered fully qualified hydrographic surveyors.

The various survey vessels and stations are officered as well as commanded by the surveyors themselves, who are thus required to pass examinations in such additional subjects as navigation, seamanship, etc. Also before an officer can aspire to the command of a survey vessel he is required to possess a certificate which empowers him to pilot any Port Commissioners' ship on the river Hooghly.

Equipment

In order to cope with all the surveying commitments a rather large survey fleet has to be operated. It includes three major survey ships : the 465-ton 165-foot *Pathfinder*, the 125-foot *Guide* and the 105-foot *Waterwitch*. In addition a relieving ship and about ten survey launches ranging from 40 to 60 feet, plus two shore stations, complete the rest of the units. One special arrangement is necessary for the survey of the " higher " reaches of the river, i.e. upstream of Bansbaria to the confluence of the Bhagirathi and Jalengi rivers. This consists of a houseboat, the *Blue Wing*, and a surveying launch-cum-tug. The houseboat is " dumb " craft and has aboard officer and crew accommodations as well as storage room for supplies. This is towed by the launch from one locality to another and the surveying itself is done in the launch, after anchoring the houseboat. This rather unusual system is followed owing to the extreme shallowness of the bars in the higher reaches of the river. The survey party therefore cannot return to Calcutta at any time as a few of the bars can only be crossed at high water in perigee spring tides, thus necessitating extended stays on the craft. As a vessel which is at the same time large enough to accommodate officers and men for long periods with supplies,

and shallow enough to be useful in this area, as well as maneuverable and fast enough to be utilized in surveying, is not available, this combination of houseboat and tug is used with advantage.

Position fixing is done by visual means—horizontal angles being taken by quintants. For soundings, lead lines are still used. This is not due to any lack of progressiveness but because a sufficiently sensitive and suitable echo sounder has not so far been readily available. The river being tidal with a mean range of about 14 feet, and the silt charge of the water varying, echo sounders are apt to be erratic as the sound wave travels through the widely dissimilar strata and varying densities prevailing in the daily tidal cycle. The accuracies called for over bars is to the nearest three inches, because seagoing vessels navigate with extraordinarily small clearances. Some echo sounders are in use for deep-water areas and new, more sensitive ones are on order. However, very fast and accurate leadsmen are available who practise this specialized trade from generation to generation.

The drawbacks of the present techniques for surveying the offshore areas, already outlined, have long been realized. However, the expense of installing elaborate electronic systems merely for the purpose of Calcutta port alone was not considered justifiable until recently. It is now contemplated that initially the Decca Navigator chain which is likely to be installed in the area should be used.

The port of Calcutta is one of the major ports of the world and the largest in India. In its smooth running the Hooghly River Survey Service continues to play its historic and vital part. The Survey is much older than the Hydrographic Office of the Indian Navy. It is also somewhat unique as a service of one port devoted solely to and run by that port. Over the years ex-members of the Survey have been occupying important positions in different ports, inland waterways, hydraulic laboratories, etc., not only in India but in the United Kingdom, Australia, Burma, Africa and some middle-eastern countries.

There is in India today a great dearth of experienced hydrographic surveyors; and in planning the vast expansion of her maritime trade and inland navigation water routes, the country need look no farther than the Hooghly River Survey and may say with just pride that in it she has a nucleus of experienced hydrographers who will ably fulfill the country's needs in this sphere.