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SUGGESTIONS FOR GAUGING RIVERS:

By K. L. RAHBEK, Esq., Mem. Dan. Assoc. C.E.

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By K. L. Rahbek, Esq., Mem. Dan. Assoc. C.E.

Mines Department, Hobart, 10th December, 1900.

Sir,

During the few months I have been at work in this country, I have had ample reason to deplore the very few records which are available as to the maximum and minimum carrying capacity of watercourses.

While examining the Ringarooma River in September last, I gauged it in several places, and thereby learned how much water was coming down at that particular time; but as to its flow during the dry season, there were only records of one set of gaugings, taken by Mr. G. J. Burke, M.Inst.C.E., in 1885; but whether these gaugings (both Mr. Burke's and my own) were to be taken as a maximum, minimum, or a mean, I had no means of ascertaining. In this case, however, I took them to be a mean, judging from the records of rainfall in adjacent districts, and made my computations in accordance therewith.

The proportion of the annual rainfall, which through different watercourses is carried out to sea, varies exceedingly for the different countries and the different localities. Of the rainfall precipitated on the catchment area of a certain stream, a part is evaporated; a part is absorbed by the soil as nourishment for vegetation; a part sinks down into the permeable strata, and travels—some of it—perhaps to supply subterranean lakes and rivers; a part meets with impermeable strata, and reappears as springs, perhaps in altogether another locality; and the balance of the rainfall travels down the bed of the watercourse.

It is obvious that the first thing we should know is the magnitude of the daily, monthly, and yearly rainfall, not for one or two years, but for such a number of years as it would constitute for the duration of its "cycle," therefore the greater number of years the rainfall has been recorded the greater is the confidence with which these results can be applied.

But even when we do know the rainfall, it is, however, not possible for us to determine what portion of it may be expected to come down the watercourse; and here I may observe, that it is of equal importance for us to know the smallest flow in the driest season, and its duration, as well as it is imperative to know the mightiest flood the stream is subject to, and its approximate length of time.

Where the catchment area consists of steep hilly impervious rocks, with only little soil and sparse vegetation, the flow-off will be far greater than in the case where the area is composed of plains with only slight fall and covered with soil, which nourishes a rich vegetation. In fact, from existing works, it has been proved that the range of the flow-off from the annual rainfall has varied from 80 per cent. to 5 per cent.; but, as a general rule, it may be stated, that the flow-off from large catchment areas—say 5000 square miles and more—seldom reaches or exceeds 35 per cent., but, on the other side, the smaller the area the greater the variation.

Therefore, when hydraulic engineering works have to be designed, for instance, a reservoir to be erected by means of weir or embankment, and corresponding waste-weir or bye-wash, and the engineer has no reliable data to go upon as to the carrying capacity of that particular water-course, he may, (always assuming him to be an honest and capable man) if he is of a pessimistic temperament, perhaps anticipate too heavy floods and construct his works unnecessarily expensive, or, if he is of a more sanguine character, he may under-estimate the forces he has to deal with, the

works may be too weak, and destruction of valuable property, and perhaps loss of human life, be the consequence.

These are, in my opinion, the different reasons why it is so very important to have water-courses regularly gauged, because the direct gauging of streams for a number of years gives absolute information about the quantities which have to be dealt with, and designs of the different works may be prepared, and the work executed in such a way that the greatest possible benefit is obtained by the smallest expenditure. To show you, sir, that I am not alone in my views, I beg to quote an extract from the report of the Hydraulic Engineer to the Colonial Treasurer, Queensland (1893):—

"The acquirement of correct knowledge, especially respecting the extent of our surface water resources, where and how best to secure and use them, should be one of the primary objects of this department. In South Australia, Victoria, and New South Wales there has been in force for some time a systematic practice of gauging the streams likely to be drawn upon for supplies of water.

"On a previous occasion I drew attention to this matter, and urged that we should follow a similar course; but as no action has yet been taken, perhaps I may be permitted to briefly revert to this subject here. Stream-gauging is of the first importance; it would afford information of great value regarding the surface-water resources of various districts of the Colony; of some of the fluctuations to which streams are subject; but this work would be of very little use unless it were carried on for a number of years. Data based on a few years' observations would most probably be imperfect, misleading, and worse than useless.

"The value of stream-gauging increases proportionately with the time over which the work has been extended, and, therefore, the sooner this invaluable State duty is commenced the greater will be the worth of the data acquired.

"In formulating and discussing water supply and irrigation schemes, what is most essential is full and accurate information respecting the extreme minimum flow rather than the average that can be expected from streams in a season of maximum aridity, as they do not discharge their waters with anything like regularity. Before any irrigation or water supply scheme can be properly formulated, it is absolutely necessary to possess most perfect data of the kind, and for drainage schemes a sound knowledge of the maximum flow in unusually wet seasons is imperative. Without such data respectively, no fair distribution of water, no scheme of water supply or irrigation or drainage can be well considered, nor can storage and distribution or drainage works be economically designed, and their permanency and efficiency be assured."

Again, I beg permission to quote a few lines from that excellent paper "River Gaugings, Victorian Water Supply, 1889, 1891, and 1895," in which the Chief Engineer says:—

"To determine the relation of river discharge to rainfall, observations are necessary of the latter at a number of stations in positions representative of all different classes of country—mountainous, hilly, undulating, and plain—comprised within the drainage area. Complete gauging also involves a knowledge of the fluctuations of water-level of the stream at the point of gauging, and of the volume of discharge at each level in every state of the river. Subsidiary to these are the determination of losses of water, both from natural streams and from artificial channels, by percolation and by evaporation; and where the storage of water is in question, the determination of the volume of silt or detritus carried by the stream, not only in suspension, but also by the transporting power of the current on the material of its bed. Without such data the design of the works for controlling or storing the flow of rivers must involve certain undetermined risks.

