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V. THE RIVER BUFFALO, ITS WATERSHED AND FLOW IN CONNECTION WITH THE RAINFALL.—By WILLIAM B. TRIPP, Assoc. M. Inst.C.E.

[Communicated by the President. Read November 29th, 1882.]

In the early part of 1880 the writer having been appointed Resident Engineer of new waterworks at King William's Town, commenced observations on the River Buffalo and its sources, from which that important town draws its water-supply, to the results of which as well as to those of the rainfall he now begs to call attention.

1. This paper was accompanied by three descriptive drawings, viz. :—

1, 2 & 3. Diagrams showing the actual flow of the river, both at Izeli and the town dam at King William's Town ; the extreme heights of the floods are not in many cases attempted to be represented. The rainfall each day at the Botanical Gardens, King William's Town, is also shown.

4. A plan of the watershed of the Buffalo—adapted from the Map of the Eastern Border Districts of the Cape Colony, compiled in the office of the Surveyor-General, Cape Town, from various surveys—showing the surrounding contiguous watersheds.

5. A longitudinal section or profile of the River along its windings from the highest springs on the slopes of Isidingi to the sea at East London.

2. Definite observations on such matters would seem to be much required in South Africa ; much capital, for instance, having been expended in erecting water-worked machinery on the stream under consideration, which such observations would show to be of too intermittent a nature to afford sufficient power to work it continuously, and therefore the steam engine or some other motive power would seem to be a preferable or a necessary adjunct to the water wheel or turbine.

Still more important and necessary are such observations for laying out works for irrigation or town water supply.

3. The River Buffalo has its chief sources in the Perie Bush, the fountains issuing from the slopes of the hills at an elevation in some cases of nearly 4,000 feet above the level of the sea.

The effect of a range of mountains in condensing vapours driven on to them and causing rain is well-known. In the case, however, of a barren and denuded range of hills, a very large proportion of the rainfall quickly runs off, and the issuing stream is intermittent and partakes of the character of a mountain torrent.

Now whatever effect the clothing of hills and valleys with foliage and herbage may have on the production of rainfall, and it is no doubt a very important one, still one of the most useful as well as apparent effects of the process appears to be that by its means the whole watershed is converted into a storage reservoir, absorbing and retaining for a long period a large proportion of the rainfall, preventing its too rapid

evaporation, and regulating the discharge to an equable flow spreading health and fertility along its course.

There is also this difference between vegetable growth and mountain ranges, which brings the former subject within reach of practical experiment, that whereas we are perforce compelled to accept the latter as we find them, the former may be increased and the water supply improved and regulated with its growth, and vice versa.

To what extent the destruction of the Perie Bush has changed the character of the Buffalo from that of a steadily flowing stream to an intermittent torrent, the observations taken by the writer extend over too short a period to enable him to speak with any certainty. That the Forest is gradually disappearing there can be no doubt, and the great probability, judging from experience gained elsewhere, is that such a change is taking place.

4. The total area of the watershed draining into the Buffalo is from 450 to 500 square miles, and it is bounded by the ridges dividing it from the watersheds of the Keiskama and the Kabousie, the Chalumna and the Gonubie, the Igulu and the Nahoon, the Igoda and a few other smaller streams flowing into the sea to the S.W. of East London.

The main points around the watershed are the Perie Mountain, culminating in Isidingi or Mount Kemp, Debe Nek on the West, and the high ground near Kei Road Railway Station on the East, Tamacha Heights and the ridge along which the old road to East London passes on the East, and the corresponding ridge on the West along which the new road passes. The greatest length of the watershed is from 70 to 80 miles, measured in a direct line from East London to Mount Kemp or Debe Nek, which are each about equidistant from it; and its greatest width from 20 to 30 miles from Tamacha Heights to those near Kei Road Station.

The total length of the river along the windings of the principal channel is about 70 miles.

