

by scaling the distance of G from the Oh. line. The datum for heights is the Admiralty one, and is 4.5 ft. below mean sea-level for Auckland. The height is scaled from the diagram. The following template curves are shown on the diagram in red :—

Tide.	Template, Value of k .	Tide.	Template, Value of k .
153 L.	- 1 ..	154 H.	+ 7
154 L.	+ 1 ..	155 H.	+ 7
155 L.	+ 1 ..	156 H.	+ 7

In practical work an excellent check is afforded by noting the value of k in the templates used. Any sudden variation in k is at once investigated and traced to its source. In this way errors are easily detected.

Check of Predictions.

To check the Wellington predictions, the tide-record for 1911, March 25 to 31, has plotted on it in red the results obtained from a diagram similar to Fig. 2. It will be noted how well the times of high and low water agree with actuality, while the heights also agree very fairly.

As so much plotting from co-ordinates is required a co-ordinatograph is being obtained, and when that instrument is available a number of improvements will be effected. Thus the K curves will be associated together and the combined curve drawn, and similarly in other cases, and, instead of the M_2 curve only being used on the diagram, all the M curves will be used. But for the present it has been found simpler to keep the curves separate.

DATUM LEVELS.

In the report on Datum Levels drawn up by Sir G. H. Darwin (British Association Report for 1886, pp. 40-58, reprinted in Scientific Papers Vol. 1, p. 97, by Sir G. H. Darwin), a description of a datum to be called the "Indian spring low-water mark," is given. And in the Tide Tables for 1911, published by order of the Lords Commissioners of the Admiralty, p. vi, this datum has been adopted for places where there is a large diurnal inequality. The datum suggested is to be below mean sea-level a distance equal to the sum of the mean semi-ranges of the tides M_2 , S_2 , K_1 , and O. Thus for Wellington—

Tide.	Semi-range. Ft.
M_2	1.594
S_2	0.112
K_1	0.078
O	0.110

the suggested datum is 1.894 ft. below mean sea-level. But this takes no account of the relatively large N tide ($H = 0.431$ ft.); nor of L ($H = 0.093$ ft.); ν ($H = 0.125$ ft.); μ ($H = 0.082$ ft.); which are all larger than the K_1 tide ($H = 0.078$ ft.). Perhaps it might be well to define the datum as being below mean sea-level a distance equal to the sum of the mean semi-ranges of *all* the short-period tides. Or, for practical purposes, it might be sufficient to include only those short-period tides whose semi-ranges are greater than one-tenth of the M_2 semi-range.

LIST OF AUTOMATIC TIDE-GAUGES IN NEW ZEALAND.

Tide-gauges from which continuous records are obtained are established at Auckland, Wellington, Lyttelton, Port Chalmers, Dunedin, Bluff, Westport, and Greymouth; while at Napier and Wanganui the records are irregular, owing to the exposed positions of the gauges.

LEVEL BENCH-MARKS.

A start has been made with a precise levelling survey, and over twenty bench-marks established between the Wellington Harbour Board tide-gauge on Jervois Quay, Wellington, and the Public Works Department tide-gauge at Seatoun. (See Fig. 4 for the situation of the bench-marks and their heights, which are in terms of the Wellington City datum.) The mean sea-level as determined from hourly ordinates of the Wellington tide-gauge for 1909 was 37.931 ft. in terms of the same datum.

Mr. Frank C. Hay, Assoc.M.Inst.C.E., Assistant Engineer of the Public Works Department, carried out the levelling with a high degree of precision.

OTHER METHODS OF HARMONIC ANALYSIS OF TIDAL OBSERVATIONS.

As opportunity offers other methods of harmonic analysis are investigated. Among them Dr. Børgen's* method has been tried, and a complete example of the analysis of the K_2 tide is given.

The observations submitted to analysis are those given in the Great Trigonometrical Survey of India, Vol. xvi, and are hourly observations for Bombay for the year 1884. The hourly observations were first summed continuously throughout the year, and were cut down to one decimal of a foot and written out in a list of sums as under :—

Day.	h. 0	h. 1	h. 2	h. 22	h. 23
0	155	130	91	142	161
1	322	284	213	260	308
2	488	454	365	349	429
367	43697	43809	41081	40413	42754
368	43834	43194	41160	40544	42896

* Ueber eine neue Methode, die harmonischen Konstanten der Gezeiten abzuleiten, Von Admiralitätsrath Prof. Dr. Børgen, Annalen der Hydrographie und Maritimen Meteorologie, Juni, Juli, August, 1894.