A NOTE ON FORECAST ECONOMICS

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Introduction.—The present discussion may be regarded as an extension of the various remarks that have appeared in the literature during the past few years concerning the need for improved forecast accuracy and the merits and demerits of probability and categorical forecasts.

It has been pointed out by Thompson [2] that categorical forecasts must be extremely accurate in order that a saving over the use of simple climatic probabilities alone can be realized in many practical applications. Thompson and Brier [1; 3] give formulae expressing the saving obtainable from the use of probability forecasts over use of climatic probabilities. Thompson's equation expressing the necessary accuracy for forecasts to improve over climatic probabilities assumes equal errors of both kinds. This note analyzes the situation when the two kinds of errors do not occur with equal frequency, and points up some facts not mentioned previously.

Climatic probability.—To review the situation, if the climatic probability of unfavorable weather P_c exceeds the ratio of protection cost C to unprotected loss L, one applies protective measures daily, and on N occasions the total expense is

$$\text{Case I:} \quad E_c = CN. \tag{1}$$

If P_c is less than C/L, protective measures are never applied, and the expense is

$$\text{Case II:} \quad E_c = P_c NL. \tag{2}$$

The ideal situation would be to have perfect forecasts so that protective measures are taken only when needed. The expense would then be

$$E(\text{min}) = P_c NC \tag{3}$$

which is less than either (1) or (2), since C must be less than L to make economic sense.

Categorical forecasts.—Thompson [2] proposed a case where $C = \$10$ and $L = \$100$. Using actual forecast and verification data from a selected weather station, he computed the cost of using the categorical forecasts issued in the following manner:

$$E(\text{categorical}) = C(51 + 6) + L(6) = \$1170.$$

There were 57 forecasts of adverse conditions, six of which were in error, and six occurrences of adverse conditions that were not forecast during a 90-day period. If simple climatic probabilities had been used, the cost would have been (Case I, since the climatic probability is 0.63):

$$E_c = 10 \times 90 = \$900.$$

The cost using the forecast was \$270 greater than the cost based on climatology despite a forecast accuracy of 87 per cent (78 correct out of 90 forecasts). If the service had been perfect, the cost would have been

$$E(\text{min}) = P_c NC = 0.63 \times 90 \times 10 = \$570.$$

Probability forecasts.—It has been demonstrated by Thompson that it is difficult to improve on the use of climatic probabilities with ordinary categorical forecasts, since with the latter, errors resulting in unprotected losses tend to occur as often as errors resulting in costs for unnecessary protection. If C is appreciably less than L, it is obviously worthwhile to attempt to decrease the ratio of "loss errors" to "cost errors" so as to achieve the best economy. Probability forecasts provide a basis for arranging a more suitable distribution of the errors for the more usual situations where C/L is small. This is because the frequency of "loss errors" is regulated indirectly by the ratio C/L. Protection will be applied when, and only when, the forecast probability is greater than C/L, and occurrences of the adverse element are far more apt to be associated with forecast probabilities greater than C/L than with less.

Effect of distribution of error types.—The question then arises as to what distribution of "loss errors"