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The new value of the yearly sinking of the level of the ground is not very accurate, as appears from the pretty high value of the mean error. To be able to judge about this in another way I have, just as in the first series, excluded some very divergent values, viz. the yearly means of 1864 and 1877; if we calculate the value of  $b$  from the 14 remaining yearly means, we find for it 0.00 cm., in other words: while from 16 yearly means a sinking of the ground of 0,3 cm. would follow, it follows from 14 of the same yearly means that the level of the ground has neither fallen nor risen.

I believe that we are justified in deriving from this investigation that neither from the first nor from the second series of the readings of the gauges communicated by Mr. RAMAER any conclusion may be drawn with reference to a rise or a fall of the level of the ground.

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*Note on the sinking of the level of the ground in recent years.* By H. E. DE BRUYN.

To examine whether of late years according to the observations on the gauges the level of the ground has risen, or whether it has sunk compared with the mean sea-level, the following remarks may be given.

Both in the case that the level of the sea rises, which in my opinion is the most probable case, and in the case that the land sinks, this will not take place regularly, i. e. every year to the same amount, but because nothing is known about this, we can only assume the sinking of the land with respect to the sea-level as regular, so represent the mean level of the sea with respect to the zeros of the gauges as a straight, ascending line.

Now the mean yearly sea-level at any point differs a constant quantity with the height of half-tide. So the rise of the mean sea-level can be derived from the height of half-tide.

The greatest difficulty in these considerations is the possible shifting of the zeros on the gauging rods. As these shiftings are much less frequent for ordinary than for registering gauges I shall only consider ordinary gauges.

The yearly sea-level depends in the first place on the wind. The deviation in consequence of the influence of the wind is great compared with the possible differences in the mean sea-level over some years in consequence of the sinking of the ground. Now it appears from the observations that the influence of the wind is generally in the

same direction during a certain number of years; thus four successive years often occur with high or low level; e. g. 1857—60, 1866—69, 1877—80 and 1903—06.

A comparison of some years, e. g. of 5 years with some other 5 years can consequently give rise to great errors; supposing one period of 5 years is on an average 3 cm. too high through the influence of the wind, the other period of 5 years on an average 3 cm. too low through this influence, this gives a difference of 6 cm.; if now the sinking of the ground during that time is 6 cm., we shall find the sinking of the ground to be = 0 if the high years are the first, but = 12 cm. if the low years are the first. It is therefore desirable to choose the longest periods possible for a comparison, for the periods in which deviations in consequence of the wind take place in positive or negative sense, may be of pretty long duration. A fixed rule for these deviations or fixed periods for them could not be found. Hence the best thing is to compare the mean of a certain number of years with the mean of another number of years.

A proof that the deviations in consequence of the wind can be in the same sense during many years is furnished in the difference of the mean monthly height of the months inter se, in which all the errors by displacement of the zero point are eliminated. Thus I have found for a 54-year period 1843—1896 of the observations on the gauge at Cuxhaven, that in the first 27 years the mean position in February was 154 mm. higher than the mean position in May, in the last 27 years 43 mm. lower, thus presenting a difference of 197 mm.

In order to derive the probable sinking of the ground from the observation on different gauges, we can, in order to eliminate as much as possible the errors caused by the shifting of the zero points, take the mean of the observations of a certain number of gauges, or draw a conclusion from every gauge and take a mean of these conclusions. For a good survey and comparison, as the deviation in consequence of the wind is not everywhere the same on account of the local conditions, and to enable us to use the observations on that gauge as much as possible for which the longest series is available, the last way is preferable. Of course no gauges are to be used at places where the mean level is modified for some reason or other, as e. g. at Zoutkamp.

When we make a graphical representation of the observations on different gauges, it appears that of late years the sea-level has very *decidedly* risen with regard to the land. The extent of this rise cannot

Year	MUIDEN			BRESKENS	
	Height half-tide mm.	Deviation with a rise of 92 mm. p. c.	Deviation with a rise of 133 mm. p. c.	Height half-tide mm.	Deviation with a rise of 129 mm. p. c.
1855	- 150	- 32	- 18		
56	- 110	7	20		
57	- 190	- 73	- 61		
58	- 175	- 59	- 47		
59	- 145	- 30	- 19		
60	- 145	- 31	- 20		
61	- 135	- 22	- 14		
62	- 130	- 18	- 8	- 165	- 23
63	- 125	- 14	- 4	- 170	- 29
64	- 170	- 60	- 50	- 205	- 65
65	- 135	- 26	- 17	- 205	- 67
66	- 95	13	22	- 90	47
67	- 55	52	61	- 90	46
68	- 80	26	34	- 100	35
69	- 70	36	43	- 110	23
70	- 140	- 35	- 28	- 165	- 33
71	- 135	- 31	- 25	- 150	- 19
72	- 145	- 42	- 36	- 140	- 11
73	- 115	- 13	- 7	- 135	- 7
74	- 135	- 34	- 29	- 150	- 23
75	- 150	- 50	- 45	- 175	- 49
76	- 95	4	9	- 120	4
77	- 25	73	77	- 65	58
78	- 45	52	56	- 80	42
79	- 75	21	25	- 120	0
80	- 40	55	58	- 95	24
81	- 80	14	17	- 120	- 2
82	- 80	14	16	- 100	17
83	- 90	3	4	- 95	20
84	- 60	32	33	- 100	14

