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Reduction in evaporation due to the bird screen used in the Australian class A pan evaporation network

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All class A evaporation pans operated by the Bureau of Meteorology are fitted with bird screens. The effect of the bird screen on evaporation was measured at four widely-spaced locations. The results, averaged over the four stations, indicated a correction of seven per cent to be added to monthly evaporation totals from screened pans.

Introduction

Australia needs to protect its class A evaporation pans from the interference of birds and other animals because of its largely arid climate. The bird screen which has been adopted by the Australian Bureau of Meteorology was based on a design from Israel (Fig. 1). The screen consists of a 300 mm high cylindrical frame covered with chicken wire, which is fitted to the rim of the class A pan. All class A pans operated by the Bureau of Meteorology have been fitted with these bird screens.

The bird screen was expected to reduce evaporation through its effect on the airflow and radiation balance at the water surface of the pan. A change in the rainfall catch of screened pans was another possible factor which could alter evaporation measurements. An experiment at three stations in Israel indicated a correction of 11.4 per cent to monthly evaporation totals from screen pans (Private communication 1967)*. An experiment was designed to determine the effect of this bird screen on class A pan evaporation measurements at several widely-spaced locations in Australia. This paper describes this experiment and discusses its results.

Experiment

The tests were conducted at four stations covering a wide range of climates. The stations are listed in Table 1. At each station two class A pans were exposed within a few metres of each other. One of the pans, referred to as pan A, was never screened. The other pan, referred to as pan B, was screened on alternate months.

Daily evaporation readings were made at both pans. Also measured were the water temperatures in both pans, the daily wind run at 2 metres and the rainfall. Several years of data were obtained from each station, in the period 1967 to 1971.

Differences in evaporation between screened and unscreened pans are not entirely due to the effect of the bird screen. The two pans and their exposures are not identical. These exposures and instrument effects were estimated from observations when pan B was unscreened. Mean evaporation differences due to exposure were then subtracted from mean evaporation differences when pan B was screened to provide an estimate of the effect of the bird screen. It was assumed in the analysis that the fitting of a bird screen to pan B would not affect the evaporation from pan A. Unscreened pans were not specifically protected from birds, but the trials were held in areas where readily available alternate water sources minimised the problem.

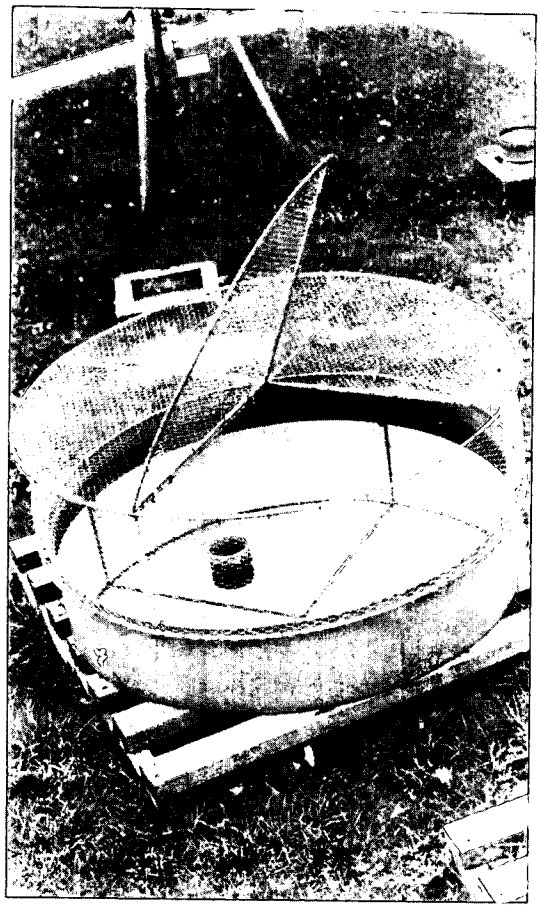
Results

Table 1 shows mean percentage differences in monthly evaporation totals of pans A and B, for pan B screened and unscreened. The corresponding effect of the bird screen, obtained by subtracting these quantities is also shown for each of the four stations.

Percentage differences were computed relative to pan A, i.e. 100 (pan A – pan B)/pan A. To maximise the data set all months with less than six days of compatible data missing were accepted in the analysis. Although the plan was to screen pan B on alternate months, pan B was left screened for longer periods at Darwin and Griffith.

*Private communication from G. Stanhill, the Volcani Institute of Agricultural Research, Israel.

Fig. 1. Class A evaporation pan fitted with the standard Australian bird screen.



Monthly evaporation totals were analysed to avoid some of the scatter inherent in daily data. A percentage correction for the effect of the bird screen is easy to apply and this measure was adopted when scatter diagrams showed that percentage evaporation differences betweeen pans were independent of evaporation amount irrespective of whether pan B was screened or unscreened.

Combining the effects of the bird screen at individual stations, using a weighted average, gives a mean reduction in monthly evaporation totals relative to unscreened pans of 6.6 per cent. This is equivalent to a correction of 7 per cent in the monthly evaporation totals from screened pans.

