SCIENCE ASKS WHETHER CONTINENT IS SINKING

Geologists Set Tide Gauges to Learn If America Is Gradually Lowering Its Actual Level—Shrinkage In a Century Measures One Foot

By DIANA RICE.

WILL the Atlantic and Pacific oceans some day meet over the submerged face of North America? To discover whether this continent is really sinking at the rate of one or two feet a century or whether evidences of shrinkage are due to so-called "warpings" of the mean sea-level, the Committee on Shoreline Investigations of the Division of Geology and Geography, National Research Council, has recently undertaken a series of important studies.

According to Dr. Isaiah Bowman, a member of this committee, the present object is to install tide gauges at critical points, to find out where is that apparently simple but really elusive thing known as sea-level. The work of the committee receives public attention simultaneously with the publication of a new book, entitled "Our Mobile Earth," by Professor R. A. Daly of Harvard University.

It looks as if the eternal hills were having an uncertain time of it, if the scientist needs to put his gauge upon the shore in order to find out what is in store for an earth whose stability has been for contemporary purposes taken for granted.

To surveys ranging over the whole earth and through the hundreds of millions of years of geological time, of course, the earth looks unsteady. Its ups and downs have been frequent, as the geologist looks at things. The layman is most concerned with the immediate state of affairs.

Sea Not Level in Bays.

As a first step it is necessary to know what sea-level is. If we are to take it as a plane of reference for the land, we must locate it very precisely, because the change in the level of the land is very slow in spite of that "mobility" of which the geologist speaks. It is so slow that it may amount to but a few inches or a foot in a century, or there may be no change at all.

If one walks along the shore and sees raised beaches, or if soundings show submerged shelves or stream courses, one concludes that the land and sea have changed their relative positions. A hundred years ago such a conclusion would have been reached without hesitation.

When the residents of Lynn, Mass., first found stumps and tree trunks exposed at low tide, the stumps with all their roots in position just as they were when the trees were growing, they naturally concluded that the land had sunk. At many other places along the Atlantic shore the same things have been found, and in addition peat deposits that were obviously made in a position relatively higher with respect to sea-level. In fact, down to very recent years such tree stumps and peat deposits have been taken as indisputable evidence of submersion.

Through the work principally of Professor D. W. Johnson of Columbia University a wholly new attack has been made upon the problem. Professor Johnson has found that the surface of the sea is not level in many of our bays, but inclined.

Changes Under Suspicion.

If the water has to come through a narrow inlet into a big bay, the tidal flow is retarded so much that before the bay has completely filled up the tide will have turned. This means that the water surface was never level. Another way of putting it is to say that the inner shore line of the bay is not as high as is the outer shore formed on the beach or headlands. If we reverse the process and suppose that the sea beat against the coast and formed a cliff and beach and was then nearly shut off from the site by the growth of beaches in loop fashion between outer and more distant headlands, the sea-level would appear to have gone down.

We could then stand on the former beach and see the new shoreline some distance away from and below us. Yet in fact the sea as measured on the outer beach would stand at exactly the level of the old beach upon which we are standing.

So many cases of this kind are known in a general way that every supposed case of recent elevation or depression is under suspicion. Yet it is curious that this scientific fact and the important property interests that are affected by every slight change of the coastline should not have prompted much earlier study. Delay has been caused in part by the fact that a conclusive answer to some of the questions involved cannot be made in one generation.

Great Lakes May Be Tipping.

We have to begin a task that posterity completes. If American scientists had made a precise study of the levels of Lake Michigan and Lake Erie a hundred years ago and established accurate bench marks from which we could now measure lake levels, we could tell how fast the Great Lakes region is being tilted and how soon Lake Michigan will rise to the level of its old outlet of 25,000 years ago, when ice dammed it on the north and made it seek an outlet through the Mississippi.

Ten States are now disputing the question of the diversion of the Great Lakes waters, and Canada, also an interested party, asks the United States Government questions about Chicago's ethics in diverting more and more water through the canal the Sanitary District has constructed. The answer is now being framed by evidence given before Charles E. Hughes, appointed by the United States Supreme Court to take such evidence. When the Supreme Court renders a decision it will have taken account of the old levels of Lake Michigan and of the present level.

It is certain that decision would be easier and that there would be much less litigation in the future could we know how fast this "mobile earth" is tilting now and what part that terrestrial action plays in the shoaling water of which Canada and some of our boundary States complain. For if the water is rising at Chicago it must be falling on the northern shores of the Great Lakes; and a fall of but a few inches matters enormously to the grain and ore ships that must pass through artificial channels whose bottoms are only a few inches below the ships' keels.

Measurements Around New York.

In regard to the Atlantic Coast. The first tide gauges to measure the form of sea-level in partly enclosed bays have been installed at the north and south ends of Jamaica Bay Causeway and at the Yacht Basin in Brooklyn. Further instrumentation will be made at other points along the Atlantic Coast. This is the first study of its kind that has ever been made, and according to the committee it will be some years before any conclusions are arrived at as to the rate at which our land is sinking—if investigations prove that it is sinking.