"For instance, the maximum discharge of the Goulbourn River at Murchison, was, in view of the proposed construction of a weir on that river, assumed at about 1,800,000 cubic feet per minute, such being the result of computations based on an empirical formula applied to observations of surface velocity extending over several years, none other having been recorded. However, more careful measurements of velocities in vertical ordinates throughout the entire available cross-section, made during high floods, showed conclusively that the assumed discharge was too low, and that in a maximum flood it would probably reach 3,000,000 cubic feet per minute. This opportune discovery, the issue of the latter and more exact methods of gauging, enabled the necessary alterations to be embodied in the design, to provide of the passage of the greater volume, without entailing the cost and annoyance of alterations to any portion of the completed work.

"In the case of the Laanecoorie Weir, on the Loddon, the maximum flood discharge was inferred from gaugings made at relatively low states of the river only, and checked by a formula applied to the drainage area, the coefficients being derived from the flood discharge of the neighbouring basin of the Goulbourn. This gave a maximum volume of about 1,250,000 cubic feet per minute, but recent gaugings tend to show that it is much too low, and that it may be as much as 2,250,000 cubic feet per minute for floods of a few hours' duration. These facts are sufficient to indicate the vital importance of careful gauging as a preliminary to the design of engineering works, in carrying out schemes for the supply of water for irrigation, for domestic use, or for drainage. Although the gauging of some of our streams may at present seem to be of scientific rather than of practical interest, it is impossible to predict what sources of water may not be drawn upon in the future; so that the results now being obtained may yet prove to be of the highest value.

"There is not one of our rivers or creeks capable at all seasons of irrigating the land commanded by it, the problem that generally presents itself being, not how to get the water on the land, but how to get water to put on the land. Storage is the only solution of the difficulty in this Colony, and it cannot be successfully undertaken without full knowledge of the volume of the streams to be operated on."

I have thus attempted to show how important it is to have these streams gauged, the water from which now, or in the not too distant future, may be required for different purposes.

The gaugings, when once started, should be carried on permanently, and should, if possible, be executed for several points on the same stream. The site chosen for the gauge, when it is on a natural water-course, should be where the bed of the stream is somewhat straight and the velocity of the water not too rapid; and, moreover, it is also advantageous when the site is close to a bridge, a road, or a railway line. In the case of a river, it will be found most practical to gauge it by measuring its cross-section and finding the mean velocity of the flowing water, either from ascertaining surface velocities, or by means of current meter. In the case of smaller streams it will, no doubt, be found most advantageous to measure the flow by passing the water over an over-fall or through an orifice.

The procedure for the establishment of a permanent gauge at a particular point of a river may then be something like the following:—The discharge at its lowest summer level is found by one of the methods mentioned above, and similar operations are gone through when the discharge of the river is heavier, including the highest flood in the following wet season. From these five to six or more different gaugings at the same place of the same river, and including the lowest and highest discharge, it can be found by computation or by a graphical method what the discharge of the river would be at any intermediate height of water-surface. A gauge-board made of wood, say 1½ in. thick by 9 to 10 ins. wide, painted and divided into feet and inches, with figures written so large that they may be read at a distance, is permanently fixed with its zero at summer-level, and the gauge-reader's services begin now. He may be furnished with a supply of printed forms on which he has to record the daily gauge-readings; each form may contain one month's record, and at the end of each month the form filled up must be forwarded to the department. The gauge-readers may perhaps best be chosen from, say country telegraph operators, country policemen, railway-line-repairers, and others, who for a small annual allowance could, and would be willing to do this light work in connection with their other duties. The gauge-reading need only be taken once a day at about the same time, except when floods occur, when two or three readings daily, including the reading of the highest flood, would be necessary.

From the Report of 1899 of the Government Meteorologist I note that there are at present 67 stations where the daily rainfall is recorded, and that the increase of the number of stations during the last year was 11. No doubt it is the intention to increase the number of stations for rainfall every year, and I beg to suggest that, when fixing new stations, preference should be given to those which would be situated on the catchment areas for important streams.

In the report mentioned I do not see any reference to records of the amount of the yearly evaporation; it would be exceedingly useful if such measurements were made permanently in five different localities, say one in Hobart, one in Launceston, one on the East Coast, one on the West Coast, and one in the interior. It would no doubt be found that the yearly evaporation in the places mentioned would differ a great deal, and it would, as mentioned above, be particularly useful to know exactly what it amounts to, especially so for the efficient designing of certain engineering works. Perhaps these measurements could best be carried out in conjunction with existing stations for recording the rainfall; the extra expense would, certainly, not be large.

I have now, sir, had the honour to comply with your verbal request, viz., to make suggestions as to what course it would, in my opinion, be the most practical to follow for obtaining full and reliable information necessary for the efficient designing and construction of certain works. However, the inauguration of a country's stream-gaugings cannot be accomplished in a week or two; but as I understand there are various projects under contemplation which would require the "tapping" of several watercourses, and also the conservation of water, I beg most respectfully to urge that the approaching dry season should be utilised as much as possible to learn something about the minimum discharge of these streams, whose water it is contemplated to utilise for different purposes. Of course the gauging during one season alone is really not so very enlightening, but it is assuredly better than no information at all. I also think it would be very useful to gauge the Ringarooma River when we arrive at the very driest period of the coming summer.

I have the honour to be,
Sir,

Your obedient Servant,

K. L. RAHBEK.

To the Honourable the Minister of Mines, Hobart.

JOHN VAIL,
GOVERNMENT PRINTER, TASMANIA.