This article was downloaded by: [FU Berlin]

On: 14 October 2014, At: 05:16

Publisher: Routledge

Informa Ltd Registered in England and Wales Registered Number: 1072954

Registered office: Mortimer House, 37-41 Mortimer Street, London W1T 3JH, UK

Scottish Geographical Magazine

Publication details, including instructions for authors and subscription information:

<http://www.tandfonline.com/loi/rsgj19>

Relative proportion of land and water on the surface of the earth

J.T. Bealby

Published online: 30 Jan 2008.

To cite this article: J.T. Bealby (1886) Relative proportion of land and water on the surface of the earth, *Scottish Geographical Magazine*, 2:6, 358-362, DOI:

[10.1080/14702548608554490](https://doi.org/10.1080/14702548608554490)

To link to this article: <http://dx.doi.org/10.1080/14702548608554490>

PLEASE SCROLL DOWN FOR ARTICLE

Taylor & Francis makes every effort to ensure the accuracy of all the information (the "Content") contained in the publications on our platform. However, Taylor & Francis, our agents, and our licensors make no representations or warranties whatsoever as to the accuracy, completeness, or suitability for any purpose of the Content. Any opinions and views expressed in this publication are the opinions and views of the authors, and are not the views of or endorsed by Taylor & Francis. The accuracy of the Content should not be relied upon and should be independently verified with primary sources of information. Taylor and Francis shall not be liable for any losses, actions, claims, proceedings, demands, costs, expenses, damages, and other liabilities whatsoever or howsoever caused arising directly or indirectly in connection with, in relation to or arising out of the use of the Content.

This article may be used for research, teaching, and private study purposes. Any substantial or systematic reproduction, redistribution, reselling, loan, sub-licensing, systematic supply, or distribution in any form to anyone is expressly forbidden. Terms & Conditions of access and use can be found at <http://www.tandfonline.com/page/terms-and-conditions>

RELATIVE PROPORTION OF LAND AND WATER ON THE SURFACE OF THE EARTH.

From the German of Professor Dr. A. Penck,¹ by J. T. Bealby.

THIS problem has all along been beset with difficulties, mainly of two kinds. One will continue to face geographers so long as there remain any parts of the earth's surface unexplored, such as the Polar regions. The other class of difficulties will have less and less influence as time goes on. They have arisen out of preconceptions, such as that of Columbus and his contemporaries, who worked upon the assumption of the Jewish writer Ezra (bk. iv. chap. 6, v. 42), that six-sevenths of the surface of the earth are land, and only one-seventh water. And this view, that the area of water was far less than that of land, prevailed generally amongst the geographers and cosmographers of the sixteenth century; they proceeded on the supposition that the bulk of the regions then unexplored were land, and on the teleological basis that the Creator would naturally create more land than water, since the former is especially destined to be the dwelling-place of animate creatures. The current views as to the relative proportion of land to water veered nearer to the truth as time went on. Several geographers, chief among whom was Mercator, and after him Varenus, came to believe that the area of land was balanced by an equal area of water. Towards the close of the seventeenth century yet truer notions began to prevail. Sir Jonas Moore in 1681, Halley in 1693, and Dr. Long in 1740, demonstrated that the area of water exceeded that of land, the last estimating the oceans and seas to cover three times the extent of the continents and islands. As the surface of the globe became better known, through the voyages of Tasman and others, the possibility of land preponderating in area over water in the as yet unexplored parts of the earth gradually diminished. Leeuwenhoek, in 1722, and Struyk estimated the proportion of water to land as two to one. The first geographer to attempt a positive estimate, after the results of Cook's voyages were made known, was Joh. Elert Bode,² whose conclusions were these:—Total area of land, 2,059,675 square miles; area of water, 6,222,385 square miles; unknown surface, 1,000,000 square miles; grand total, 9,282,060. This computation, exclusive of the unknown portions of the globe, gives the proportion of land to water as 1:3. Since Bode wrote other estimates have been made by Rigaud³ (1:2·76), whose view received the support of Humboldt and Ritter; by Engelhardt⁴ (1:2·827); Dove⁵

¹ *Mitt. der k. k. Geogr. Ges. in Wien*, xxix. 1886.

² *Anleitung zur allgemeinen Kenntnis der Erdkugel*, 1786.

³ *On the Relative Quantities of Land and Water on the Surface of the Terraqueous Globe*, in *Trans. Camb. Phil. Soc.*, 1838, vol. vi. pp. 289-300.

⁴ *Der Flächenraum der einzelnen Staaten in Europa, und der übrigen Länder der Erde*, Berlin, 1853.

⁵ *Ueber die Verhältnisse des Festen und des Flüssigen auf der Erdoberfläche*, in *Zeitschr. f. Erdkunde* (N.S.), Berlin, 1862, vol. xii. pp. 111-118.

