Rainfall and Land Drainage.[1]

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THE problem of the economical disposal of surplus rainfall in cultivated districts is one which naturally engages the attention of the agriculturist and, as a consequence of his needs and interests, of the meteorologist, the engineer, and the lawyer. All three aspects of the matter have been dealt with recently in an article in *Engineering* and in two papers read before the Surveyors' Institution.

The precipitation of atmospheric moisture is counterbalanced in part by the processes of (1) evaporation, (2) transpiration, and (3) percolation, the residue forming the run-off which collects on the surface of the ground and ultimately finds its way to sea by watercourses, either natural or artificial. In cultivated areas it is essential that the soil should be drained promptly and effectively, and left in a "moist," as distinguished from a "wet," or saturated, condition. Ill-drained land is incapable of experiencing the full benefit of those seasonal physical and chemical changes which promote the growth and development of crops.

The article by Lt.-Col. Craster discusses the proportion of run-off to rainfall, and the author finds that it varies in this country, as also in America, roughly between the limits of 33 and 67 per cent. It has been found that 0·065 in. of water is required to wet a crop of rough grass about 5 in. in height, the aftermath in a hayfield, up to the point at which it commences to drip on to the soil. It may therefore be assumed that the amount of water required to wet vegetation and the surface of ploughed land is not less than 0·04 in. or 1 mm. The whole of this amount is lost by direct evaporation after every fall of rain. If the number of days with a rainfall of 0·04 in. or more be 127 (as in the North-East of England in 1918) and the number of days with less rainfall be 67, the direct evaporation for this area will be $0·04 \times 127 + 0·02 \times 67 = 6·42$ in. As regards transpiration (*i.e.* absorption by vegetation), figures from German sources show that a beech wood transpires 14·2 in. of water per year; a crop of oats, 8·98 in.; and a crop of barley, 4·88 in. For an average of 9 in. per year this would be divided as follows: July, 25 per cent.; June, 18; August, 15; May, 12; April and September, 8 each; March and October, 5 each; and the remaining months, 1 per cent. each. Percolation is more difficult to estimate, owing to variable geological conditions, but, as a rough rule, may be taken at not less than 10 per cent. Summarising these figures for the North-East coast of England, there would be a residue, or run-off, of 8·7 in. out of an annual rainfall of 26·8 in., *i.e.* 32·5 per cent., and for Fort William, Inverness, a run-off of 52·67 in. out of an annual rainfall of 78·7 in., *i.e.* 67 per cent.

From a survey of the flood discharges in England and Wales, Mr. Clayton arrives at the conclusion that, while no general rule can be laid down, it is permissible to assume that in average areas the run-off to the sea is from 50 to 60 per cent. of the total rainfall. As the general average rainfall is about 32 in. per annum, this means that, roughly, 1800 tons of water per acre finds its way annually into rills, brooks, streams, and rivers. Taking into consideration the fact that about 60 per cent. of the whole rainfall occurs in the six months October to March, the general proposition is established that 36 per cent. of the total rainfall has to be received by watercourses during a period of 182 days, whence it follows that an average wet period run-off to sea is 0·0633 in. per day. In designing drainage channels and in order to cover reasonable cases of abnormal rainfall, Mr. Clayton advises that this figure should be multiplied by 5, and the result so nearly equals 1 per cent. of the total annual rainfall that he recommends the adoption of this standard.

The calculation is pursued further to the determination of the flow in tidal rivers necessary to discharge this accumulation of land water. Applying the rule to a catchment area of half a million acres, the total volume to be discharged within an ebb-tide period of fourteen hours per day is 576,000,000 cu. ft., or, say, 11,430 cu. ft. per sec., which for a distance to sea of twenty miles would necessitate a channel with a theoretical mean area of 2721 sq. ft.

The maintenance and deepening of these outlet channels are important considerations, but, unfortunately, the jurisdiction and supervision exercised over them are casual and unsystematic in the extreme. Before the railway era, river and canal navigation brought in revenues from tolls which enabled due regard to be paid to the drainage needs of the districts through which they passed, but the decay of inland navigation has resulted in the loss of these financial resources, and drainage conditions have, in many cases, become deplorable. This view is endorsed in Mr. Konstam's paper, which deals with the legal and administrative point of view. The startling assertion is made that it is doubtful whether there is a single river in England which is at present in a satisfactory condition as a means of draining water from agricultural land. Whether strictly or approximately true, the situation calls for earnest attention. Drainage authorities—known as Commissioners of Sewers in many parts of the country—date back to medieval times, and their powers and functions have, in many cases, become ineffective and obsolete. The Land Drainage Act of 1918, however, does something towards alleviating the situation by enabling the Board of Agriculture and the Ministry of Transport to sanction the transfer of a navigation undertaking to drainage functions. No doubt in process of time some degree of co-ordination and system will be established.

[1] "Estimating River Flow from Rainfall Records." By Lt.-Col. J. E. E. Craster. *Engineering*, January 2.
"Land Drainage from the Engineering Point of View." By C. H. J. Clayton.
"Land Drainage from the Administrative Point of View." By E. M Konstam. The last two are papers read before the Surveyors' Institution on January 12.