

It is desirable that the temperature of the sea should be observed at a number of stations, so that data can be obtained to make charts of the Dominion which will show the variations of the sea-temperatures for the different seasons of the year, and from which predictions will be obtainable that will have an important influence in assisting to forecast the climatic conditions. These sea-temperatures are also invaluable to the various acclimatization societies which are interested in the introduction of edible species of fish for the improvement of the fishing industry.

Since tide-tables are now prepared for the ports of Auckland, Bluff, Dunedin, Lyttelton, Wellington, and Westport, the tidal work has become an important function of the Department. The inclusion of four extra ports for which predictions of the times and heights of high and low water for the year 1921 will be published, without an increase to the computing staff, was accomplished by making use of the tide-predicting machine at the National Physical Laboratory, Teddington, England, to run off the tide curve for the year from the data supplied for setting the machine, instead of computing the tide-tables in this office as previously, when the predictions for only two ports could be done. These six ports are now available as standard ports, and give indirectly, by means of an auxiliary table which can be prepared, the information as to the time and height of high and low water of all the intermediate ports within the Dominion where tidal observations have been taken.

A study of the tides of the South Pacific Ocean promises to throw a great deal of light on the tidal theory, in which, notwithstanding the enormous increase in the power of the mathematical resources at our disposal, but little advance has been made, and the problem has remained in very much the same condition as it was left by Laplace over a hundred years ago. The great extent of the South Pacific and Antarctic Oceans furnishes conditions more nearly resembling the ideal tides, upon a sphere covered completely by water of uniform depth, and which can be foretold from astronomical data alone, than are met with on any of the other oceans. But even in the South Pacific Ocean the continents, islands, and the great differences in its depth, modify the theoretical conclusions as regards both time and magnitude, so that before the height and time of future tides can be computed it is necessary to resort to observation to determine the characteristic elements of any place. Nevertheless some striking results have been disclosed—as, for instance, at Papeete, on the Island of Tahiti, the lunar tide appears to be totally eliminated, and a tide of about 10 in. in height occurs about one hour after noon daily, there being a night tide about the same time after midnight. Again, the principal solar tide vanishes in the vicinity of Lyttelton, so that the luni-tidal intervals at that port are sensibly constant. Further, when high water of this component, considered separately, occurs at Wellington it is low water at the same time at Lyttelton. These peculiarities of the tides at a port have to be carefully considered when such port is used as a standard of reference for other ports by means of the tidal differences, since it is obvious that only such stations as have similar characteristic elements should be referred to each other.

The tidal observations are made mainly by the self-registering tide-gauges, in which a curve is traced which shows the height of the water at any time above an arbitrary datum. This curve is decomposed by a process devised by Lord Kelvin, and known as “harmonic analysis,” into its harmonic elements.

All the important theoretical components due to the varying motions of the sun and moon in their elliptical orbits inclined to the plane of the Equator were carefully determined and published by the British Association for the Advancement of Science. In the reports for 1872 and 1876 are given the values of the components as determined by Lord Kelvin. Later, in 1883, they were extended and improved by Sir George H. Darwin, who introduced a notation, partly adopted from the Tidal Survey of India, by which each harmonic component is known by a symbol, and this system is adopted for convenience the world over by all who have to do with tidal computations.

Sir George Darwin also prepared computation forms and an apparatus for facilitating the reduction of tidal observations. The manufacture of this apparatus, or abacus, has been discontinued, as it was never entirely satisfactory. A substitute will be devised during the coming year for use in this office by the computing division, as the abacus procured when the tidal work was initiated about ten years ago is very much worn.

When the amplitudes and epochs of the various components entering into the tides have been determined for any port the tide can be computed in advance by a general principle of dynamical theory that the tidal elevation at any place for a given time is equal to the sum of a series of simple harmonic functions of the time whose periods are known—that is, by the summation of the formula—

$$H = A_0 + A_1 \cos (n_1 t + a_1) + A_2 \cos (n_2 t + a_2) + A_3 \cos (n_3 t + a_3) + \dots \dots \dots (1)$$

in which H is the height sought; A_0 is a constant expressing the height of mean sea-level above a datum-line, which usually represents the plane to which the soundings given on the charts are referred (this datum should have a scientific definition, and should consist of the sum of the amplitudes of a certain number of the principal tides); $A_1, A_2, A_3 \dots$ are the amplitudes of the successive components, expressed in feet; and $n_1, n_2, n_3 \dots$ the hourly speeds of the same components in degrees of arc; t is the time in mean solar hours from the beginning of the prediction to the instant for which the height is required; a_1 is the interval from the beginning of the prediction back to the preceding high water of the component A_1 , expressed in degrees; a_2, a_3 being like intervals for the components A_2, A_3 .

The computation of the tides by the above formula involves an enormous amount of labour of a kind particularly tedious and subject to error. The performance of the work mechanically, therefore,