(1:2·76); Hermann Wagner¹ (1:2·765), who attempted an actual theoretical measurement of the land; and Krümmel² (1:2·75), who worked out the area of the water. But both Wagner and Krümmel have fallen into a similar mistake to that of the old geographers, in that they believe all the still unexplored parts of the earth to be covered with water. Around the North Pole, however, there is at least an area of 2,446,670 square miles, and around the South Pole an area of 6,369,000 square miles, which have not yet been explored. To class all these wide expanses—almost equalling in extent Australia and Europe put together—as water only, seems to be certainly unscientific. A more strictly scientific procedure would be to eliminate them from the computation. This decreases Krümmel's figures for the area of water (which he gives as 144,386,354 square miles) by 8,815,670 square miles, leaving 135,570,684 square miles as the area of water; and with this must be compared the area of land—53,517,373 square miles. The proportion yielded by these figures is 1:2·58; and, according as the unknown Polar regions should turn out to be land or water, the proportion will fall somewhere between 1:2·21 and 1:2·76.

But the result, 1:2·58, has only a relative, not an absolute value; all the coast-line measurements, which afford the only safe and satisfactory basis for a sound scientific conclusion, have not yet been completed. Europe is the only continent in which the coast surveys are finished. In Africa the north coast alone has been surveyed, while of the west and east coasts fragmentary portions are all that is known. The south and east coasts of Asia have been in parts pretty accurately measured, but the whole of the north coast can as yet be no more than approximately sketched. Although America is, on the whole, accurately known, there are several stretches of coast-line in South America which require more precise measurement; but the outline of the north coast is still very imperfectly known. In Australia there remain only comparatively few portions of the coast to be surveyed. Thus, out of a total length of coast-line of all continents, about two-thirds only have been sufficiently surveyed, viz., about 86,950 miles out of 124,200.

In addition to these reasons for distrusting the estimate 1:2·58, there are others arising out of the necessarily incomplete methods of measurement which are employed in surveying a coast-line. For instance, the exact position of a place on shore is determined, from the sea, to within only 1' of precise accuracy; hence the determination of the coast-line upon such data may deviate to the extent of 1·178 mile from the actual lay of the shore. In consequence of this and of the unmeasured sinuosities of coast-line occurring between any two actually fixed points, it is not too much to say that the outline of such stretches of shore may be incorrect to the extent of about six miles. Arguing upon these premises, it follows

¹ *Guthe's Lehrbuch der Geographie*, 1877, p. 28.

² *Morphologie der Meeresräume*, p. 101.

that a more precise and accurate survey of the coast-lines of the globe would affect the area of land to the extent of 231,600 square miles, or 0·5 per cent. of the total area of the land, and consequently alter the proportion of land to water to something between 1 : 2·57 and 1 : 2·60.

A further source of inaccuracy in the computation is observable in the uncertainty that obtains as to the exact dimensions of the globe itself. An important difference results from the use of different ellipsoids. For example, with a Bessel ellipsoid the proportion between the solid and the difference between the long and the short axis is 1 : 299 ; with a Clarke ellipsoid, 1 : 294 ; and with Listing's, 1 : 288. This, of course, affects the area of all land in the regions of the two Poles. Now, the geometrical surface of the globe is not exactly that of a rotating-ellipsoid, but a geoid—a surface peculiar to itself, partly rising above and partly sinking below what would be the regular superficies of a spheroid. The elevated parts are represented by the land and the depressed parts by the water of the earth. The determination of the area of the globe is generally worked out from an ideal rotating-ellipsoid. But it is evident that those elevated portions of the geoid which project above the regular spheroid have a larger superficial area than the corresponding underlying projections of the latter, and the contrary will be the fact with respect to the depressed portions. Consequently the planimetric measurements made on the spheroid will give the surface of the water too great, and that of the land too small. On the other hand, the general divergence between the actual slope of the sea-bottom, immediately contiguous to the continents, and the floor of the sea as determined by soundings, causes the diameter of the continents in all directions to appear considerably (about 2') too large. But this error may to some extent compensate for that due to the above method of determining the dimensions of the earth's surface.

Passing from the summits of the elevated portions of the globe to the deepest of its depressions—*i.e.* from the highest levels of the land to the lowest levels of the sea—an abrupt declivity in the general contour of the globe is noticeable along the broad belt of division between land and water ; in other words, the regions of land are sharply differentiated from the regions of water. This conclusion is deduced from De Lapparent's investigations into the heights of the globe's surface when divided into zones rising each 1000 mètres (3280 feet). The results of his labours¹ were as follows, the percentages expressing the superficial area of the land in the zone in terms of the total superficies of the globe :—

At 2000 mètres and over above sea-level,	1·3 per cent.
Between 1000 and 2000 mètres above sea-level,	4·2 „
„ 0 „ 1000 „ „ „	20·6 „
„ 0 „ 1000 „ below „	5·9 „
„ 1000 „ 2000 „ „ „	4·4 „
„ 2000 „ 3000 „ „ „	7·4 „

¹ *Traité de Géologie*, Paris, 1883, pp. 62, 63 ; 2d. ed., pp. 66, 67.

