A BRIEF HISTORY OF TIDAL WORK IN INDIA

In order to complete information given in *Hydrographic Review*, Vol. VI, N° 1, pages 129 and 137 (A Study of the Tide Tables published by the Different Nations), the following has been extracted from publications of the Geodetic Branch Office, Survey of India, Dehra Dun :—

The earliest recorded tidal observations in India were those taken by James KYD at the Kidderpore Docks, Hooghly River, 1806-27, and continued at Sagar Island, 1828-29. The next appear to be those carried out by Col. DE HAVILAND at Madras in 1821. As a result of investigations in England by Sir J. LUBBOCK and suggestions by Dr. WHEWELL in 1833, the Asiatic Society was requested by the Governor-General to take up the question of tidal observations along the Indian coasts. These suggestions resulted in tidal observations being carried out at various places on the coasts of India by independent observers, and P. G. SINCLAIR published a table of times of high-water at places between Calcutta and Point Palmyras. The results of the Madras observations were also published. In 1837 tidal observations were made by Lt. H. SIDDONS at Chittagong, and a review of tidal observations in the Indian Archipelago was published in 1839. Also the registers of tides at Singapore and Prince Edward Island were published in 1834-35 and 1840-41 respectively. In 1869 special tidal observations were carried out in the Hooghly and Kidderpore dockyard, and annual tide-tables were produced by the Master Attendant at Calcutta. These tables, when compared by Mr. PARKES against actuals, were found so erroneous as to be useless.

On the west coast the first tide-tables produced were those of Benjamin NORTON at Bombay in 1832. At Colaba a contrivance was devised by Captain Daniel Ross for registering tides and put into operation by his successor, Dr. BUIST, in July 1842. Captain Ross also constructed a set of tide-tables for Bombay from 1835-40. The above observations were followed by more numerous observations conducted by the Survey, Irrigation, and Marine Departments at various places along the coast. Among these may be mentioned those of Lt. J. F. TENNENT, R.E., who utilised a self-registering tide gauge for the first time at Karachi in 1855, with a view to obtaining a datum for triangulation ; and those of Commander A. D. TAYLOR, who rendered great assistance in the tidal observations at Madras, Beypore, Pamban Pass, Cochin, Karwar and other places on the Madras coast.

In 1857 visual observations were begun at Karachi by Mr. W. PARKES, M.I.C.E., and continued by Mr. PRICE, M.I.C.E., till 1868, when a small self-registering instrument was installed. The observations were then continued till 1880.

Mr. PARKES prepared tide-tables for Bombay from the Colaba observations since 1846, as well as for Karachi from the observations above mentioned.

Major B. R. BRANFILL, R.E., of the Survey of India, employed a self-registering tide-gauge at Tuticorin from May 1871 to June 1872, and these observations were reduced by the method of Harmonic Analysis.

A small self-registering tide-gauge was set up at Aden in 1876, but the observations were not very carefully taken and were not very valuable. Besides these, the Marine and Irrigation Departments used self-registering tide-gauges at various places on the Hooghly in connection with their respective works of sounding and canal-making.

The next observations of importance were carried out in the Gulf of Cutch with a view to establish an accurate Mean Sea Level, with respect to which the encroachment of sea on land, or land on sea, as evidenced near Cambay and Kathiawar, and the alternate sinking or rising of land, as evidenced in the Rann of Cutch, could be carefully ascertained. These observations were carried out with self-registering tide-gauges by Lieut. A. W. BAIRD, R.E., commencing in November 1872 at the stations Hansthal, Navanar and Okha Point. These observations were harmonically analysed in England by Captain BAIRD and Mr. E. ROBERTS of the *Nautical Almanac Office*.

When the work was completed Captain BAIRD returned to India, stopping at Aden, under instructions from the India Office, to examine and to set right a small self-registering tide-gauge which was working there. He found the previous records useless and advised that the instrument itself should be discarded and a new set of instruments submitted.

On the 4th July 1877, the Government of India passed a resolution entrusting the general superintendence and control of systematic tidal observations to the Survey of India, Captain BAIRD being the first officer detailed to carry out these duties.

It was thus decided that the ports were to pay for the instruments and also for the cost of conducting the operations; but in the case of ports too poor to pay for the instruments, the use of those belonging to the Survey Department was granted on loan. The places at which gauges should be set up was decided by Captain BAIRD, in consultation with the Surveyor General and the Superintendent of Marine Survey. It was further decided that some of the ports should be permanent stations, that is, that the registration shoud be carried on continuously for at least nineteen years, while four or five years' observations would be sufficient at all minor ports for all practical purposes. The arrangements for procuring and setting up the instruments were made by Captain BAIRD with the various local Governments, and by October 1878 gauges were set up at Bombay, Karwar, Vizagapatam, Pamban near Cape Comorin, and Beypore near Calcutta; the establishment of a gauge at Madras was kept back by delay.

