A NOTE ON THE QUANTITIES GIVEN IN DR. MARLOTH'S PAPER "ON THE MOISTURE DEPOSITED FROM THE SOUTH-EAST CLOUDS."

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The interesting experiments carried on by Dr. Marloth between December 21, 1902, and February 15, 1903, constituted an attempt to measure the amount of moisture deposited during the prevalence of the so-called summer "South-Easters," winds which are usually accompanied by a cloudy mass on the top of Table Mountain, forming the well-known "Table-cloth"; in other words, an endeavour was made by the author of the above-mentioned paper to ascertain the quantity of moisture deposited on a vertical surface by what may be assumed to be a saturated, horizontally-moving current, as against the amount deposited on a horizontal surface, represented by an ordinary rain-gauge.

The quantities given in the account published in the *Cape Times* of 27th of May last are so enormous as to have excited considerable astonishment and wonder; it therefore seems advisable to inquire into the method adopted so as to ascertain to what extent the figures are reliable, and thus enable it to be decided whether or not the problem has been satisfactorily solved.

Dr. Marloth's description of the apparatus employed by him is given in the following paragraph :—

"In November, 1902, I took two five-inch rain-gauges to the top of Table Mountain, and placed them about midway between the east and west ends of the upper plateau. One I left open in the usual way, the other I surmounted with a framework representing a bundle of reeds. The arrangement consisted of two rings of 5 inches diameter, which were connected by four rods of stout wire, the whole framework being 1 foot high. Pieces of wire netting were fixed inside the rings, and reeds were drawn through the meshes and fastened with thin wire. The frame was then inserted into the

other rain-gauge, fitting into its opening by means of a narrow socket. Four wires attached at opposite sides, and fastened to stones near by, protected the frame against the fury of the wind. I had consequently one ordinary gauge and one with an imitation bundle of reeds 1 foot high."

Further on we are informed that the observations came to an untimely end on the 15th of February, the gauges being destroyed the week after.

In order to understand what follows it is necessary to make the following remarks on rainfall-measurement in general.

The object of rainfall-measurement is to ascertain as accurately as possible the depth in inches of the water which would accumulate on a level surface if the rain were to remain where it fell.

To enable this to be done, the rain is collected in a specially-constructed vessel, called a rain-gauge, of known area, and the amount is measured off by means of a graduated measure which shows true inches and fractions of an inch, corresponding to the receiving-area of the gauge. One of the chief points to be attended to by rainfall observers is that the area is not altered in any way, otherwise the graduated measure will indicate erroneous quantities, and the results will be worthless. Rain gauges are generally circular in shape, and as a circle encloses the greatest area of all closed curves of the same perimeter, the smallest indentation or squeezing in of the rim of the funnel must make the rainfall indicated too little in amount. Conversely, if by any means whatever the receiving-area is artificially increased, the measure will indicate quantities which are too large.

Now in the case of the rain-gauge with the framework containing the reeds, used by Dr. Marloth, we have not only the actual horizontal area of the five-inch rain-gauge collecting the moisture, but the whole of that part of the superstructure above the lower ring is capable of catching moisture, and being so constructed as to drain into the gauge, thus adds its quota to that which would be caught under ordinary circumstances by the plain open rain-gauge. It will therefore be seen that the catchment area has been increased in the case of Dr. Marloth's second rain-gauge by an amount depending on the area of that part of the superstructure already indicated.

Through the courtesy of Dr. Marloth I have been able to closely examine the apparatus used, which was but roughly constructed, and defies accurate measurement. However, the following figures, which were obtained by using a pair of compasses as callipers, and

measuring off on a diagonal scale, will give a rough approximation to the true area :—

Upper ring, inside surface	=	15·371 sq. in.
Upper ring, outer surface	=	18·394 ,,
Wire netting (51·84 in. × 0·05 in.)	=	8·143 ,,
Four wire rods (each 9·2 in. × 0·16 in.)	=	18·498 ,,
Eighteen reeds (each 10·5 in. × 0·09 in.)	=	53·438 ,,
Rain-gauge (decreased in diameter to 4·82 in.)	=	18·247 ,,
Approximate catchment area	=	132·091 ,,

This result is well under the actual area, as certain surfaces, such as the bent-over ends of the reeds, part of the lower wire netting which has been so pulled up as to project above the gauge and thus act as an addition to the receiving surface, as well as other small items, have been omitted.

