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Stochastic generation of annual, monthly and daily climate data: A review

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Abstract. The generation of rainfall and other climate data needs a range of models depending on the time and spatial scales involved. Most of the models used previously do not take into account year to year variations in the model parameters. Long periods of wet and dry years were observed in the past but were not taken into account. Recently, Thyer and Kuczera (1999) developed a hidden state Markov model to account for the wet and dry spells explicitly in annual rainfall. This review looks firstly at traditional time series models and then at the more complex models which take account of the pseudo-cycles in the data. Monthly rainfall data have been generated successfully by using the method of fragments. The main criticism of this approach is the repetitions of the same yearly pattern when only a limited number of years of historical data are available. This deficiency has been overcome by using synthetic fragments but this brings an additional problem of generating the right number of months with zero rainfall. Disaggregation schemes are effective in obtaining monthly data but the main problem is the large number of parameters to be estimated when dealing with many sites. Several simplifications have been proposed to overcome this problem. Models for generating daily rainfall are well developed. The transition probability matrix method preserves most of the characteristics of daily, monthly and annual characteristics and is shown to be the best performing model. The two-part model has been shown by many researchers to perform well across a range of climates at the daily level but has not been tested adequately at monthly or annual levels. A shortcoming of the existing models is the consistent underestimation of the variances of the simulated monthly and annual totals. As an alternative, conditioning model parameters on monthly amounts or perturbing the model parameters with the Southern Oscillation Index (SOI) result in better agreement between the variance of the simulated and observed annual rainfall and these approaches should be investigated further. As climate data are less variable than rainfall, but are correlated among themselves and with rainfall, multisite-type models have been used successfully to generate annual data. The monthly climate data can be obtained by disaggregating these annual data. On a daily time step at a site, climate data have been generated using a multisite type model conditional on the state of the present and previous days. The generation of daily climate data at a number of sites remains a challenging problem. If daily rainfall can be modelled successfully by a censored power of normal distribution

then the model can be extended easily to generate daily climate data at several sites simultaneously. Most of the early work on the impacts of climate change used historical data adjusted for the climate change. In recent studies, stochastic daily weather generation models are used to compute climate data by adjusting the parameters appropriately for the future climates assumed.

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