A method for discriminating between evaporation and seepage losses from open water canals

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Abstract

A method to discriminate between evaporation and seepage losses from open water canals was developed under controlled conditions and applied to standing water in two blocked-off concrete-lined canal compartments having sealed and unsealed joint treatments respectively.

Evaporation loss from both compartments averaged 11% monthly. Seepage loss ranged from 1% to 30%, on average, for sealed and unsealed compartments respectively.

Introduction

Water losses from irrigation canals have adverse economic and environmental consequences. The former include not only curtailed crop production but loss of revenue needed to operate and maintain irrigation schemes. Environmental consequences such as water-logging adjacent to earth canals, and seepage further afield are unacceptable in a country such as South Africa where both water and irrigable land are scarce.

Efficient management of a canal system depends on knowledge of losses *en route*, notably by evaporation, leakage and wetting of the concrete lining of the canals. Only on such information can a soundly-based decision to line or reline a canal be reached - a decision which has financial implications for both the supplier of water and the irrigation farmer.

Of the two main water loss components, leakage cannot easily be measured unless it is possible to get a reasonable estimate of evaporation. One option would be to measure evaporation from an evaporimeter such as an American Class A-pan or a Symon's tank, and convert it to evaporation from a canal, but it would take at least a year to derive a reasonably accurate conversion factor, during which time the calibration canal would be out of commission. Moreover, the conversion factor could contain an unknown seepage component, and thus would not be accurate and applicable to other canals.

As an alternative to using evaporimeters to gauge evaporation loss from canals, meteorological or thermodynamic models are unsatisfactory in that they require input data which are difficult to measure, and time-consuming and expensive to collect if the number of input variables is large. Moreover, calculated gross evaporation is seldom accurate for periods of less than 7 d (Gray, 1973). Uncertainties and errors inherent in empirical formulae make it difficult, if not impossible, to ascertain whether water loss from impoundments is due to evaporation or seepage, or a combination of the two.

A third alternative recommended by the author was used by

Reid et al. (1987). It is an inexpensive technique for differentiating between leakage and evaporation from standing water in canals. This paper describes the technique and its practical implementation. However, it must be stressed that the main purpose of this paper is to describe the principle rather than the details of the technique. When applying the principle to specific projects, modifications may be required to suit particular circumstances.

Materials and methods

Study area

Evaporation determination as used by Reid et al. (1987), was tested under controlled experimental conditions in a fully equipped meteorologial station at Roodeplaat Dam (25°37'S and 28°22'E) 20 km north-east of Pretoria.

Prior to its commissioning in 1987, seepage tests were run (March to November 1986) on the then newly constructed Sarel Hayward Canal (downstream of PK le Roux Dam) with a carrying capacity of 16 mVs which supplies irrigation water to 17 600 ha *en route* and supplements Kalkfontein Dam water to the Riet River Government Water Scheme at Jacobsdal (29°08'S and 24°46'E).

The canal passes through a region with a mean annual rainfall of 370 mm (Weather Bureau, 1972) and conforms to W Köppen's climate classification Type BShw which represents semi-arid, hot and dry conditions with mean monthly air temperatures exceeding 0°C (Weather Bureau, 1984) and with the driest season in the winter (Trewartha, 1954).

Hypothesis

It is hypothesised that water inside the evaporimeter cylinders, installed in water-tight evaporation tanks will, due to the restriction of air movement, evaporate less than the larger water surface of the evaporation tank surrounding it.

Materials

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To test the hypothesis i.e. whether or not water from the larger