5. The portion of the river more immediately under observation is that from which the water supply of King William's Town has for many years been taken, and this part is chiefly supplied from two streams, viz., the Buffalo proper and the Wytela stream, whose junction takes place about 10 miles above the town, measured along the channel. Other streams such as the Balasi join it between that point and the town dam, but they are not continuous, ceasing to flow in the dry seasons.

The area of watershed above the junction of the above two streams is from 80 to 90 square miles. The portion drained by the Buffalo is larger, has much higher mountains, and a greater area still covered with forest, consequently the discharge from it is much greater than that from the watershed of the Wytela.

Below this junction down to the town dam by which the water is diverted into the furrow supplying King William's Town, the stream passes through farms occupied by German immigrants, and has its channel cut deep below the level of the adjoining lands down to the rock, the banks on each side exhibiting a bed of rich soil resting on a deep loamy deposit.

The successive beds of loam seen in a passage down the valley present the appearance of having been the beds of a series of lakes at one time impounded by the successive outcrops of the strata of rocks, whose dip though slight is suitable in direction for producing such effect, but by erosion the rocks were gradually lowered, and the lakes were at the same time gradually being filled by matter washed down from the hills; by these combined processes all the waters were at length gathered into one channel, which was gradually deepened until the channel was continuously formed on the underlying rock beds.

Other temporary channels have left marks of their existence, and appear to have acted as feeders or drains eventually rendered unnecessary by the deepening and widening of the main drain or channel.

Marks of floods may be distinguished by debris washed up in places some 30 feet above the present bed of the river.

Causes such as those attempted to be described above will account for the frequent steep approaches to "drifts" walled in on each side by high banks of loam, which form such a characteristic feature in South African scenery.

6. The rainfall at King William's Town—from the valuable observations taken at the Grey Hospital since the year 1868 by Dr. Egan—may be taken at an average of 27 inches yearly, of which the normal distribution throughout the year is as follows:—Rather more than one-third of the whole quantity falls in the summer months, from January to March, and rather less than that quantity during the spring months, October to December. About one-sixth of the whole falls in the autumn, from April to June, and rather less than one-sixth in the winter, from July to September.

The wettest observed year was 1876, when 37 inches fell, and the driest was 1878, when the total fall did not amount to 15 inches.

The heaviest fall on record was in May, 1872, when about $9\frac{1}{2}$ inches fell in three days, of which nearly 8 inches fell during 6 hours only. The last great flood in the river is said to have occurred in 1876, others having previously taken place in 1874. Since 1877 a succession of dry years has ensued.

There is usually a drought in winter, and the rainy season is usually inaugurated by a heavy fall just about the end of September or the beginning of October. Some years are, however, exceptional; for instance, the winter of 1881 was very wet, while during the spring of 1881 and summer of 1882 the rainfall was more than 8 inches below the average.

It is to be regretted that no record extending over any considerable period has been kept of the rainfall in the Perie Mountains. It is certain, however, that rains are more frequent, as they are probably much more copious than at King William's Town. From returns published in the report of the Meteorological Commission for 1881, it appears that the fall during the first three and last three months of the year in the Perie Forest was about one-third more than that at King William's Town during the same periods, while the fall in the month of September was about the same in both places.

* Fords.

7. With so variable a rainfall it may be supposed that the flow in the river is extremely changeable.

The ordinary flow may be taken at from $4\frac{1}{2}$ million gallons per day in dry seasons, to $21\frac{1}{2}$ million gallons per day in wet.

The minimum flow is from about 2 millions to nine hundred thousand gallons per day. When the stream falls to that point, even in dry seasons, it is apparently invariably replenished by small "freshets" due to rains high up in the mountains raising the flow for the time up to the rate of $13\frac{1}{2}$ to 18 million gallons, and these occurring at frequent intervals constantly replenish the river and prevent its being altogether dried up in the long droughts.