Table 1 shows the mean reductions in monthly evaporation totals attributed to the bird screen for the four stations. The reductions in evaporation range from 4.1 to 8.2 per cent. The differences in the effect of the bird screen at the four stations are statistically significant (details not shown) but the actual causes for this variation are not obvious. Climate could be a factor, but then seasonal effects would also be likely. A one-way analysis of variance for seasonal effects was possible because the trials were conducted over several years and up to four differences in monthly evaporation totals were obtained for alternate calendar months. Table 2 presents the data and the analysis for Adelaide. Testing the differences in monthly evaporation totals in this way did not indicate that seasonal effects were present.

Mean differences of 3.1 and 3.8 per cent in monthly evaporation totals between unscreened pans were observed at Aspendale and Griffith, respectively. At Aspendale there was a difference in the exposure of the two pans. Pan A was sited 3-4

Table 1. Percentage differences in monthly evaporation totals from 2 adjacent pans, one of which is screened on alternate months and the associated percentage reductions in monthly evaporation totals due to the bird screen.

	Pan B Screened			Pan B Unscreened			Effect of birdscreen	
Station	Mean % difference in monthly totals	Standard deviation %	No. of months of data	Mean % difference in monthly totals	Standard deviation %	No. of months of data	Mean reduction in monthly evaporation totals	Standard deviation %
Griffith 34.3 °S 148.1 °E	4.4	4.3	28	−3.8	2.6	15	8.2	5.0
Darwin 12.5 °S 130.8 °E	6.8	4.8	20	−1.0	2.5	8	7.9	5.4
Aspendale 38.0 °S 145.1 °E	2.8	6.6	8	−3.1	2.0	9	5.9	6.9
Adelaide 34.9 °S 138.6 °E	3.9	4.2	18	−0.2	2.1	18	4.1	4.7
Combined							6.6	5.3

Table 2. Test for seasonal effects of the bird screen at Adelaide.

Percentage differences in monthly evaporation totals (pan B screened)			
	Year 1	Year 2	Year 3
Feb.	8.8	7.2	0.3
Apr.	3.5	3.3	4.8
Jun.	12.0	4.3	3.2
Aug.	−4.3	1.1	−0.7
Oct.	8.6	−2.7	6.4
Dec.	3.3	3.7	7.4

Source of variation	Degrees of freedom	Sum of squares	Mean squares
Total	17	259.26	17.37
Months	5	110.92	22.18
Residual	12	184.34	15.36

$F_{5,12} = 1.4$
(F5, 12 at the 5 per cent level is 4.68)

metres north of a tower with a small hut built into the base. It was also located in a shallow depression compared to pan B sited some 11 metres away. At Griffith there was no obvious difference in the exposure of the two pans. A close look, however, showed that pan B was systematically filled to a level 2.5 cm higher than pan A, due to a non-standard marker reference. These evaporation differences between unscreened pans at Griffith and Aspendale illustrate how sensitive evaporation measurements are to changes in exposure and equipment.

The effect of the bird screen on the rainfall caught by the class A pan was also considered. The screen overlaps the rim of the class A pan. There is a possibility, therefore, that some of the rain intercepted by the screen, which should have entered the pan, will drop down outside the pan. The net effect of this would be that evaporation on a rain day would be overestimated since more rain than that which actually entered the pan would have been corrected for. A regression analysis of daily evaporation differences (one pan screened) with daily rainfall using 191 rain days at Darwin, gave a correlation coefficient of −0.13 which is not significantly different from zero. Darwin was chosen because it provided a large range of daily rainfalls (up to 68 mm). The lack of correlation between daily rainfall and evaporation differences suggests that the bird screen does not significantly affect the rainfall catch of the class A pan.

The reduction in water temperatures of screened pans was calculated using Aspendale and Adelaide data. At these two locations the mean monthly water temperature, (max + min)/2 for each day averaged over the month, was reduced by 0.3 °C when a bird screen was fitted to the pan.

Conclusions

The reduction in monthly evaporation totals due to the standard Australian bird screen ranged from 4 to 8 per cent at the four test sites. Combining the effects of the bird screen at individual stations, using a weighted average, gave a mean reduction in monthly evaporation totals relative to unscreened pans of 6.6 per cent. This is equivalent to a correction of 7 per cent in the monthly evaporation totals from screened pans.

The significant differences between the corrections required at the four sites raises the problem of how best to apply the results to the Australian network. The application of individual correction factors for each pan site would be cumbersome and appropriate figures are not available. It would be more practical to apply a single correction at all sites.

The use of a single correction factor for the whole network would be a source of error at some locations. The errors which apply at the test sites range over a few per cent. These sites covered a wide range of climatic conditions and similar errors should apply over much of the network. The errors inherent in a single correction factor are compatible with evaporation changes noted with small differences in pan exposure and equipment. This suggests that the application of a single correction factor over the entire network may be acceptable.

A seasonal trend in the effect of the bird screen on monthly evaporation totals is not apparent from results of this trial. The analysis of evaporation differences between screened and unscreened pans at Darwin indicated that daily evaporation differences and daily rainfall are uncorrelated. This result implies that the bird screen does not significantly alter the amount of rain caught by the class A pan.