Year	MUIDEN.			BRESKENS	
	Height half-tide mm.	Deviation with a rise of 92 mm. p. c.	Deviation with a rise of 133 mm. p. c.	Height half-tide mm.	Deviation with a rise of 129 mm p. c.
1885	— 95	— 4	— 3	— 115	— 2
86	— 110	— 20	— 20	— 110	1
87	— 95	— 6	— 6	— 130	— 20
88	— 100	— 12	— 12	— 140	— 31
89	— 70	17	16	— 120	— 13
90	— 100	— 14	— 15	— 130	— 24
91	— 95	— 10	— 11	— 125	— 20
92	— 80	4	2	— 115	— 11
93	— 75	8	6	— 105	— 3
94	— 85	— 2	— 5	— 105	— 4
95	— 90	— 8	— 12	— 110	— 10
96	— 100	— 19	— 23	— 115	— 17
97	— 110	— 30	— 34	— 105	— 8
98	— 55	24	19	— 95	1
99	— 60	18	13	— 75	20
1900	— 80	— 3	— 8	— 90	3
01	— 55	21	15	— 100	— 8
02	— 85	— 10	— 16	— 105	— 14
03	— 15	59	53	— 15	74
04	— 65	8	1	— 60	28
05	— 40	32	25	— 55	32
06	— 40	31	24	— 55	31
07	— 100	— 29	— 38	— 90	— 6
08	— 90	— 20	— 29	— 80	3

be accurately ascertained, because the time that we have had sufficiently good observations at our disposal, is too short. A calculation follows here of two gauges leading to an estimation of the extent of this rise. They are the gauges at Muiden and at Breskens. (The values have been borrowed from a paper and an account over 1907 and 1908 by Mr. RAMAER).

Muiden; given the years 1855 till 1908 (this year included).

The rise of the sea-level per century has been derived from the years :

- a. 1855—1860 and 1903—1908 (12 years) . . . . . 196 mm.
- b. 1861—1902 (42 years) . . . . . 92 „
- c. 1855—1865 and 1898—1908 (22 years) . . . . . 196 „
- d. 1866—1897 (32 years) . . . . . 17 „
- e. 1855—1908 (54 years) . . . . . 133 „

Now the values *a* and *c* are certainly too high, because the years 1855—1865 were low years, and the years 1898—1906 high years. The value *d* is certainly too small, because the years 1866—1869 were high years and the years 1885—1897 low years.

For the assumptions that the rise of the sea-level per century is 92 and 133 mm., we adjoin a list containing the deviations on those assumptions. The mean height of half-tide on January 1<sup>st</sup> 1882 (the middle of the period) is in the first case 94 mm. ÷ N. A. P <sup>1)</sup>, derived from 42 years; in the second 96,4 mm. ÷ N. A. P., derived from 54 years. (The height of high water and of low water of every year only being given in cm., a difference of 5 mm. for every year is possible).

It appears from this list that the direction of the deviation for every year is the same in the two assumptions. So this cannot decide in favour of one or the other of the assumptions. It further appears that the periods of permanent deviation either in positive or negative sense may be pretty long, and that the greatest deviations are distributed very irregularly. The most probable assumption is that for so far as displacement of the zero of the gauges has not exercised any influence, the rise lies between 92 and 133 mm. per century.

Breskens; given the years 1862—1908.

The rise of the sea-level per century derived from the 47 years is 129 mm.

In the above-mentioned list the deviation on this assumption has been given. The mean height of half-tide on July 1<sup>th</sup> 1885 (middle of the period) is 112.6 mm ÷ N.A.P. On the whole the deviations agree pretty well with those at Muiden.

In virtue of the above and because the observations at Muiden and at Breskens are in fairly good harmony with those of other tide-gauges, we may assume as probable that the rise of the sea-level in the last 50 years amounts to about 100 mm. per century.

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<sup>1)</sup> N. A. P. = Amsterdam zero.