In fact this superstructure practically acts as a sponge or filter, having an area approximately equal to 114 square inches, which with the receiving surface of the gauge itself brings it up to about 132 square inches.

Now as the water (79·84 inches) collected by this gauge represents the depth as measured off by means of a measure graduated to show inches of rainfall collected by a rain-gauge 5 inches in diameter (*i.e.*, having an area of 19·635 square inches), it follows that—

$$79{\cdot}84 \text{ in.} \times 19{\cdot}635 \text{ sq. in.} = 1567{\cdot}6584 \text{ cubic in.} =$$

the total amount collected.

Therefore this quantity divided by the approximate area found as above would give a result closely approaching the true depth of rainfall—

$$\therefore 1567{\cdot}6584 \text{ cubic in.} \div 132{\cdot}091 \text{ sq. in.} = 11{\cdot}87 \text{ in.}$$

If we assume that the 4·97 inches collected by the plain rain-gauge was equal to the rainfall collected by this second gauge. subtracting we get

$$11{\cdot}87 \text{ in.} - 4{\cdot}97 \text{ in.} = 6{\cdot}90 \text{ in.}$$

as the amount deposited from the "South-East Cloud." This amount divided by 57, the number of days during which the experiments were carried on (December 21, 1902 to February 15, 1903), gives an average deposit of 0·12 inch *per diem*, on the assumption

that the cloud-covering on the mountain was continuous throughout this period.

Even on the very improbable supposition that the rain collected by the open gauge fell absolutely vertically, so that the horizontal area of the rain-gauge alone formed the catchment area, while the remainder of the water caught was deposited only on the vertical reeds, &c., by a horizontal current, it will be found that the deposit from the "Table-cloth" is simply almost doubled, amounting to 12·97 inches during the period, and representing a daily average of 0·23 inch.

In fact, in whatever way we may care to regard the deposition of moisture to have taken place, it will be found that Dr. Marloth's figures are enormously in excess of the true amount.

All experiments in this connection ought to admit of but one interpretation if any reliance has to be placed on the results obtained, and a comparison made between the amounts collected by the two gauges. The following considerations will show how faulty the experiments discussed are in this respect:—

The reeds have been assumed to be right circular cylinders of 0·09 inch diameter, but it may be regarded as an open question if the moisture soaking in through the cut ends would not cause the reeds to swell in spite of their siliceous skeleton, and thus still further increase the area exposed to the horizontally-moving current.

Attention ought also to be drawn to the possible effect of the reeds in decreasing the velocity of the wind by breaking it up into small whirls, and so producing practically a calm over the gauge, thus admitting of a vertical deposit of moisture. The action is similar to that of a Nipher's shield for rain-gauges at any considerable elevation above the ground, which breaks up the eddies tending to carry the rainfall over the gauge, and so renders the amount caught at any elevation practically the same as that falling on the ground.

The amount deposited from the mist ought to vary with the density of the mist and the velocity of the wind.

One advantage that the vertical catchment area possesses over that of the horizontal gauge is that the water rapidly runs downwards into the receiver, and so is protected from possible evaporation during any break in the prevalence of the mist.

In estimating the effect of such deposits from mists on water supply, it ought to be borne in mind that in the apparatus described the reeds have been placed to the best advantage, being on an average 1 inch to 1½ inch apart, and so arranged that they do not overlap, as would be the case with a close natural growth of these plants; con-

sequently the deposition of moisture under natural circumstances would most likely be confined almost entirely to the few outer layers of a patch of these reeds, thus materially diminishing the average amount of moisture deposited. In all probability the effect of a fog or mist on reservoirs is mainly beneficial as a check on evaporation.

Again, as both iron and vegetation are good radiators of heat, it follows that under a calm, clear sky a certain amount of dew would be deposited during the night, thus complicating matters still further, unless special observations were made and daily readings taken.

The nett result of the experiments seems to be that it has been proved that a deposit of water takes place on growing plants during the prevalence of the "South-Easters," probably sufficient for their nourishment during the dry season, although it is possible that the plants would thrive equally well in a humid atmosphere, from which, however, no actual deposition of moisture took place, as on the lower slopes of low hills during the prevalence of a sea breeze. As far as actual quantitative results are concerned, the problem is as far from being solved as before these experiments were undertaken.