An immense volume of water rushes down the river in the heavier "freshets." Even a flood raising the water only $2\frac{1}{2}$ feet at the town dam would carry down at the rate of more than 750 million gallons per day, and a 5-foot flood more than three times that amount. These, however, are only floods of a very minor order, of which some 3 or 4 occur each year. About every few years, some say seven, a period of "heavy freshets" is said to occur, which are sufficiently violent to clear out the sand bar at the mouth of the river, rendering the harbour accessible for the time to large vessels.

Rains from the coast often hardly affect the upper parts of the river, while those in the bush are often only known of in the town from their effects on the river. Storms often follow the summits of the hills and are hardly noticeable in the valleys.

The quantity of water flowing at the abovenamed junction of the two principal branches frequently appears—as may be seen by looking at the diagrams accompanying this paper—particularly in dry seasons, to be greater than that at the town dam 10 miles below.

This may be of course accidental at times owing to the long time—varying from 24 hours to 3 or 4 days—that a freshet in the upper parts takes to travel along the windings and fill all the pools of the river, and make itself felt at the lower parts. But the writer is of opinion that the difference is more than accidental, and that the stream in the upper part is more constant, *i.e.* that it does not rise so high or fall so low at the upper point as at the lower, and this is explained in the following manner:—After heavy rain all the temporary feeders run down in torrents, and this raises the lower part of the river in a rapidly increasing ratio as compared with the upper. When, however, all these feeders cease to flow after a long drought, the loamy banks absorb a large proportion of the flow—the water being frequently seen wetting them at least one foot above the surface of the river, being drawn up by capillary attraction—and then there is a greater waste of water, this being much more felt through the bare formed lands than where the stream has just issued from the forest, consequently the flow decreases until the stream reaches the next permanent feeder.

"Freshets" or "Floods" might be always foretold, were observers always on the spot, sometimes a longer sometimes a shorter period beforehand. When the floods come they appear almost suddenly, workmen having to make haste to escape them, if such are engaged in engineering works in the bed of the river.

This is owing to their being caused by a heavy rainfall at a distance, and as the volume increases by continued fall of rain the back waters overtake those in advance by the greater velocity due to their increased volume. This effect of floods caused by rains at a distance is always more or less observed.

On the Vaal River, I understand, the Engineers engaged on the works of the Kimberley Waterworks can hear of advancing floods as much as a fortnight before their arrival, and consequently take every precaution beforehand.

The same has been observed in large valleys such as that of the Trent at Burton, where floods can be predicted and prepared for by observing the amount of rainfall, and doubtless in many other places.

8. The question of the future of the River Buffalo and streams like it is an important one, particularly for the towns and farms situate on their banks.

One thing appears to be very probable, that by the different destructive agencies of bush fires, Kaffir hut builders, sawyers, as well as cultivators of the soil, the area of watershed covered with "bush" or luxuriant vegetation will year by year become more circumscribed, and the flow of stream will become year by year more variable, and at last, the natural storage ground being destroyed, the rain will run off as soon as it falls, causing the stream bed alternately to present the appearance of a torrent and a dry assemblage of boulders.

When the effect of this begins to be sensibly felt artificial storage reservoirs will be required to equalise the flow, taking the place of the natural one destroyed; the expense of these will be considerable, and their result only partially to restore the character of the stream.

9. In conclusion the writer would venture to urge the importance of regular observations in the flow of streams in connection with the rainfall.

In order to do this effectually rain gauges should be fixed at carefully chosen positions all over the area of the watershed.

There can be little doubt that as the importance of these subjects becomes more widely felt Government will undertake as a duty, more and more, the protection of the natural advantages bestowed on countries with a view of benefitting the inhabitants under their rule, and will take greater pains to study the phenomena of Nature.

VI. NOTE ON THE (ALLEGED) SUICIDE OF THE SCORPION.

—By C. LLOYD MORGAN, F.G.S., Assoc. R.S.M.

[Read February 27th, 1883.]

There is a current belief, in this colony and elsewhere, that the scorpion, under certain irritating circumstances, will commit suicide. If, for example, a scorpion be placed within a ring of burning grass he is said to inflict on himself a death wound with his own sting. I have