

TIDAL OBSERVATIONS

(Extract from an article entitled: *Les Réseaux modernes de Nivellements* by M. Jean VIGNAL, Inspecteur général des Ponts et Chaussées : "Annuaire du Bureau des Longitudes" for 1938).

(Translated from the French).

The traverses of the General Land Survey terminate at the sea at various points along the coast. In many of them there have been installed continuously-operating *tide gauges*, whose object is to determine the *mean sea level*. The local authorities under the administration of the Department of *Ponts et Chaussées* are charged with the supervision, and assume the responsibility for the daily upkeep of the apparatus. The *Service du Nivellement* checks the operation and performs the calculations.

The most important of these apparatuses is the *automatic totalizing tide gauge* at Marseilles, on which is based the datum for the General Land Survey of France. Highly perfected and equipped with a float, it traces the curve representing the height of the tide at every instant. At the same time, by means of several simple readings, and thanks to a delicate arrangement of integrating rollers, it indicates the average level over any desired interval of time. It has been in continuous operation without appreciable interruption since its installation at Marseilles in 1885. Previous to this, only two other apparatuses of this type existed in Europe, one at Cadix and the other on the island of Helgoland.

Aside from this, the other tidal apparatuses controlled by the *Service du Nivellement* are all of the medimarimetric type, instruments invented by Mr. Ch. LALLEMAND, as simple as they are ingenious, and for which the cost of upkeep and supervision is incomparably less than for the tide gauges.

Their principle, which is entirely different, is as follows:- in a vertical or inclined tube which is in free communication with the sea through a constantly immersed porous partition, the tides are considerably smoothed out (and, besides, displaced in phase in a rather complex, and on the other hand, important, manner); but the mean level about which the tides oscillate is not changed. The medimarimeter therefore does not indicate the height of the tide at any instant as does the tide gauge, but the measurement of the daily rise of the water in the tube does suffice for obtaining, by simple calculations, the *mean level* over a sufficiently long interval of time (a duration equal at least to several months).

The *Nivellement général* has at present available the tide gauge at Marseilles and twenty-two medimarimeters distributed along the coast of the country. Further, at the request of the *Service Géographique* of the Army, or the geographical services of the territories interested, it checks the operation and performs the calculations for the fourteen medimarimeters installed along the sea-coast of the various outlying possessions.

RESULTS OF THE OBSERVATIONS OF THE FRENCH MEDIMARIMETERS.

The continuous observations effected along the French coasts have permitted Mr. LALLEMAND to demonstrate that, contrary to the usually accepted opinion, the mean level along the coast remains the same, with the exception of small irregularities which do not exceed at the most a few decimetres and which are probably due to the influence of the prevailing winds and currents.

The systematic study of the data amassed during many years with the medimarimetric measurements have led to certain rather interesting scientific conclusions. Thus, in 1927 Mr. E. PREVOT discovered that in addition to the known tides due to the diurnal monthly and yearly movements of the moon and sun, there is a series of seven other regular fluctuations influencing the level of the ocean. These newly discovered waves of a very long period, having an amplitude of several centimetres only, are associated with various periodic astronomical phenomena. The longest period revealed is 93 years and the total corresponding amplitude of oscillation is 3 centimetres.

Also the preceding research has already yielded certain useful practical results. It has been noted that the long period tides which have thus been discovered act simultaneously and with the same amplitude over the same region, even though it be rather extensive, such as for instance, from Marseilles to Brest. This verification permits the medimarimetric observations continued over only a few years to be employed to establish

the general mean level at any point, such as could only have been obtained otherwise from observations extending over long periods of time. It suffices to compare them with those obtained during the same reduced interval of time at some neighbouring port where the general mean level is known.

FOREIGN MEDIMARIMETRIC OBSERVATIONS.

In foreign countries, as in France, the General Land Survey Offices have been led to establish numerous tidal observation stations along the coasts in order to determine the mean sea level, which is everywhere adopted as the plane of reference for the triangulations. In general, the apparatuses employed for this purpose are the tide gauges, with very occasionally medimarimeters. The measurements thus obtained confirm the determinations made in France, principally in regard to the similarity in behaviour of the slow fluctuations exerted at points relatively widely separated. Certain novel results which have gradually been discovered present rather curious problems which have not as yet been solved.

Thus in the northern hemisphere where the stations are more numerous, the observations made in North America, France, England and Norway, show a progressive rise in the mean sea level in the direction of the pole. However, this phenomenon does not appear to exist in Japan. Further, in North America and Japan, the mean sea level appears to be higher on the west coast than on the east, doubtless under the influence of the prevailing winds. In the United States and Canada, from south to north, along both the east and west coasts over distances slightly less than 3000 kilometres as the crow flies, the rise in mean sea level amounts to some thirty centimetres. At the same latitude the waters of the Pacific are higher by half a metre than the waters of the Atlantic — about 4000 kilometres distant. Such differences greatly exceed the errors which might be imputed to inaccuracies in levelling.

