

ROYAL METEOROLOGICAL SOCIETY: AUSTRALIAN BRANCH MEETING

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The Analysis of Rainfall and River Flow

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Although Dr Gani, CSIRO Division of Mathematics and Statistics, Canberra, introduced himself as an ignoramus in meteorology, he promptly went on to mention the role his Division of CSIRO has played in the analysis of cloud seeding experiments. He also referred to involvement in the analysis of hydrological data, including the water table, rainfall and river flow. Users need to understand the statistical properties of the data in order to produce extended artificial series for simulation, e.g., for dam designs. If the data series approximates a particular theoretical distribution or model, this can be used for planning and prediction.

However, Dr Gani felt that we do not fully understand the statistical behaviour of rainfall. It is thought that high rainfall is usually normally distributed, while low rainfall follows a log-normal distribution. Unfortunately, in any particular case it is not certain which applies, and this varies from place to place and often with time of year or from one epoch to another.

Interest in droughts and floods leads to great interest in the occurrence of runs of dry or wet days, and in serial correlations, but these properties, too, vary with locality. Data are not necessarily homogeneous: statistical properties may change with time - not only may mean values change, but also the variability. Investigations on the homogeneity of Australian rainfall were so far not very conclusive. It was pointed out that the occurrence of periodicities in data implies a strong serial correlation, i.e., a value at a given time is closely related to that at some preceding time, with an additional random component.

Dr Gani referred to work he had done as a student of Prof. P.A.P. Moran (Australian National University) on river flow in relation to planning for the Snowy Mountains Scheme. One problem was to predict maximum likely river flows from an assumed model distribution. Although the model was only approximate, the results proved to be useful. The analysis of data from Victorian rivers indicated that some rivers have flows that are nearly normally distributed, while others are nearly log-normal. Serial correlations for annual values vary considerably from one river to another in Victoria.

In conclusion, Dr Gani maintained that in both rainfall and river flow one could construct useful models, provided one did not place too much reliance on their results: we should not be too zealous by having total faith in answers from our models. He added that he regretted that more members of his Division were not working on meteorological and hydrological problems.

In discussion, Dr Brook raised the problem of intermittency and self-similarity in meteorological records. Dr Gani replied that time dependent problems have proved very difficult; it is hard enough to characterise processes that are homogeneous and stationary, and so far one cannot deal adequately with those that are not. Dr Pittock asked why apparent periodicities so often break down, and Mr Coughlan inquired about spatial correlations. Dr Gani commented that statisticians do not have all the answers: we have to live with imperfect knowledge, and accept that by the time we have more data, the situation we seek to describe may have changed. Long series of data, as in the more obvious case of health statistics, are simply not homogeneous.

In answer to a question from Dr Gibbs about how we can decide if and when to advise people to stop burning fossil fuels (because of the increase in atmospheric carbon dioxide), Dr Gani commented that there is no easy answer - such decisions are usually made in an empirical fashion on the basis of practical experience.

In reply to a number of further questions, the speaker gave it as his opinion that statistical analysis was still in its infancy; there was some hope of enhanced usefulness for the future. He also commented that while some meteorologists and hydrologists are quite knowledgeable about statistics, others make inadequate or wrong use of statistics. In relation to various improbable (spurious) correlations, he stated that even though one might be a statistician, one should not take leave of one's senses. Several references were made to Dr Gani's paper 'The use of statistics in climatological research' (*Search*, 6, 504-8, 1975), which is a useful supplement to his talk.

A.B.P.