A visit to the small red house on the Yacht Basin Wharf shows the tide gauge busily at work. An ordinary lead pencil controlled by a brass ring travels night and day across white paper revolving over the gauge's brass rolls. This pencil, tracing its tide curve along the moving paper, trips at each hour, leaving a short black mark on the sheet.

The pencil is connected by a brass wire (passing over two spools) with a bobber floating on the water below the wharf platform. The rising and sinking of this bobber produces the curve that zigzags along the rolling paper. A time clock and motor clock regulate the two-foot machine whose job is to get elevation of bench mark above mean sea-level. These bench marks, or small brass discs, are set in piers or buildings in the vicinity of the gauge—three to ten around each tide gauge, the number being determined by permanence of the station. If one is washed away or destroyed, another will carry on.

Tide gauge stations are usually visited each day by an inspector, who stamps the paper chart, noting the date, the hour of his visit and water-level registered on tide staff. This staff, resembling a huge thermometer, stands upright in water below the tide gauge house. The staff is painted white and the black figures that mark the feet stand out as sharply as hieroglyphics on a totem pole. As the water washes away these markings in a short time, the tide staff is usually taken down between inspector's visits, its red support being left to indicate the position.

By a surveyor's level the height of the bench mark above zero on the tide staff is obtained. Then by numerous comparative readings the relation of tide curve to tide staff is arrived at. By averaging tide heights for each hour of the day over a considerable period the relation of the mean (or average) sea-level to tide staff and, consequently, to bench mark is determined.

From a short series of observations the results are corrected by a comparison with simultaneous observations at a primary tide station, where observations have been continued over a great many years. This is but one small mechanical detail in the intricate job of determining shoreline changes.

It is pointed out by a member of the committee that what land has done in the past is no indication of what it may do in the future. Evidence appearing to show whether it is rising or has risen, whether it is sinking or has sunk, is of little assistance in determining what it will do in years to come. Signs do not always mean what they seem to mean in water levels, geologists assert. A very careful analysis indeed must be made of all available data before one can be sure.

Disagreement among geologists as to what features are normally characteristic of a stable coast, and what features are peculiar to coasts that are rising or subsiding, have so far prevented any final conclusions as regards the Atlantic Coast of North America within historic time. The new study just getting under way will, it is hoped, fill many gaps in the data already gathered.

The members of the Committee on Shoreline Investigations of the National Research Council are Professor Douglas W. Johnson of the Department of Geology at Columbia University, Commander R. S. Patton of the United States Coast and Geodetic Survey and Dr. Isaiah Bowman of the American Geographic Society. The committee's recently issued report points out that through researches on the supposed progressive subsidence of the Atlantic Coast it has been discovered that many of the apparent changes of level were in fact caused by local fluctuations of high tide surface, due to change in form of the shoreline.

Low-tide levels are known to vary with variations in the form of the shore. But a given shore change does not necessarily produce equal or equivalent changes in the high and low tide levels. Thus the question arises as to whether mean sea-level itself may not change with changes in form of shore. The importance of determining, the report continues, whether mean sea-level is locally an irregular surface and whether it may change to an appreciable degree and with rapidity consequent upon changes in shore form, is obviously very great.

Many of the supposed proofs of a recent and continued subsidence of the Atlantic Coast of North America may be interpreted as due to local fluctuations of high-tide level, amounting in some cases to several feet. Proof of subsidence, if it exists at all, must be based on a comparison of mean sea-level made at different periods. However, the necessary evidence can be regarded as reliable only when it shall have been demonstrated that changes in shore form do not affect the position of mean sea-level.

Local Fluctuation.

Altitudes of official benchmarks throughout the country are calculated on the basis of tide gauge records obtained in localities many of which are apparently favorable to local fluctuation of the high and low tide surfaces, and hence possibly of the mean sea-level surface. This is due to the fact that tide gauges are most conveniently located in bays, harbors, or other protected parts along the coast, the very places most subject to fluctuations of tidal levels. If neither accurate tide gauge observations extending over long periods of years nor the most precise leveling from gauge to permanent benchmarks gives results of permanent value because a gauge is unfortunately located, this fact, the report points out, should be known.

A tentative promise of assistance from the Canadian authorities has been received by the committee. The region of St. John, N. B., offers, it is said, favorable conditions for comparing the mean level of the sea with that of a large embayment (Kennebecasis Lake), connecting with the ocean by an extremely narrow inlet and receiving great quantities of fresh water. Three or four tide gauges will also be operated in the vicinity of Eastport, Me., where conditions contribute interesting points for study.

The report remarks that if the tidal studies projected for the New York, Eastport and St. John regions can be carried to completion, as now planned, they should make possible definite conclusions as to the nature and extent, if any, of local variations in mean sea-level due to variations in the form of the shore. In other words, if America is sinking, the tide gauge should show it.

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