Between 3000 and 4000 mètres below sea-level,	10.4 per cent.
" 4000 " 5000 " " " .	15.5 "
" 5000 " 6000 " " " .	21.4 "
" 6000 " 7000 " " " .	7.4 "
Under 7000 " " " .	1.5 "
<hr/>	
Total,	100.0 per cent.

Thus two out of the eleven zones contain together 42 per cent. of the total superficial area of the globe. The first of these is the girdle embracing all parts between sea-level and 1000 mètres (3280 feet) high, and the second the girdle embracing those between 5000 (16,400 feet) and 6000 (19,680 feet) mètres below sea-level. The former represents the average elevations of land, and the latter the average depths of the sea; and between them the crust of the earth sinks with considerable abruptness. Above the former, again, the contour shows a gentle upward slope, and below the latter a gradual downward slope. An easy graphic representation can be got by means of a curve drawn so as to touch the percentage points, marked off along the various horizontal parallel lines which indicate the various heights and depths above or below the level of the sea.

This curve suggests also another important train of ideas; it demonstrates in what direction the existing border-line demarcating land from water could be most easily shifted. If the sea-level were to sink 1000 mètres, the area of the land would be augmented by 30 per cent. of its present area; but if the sea were to rise permanently 1000 mètres, the area of the land would be diminished by 80 per cent. The importance of this conclusion for geology can hardly be over-estimated, since it lends considerable weight to the belief that in distant geological ages the distribution of land and water was different from what it is at present. The results of recent geological investigations tend to prove that in former periods the boundaries between land and water must have been very variable. Those eras in which considerable portions of the land were inundated by the sea have been called "transgression periods" by Ed. Suess. There have also been eras in which the land extended its borders at the expense of the ocean, and such seem to have generally marked the conclusion of a geological period. Among the reasons for holding this view, the following may be briefly mentioned:—Towards the close of the Palæozoic Age, during the Later Carboniferous Period, we find certain evidence of the existence, for the first time in geological chronology, of widely extended masses of solid land. In the succeeding period (Permian, Dyas) the land seems to have attained to at least its present extent, for there is no portion of the existing surface of the world's continents or islands which was submerged by the sea during the whole of the Permian Period. Similar phenomena are again observable at the close of the Mesozoic Age. The Cainozoic era begins with a continental period, and there is only one single region, in the Libyan Desert, which can be

demonstrated to have been submerged by the sea, namely, from the close of the Cretaceous Period on into the Tertiary Period. Since, then, geological chronology readily seems to divide itself into periods of transgression and into continental periods, it obviously occurs to ask: How were the transitions caused? To what circumstances are the changes to be attributed? An answer is suggested by the graphic curve spoken of above, and by the general conclusion based upon it, that the sea can more easily increase at the expense of the land than the land can be augmented at the expense of the sea. If the difference between the average continental height above the sea-level and the average depth of the ocean below it, which now stands at about 4900 mètres (16,100 feet), were increased by 1000 mètres (3280 feet), by the sinking of the floor of the ocean, the area of the land would become 30 per cent. larger; if decreased by 1000 mètres, by the elevation of the floor of the ocean, the area of the water would become about 80 per cent. less. This conclusion throws light upon the relative proportion of land and water during periods of transgression and during continental periods. During the former the difference between the average level of dry land and the average depth of the ocean was less than it is at the present time; during the latter the difference was greater. At present only a very narrow oceanic fringe off the shores of the existing continents—namely, those which have a less depth than 100 fathoms—can be regarded as a marginal inundation of the permanent land surface; and to this extent only are we now witnessing a period of transgression. Nor is this result materially affected by the risings and sinkings which are known to be taking place along the shores of several countries, for they are for the most part comparatively local, and may be set one against the other, so that their respective tendencies are mutually compensatory. The final result yielded by these considerations is that the existing relation between the respective areas of land and water is not a constant relation, but one that is more or less fluctuating.

PROCEEDINGS OF THE SCOTTISH GEOGRAPHICAL SOCIETY.

AN Ordinary Meeting of the Society was held in the Merchants' Hall, Edinburgh, on the afternoon of the 21st April. Colonel Dods, Member of Council, presided.

The Rev. William Deans Cowan read a paper, entitled *Travels in (Eastern and Central) Madagascar: the Present Condition and Commercial Future of the Island*, which we publish with the present number of the *Magazine*.

Dr. Robert Felkin proposed, and Professor Maclagan seconded, a vote of thanks to Mr. Cowan.

After the Paper, Dr. Robert Cust and several members of the Society interrogated Mr. Deans Cowan on the system of slavery that is supposed to exist in Madagascar, with the result that the answers elicited did not point to any but a very mild form of slavery, which the missionaries themselves have, it appeared, taken no measures to restrict.

A Joint Meeting of the Society and the Philosophical Society of Glasgow was held in the Lecture Hall of the latter Society, Glasgow, on 28th April, when Mr.