In 1877 also a tide-predicting machine was constructed by Messrs. LÉGÉ & Co, for the Indian Government, under the supervision of Mr. E. ROBERTS, on principles suggested by Lord KELVIN.

But owing to the delicacy of its mechanism it was deemed advisable not to expose it to the risks of transit to India, and this machine was therefore erected at the observatory of the Indian Stores Department, Lambeth, London, where the predictions were run off on the machine by Mr. ROBERTS. The tide-tables were printed in England.

The data for these predictions were computed and forwarded regularly from the Office of the Tidal and Levelling Party at Poona from 1878. Later on, in 1904-05, the machine was transferred to the National Physical Laboratory, Teddington, where the predictions were continued in the same manner by members of their staff till 1921, when the machine was brought out to India, and set up in the Office of the Director, Geodetic Branch, Survey of India, Dehra Dun.

The last tables published in England were those for 1922, and thereafter the entire prediction, printing and publication of the tide-tables has been carried out in India.

The development of the series of systematic tide-tables for Indian ports has been as follows :—

1880. — Tide-tables for 2 ports. Bombay and Karachi only.
1881. — Tide-tables for 8 ports. Above with Aden, Okha Point, Karwar, Beypore, Pamban and Vizagapatam.
1882. — Tide-tables for 15 ports. Above with Madras, Diamond Harbour, Fort Gloster, Kidderpore, Rangoon, Moulmein and Port Blair.
1883. — Tide-tables for 18 ports. Above omitting Fort Gloster, and with Dublat, False Point, Elephant Point and Amherst.
1884. — Tide-tables for 20 ports. Above with Kathiawadar (Port Albert Victor) and Negapatam.
1886. — Tide-tables for 23 ports. Above with Mormugao, Galle and Colombo.
1888. — Tide-tables for 27 ports. Above with Bhavnagar, Cochin, Chittagong and Cocanada.
1889. — Tide-tables for 28 ports. Above with Akyab.
1890. — Tide-tables for 29 ports. Above with Tuticorin.
1891. — Tide-tables for 31 ports. Above with Mergui and Prince's Dock (Bombay).
1893. — Tide-tables for 33 ports. Above with Minicoy and Trincomalee.
1895. — Tide-tables for 35 ports. Above with Maskat & Bushire.
1897. — Tide-tables for 37 ports. Above with Porbandar and Diamond Island.
(The tide-tables were published as a combined Volume : Part I, Western Ports, Aden to Pamban Pass; Part II, Eastern Ports, Negapatam to Port Blair. Separate Pamphlets for single ports, and combined Pamphlets for Hooghly, Rangoon and Moulmein Rivers, Ceylon and Gulf of Cutch ports were also published).
1899. — Tide-tables for 38 ports. Above with Suez.
1900. — Tide-tables for 39 ports. Above with Perim.
1904. — Tide-tables for 40 ports. Above with Bassein (Burma).
1917. — Tide-tables for 41 ports. Above 40 in combined Volume, and Basrah as a separate Pamphlet.
1923. — Tide-tables for 40 ports. Above omitting Prince's Dock (Bombay), and with Basrah included.
(The combined Volume was discontinued and Part I, including 19 Western ports, Suez to Pamban Pass, and Part II, including 21 Eastern and Burma ports, Colombo to Port Blair, were published separately. Separate Pamphlets for single ports and combined Pamphlets for Hooghly, Rangoon and Moulmein Rivers, Ceylon and Golf of Cutch ports

were continued. Indian, Burma and Iraq Standard Times were introduced at all ports which keep these times).

1925. — Tide-tables for 40 ports. As above in separate and combined Pamphlets.

(Part I and II were discontinued and a Major Series Volume for 19 of the more important ports was published).

1926. — Tide-tables for 37 ports. As above, but ommitting Perim, Maskat and Minicoy.

1931. — Tide-tables published in a single Volume as *Tide-tables for the Indian Ocean*, including the full 40 Indian Standard Ports as in 1925. 28 supplementary Standard Ports are also added covering the whole of the Indian Ocean and Far East; also a few Mediterranean and English ports. The information for the supplementary ports is supplied in advance by the Hydrographer to the Admiralty and by the U. S., French and Japanese Hydrographic Departments and the Liverpool Tidal Institute. Non-harmonic Constants and Tidal Differences, and also Harmonic Constants for a large number of ports on the main Eastern trade route, have been extracted and published with permission from the Admiralty Tide-Tables. Separate Pamphlets have been published only for the Hooghly River, the Rangoon River, and Bombay.