

A Markov chain probability model to describe wet and dry patterns of weather at Colombo

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Abstract The hypothesis that the wet and dry patterns of daily precipitation observed in Colombo can be modeled by a first order Markov chain model was tested using daily rainfall data for a 60-year period (1941–2000). The probability of a day being wet or dry was defined with respect to the status of the previous day. Probabilities were assumed to be stationary within a given month. Except for isolated single events, the model is shown to describe the observed sequence of wet and dry spells satisfactorily depending on the season. The accuracy of modeling wet spells is high compared to dry spells. When the model-predicted mean length of wet spells for each month was compared with the estimated values from the data set, a reasonable agreement between the model prediction and estimation is seen (within ± 0.1). In general, the data show a higher disagreement for the months having longer dry spells. The mean annual duration of wet spells is 2.6 days while the mean annual duration of dry spells is 3.8 days. It is shown that the model can be used to explore the return periods of long wet and dry spells. We conclude from the study that the Markov chain of order 1 is adequate to describe wet and dry patterns of weather in Colombo.

1 Introduction

Sri Lanka is an island in the Indian Ocean, located about 31 km off the southern coast of India. The climate of Sri Lanka is considered to be warm and tropical. Its position

between 5 and 10 ° North latitudes has blessed the country with a warm climate moderated by ocean winds and considerable moisture. The mean temperature ranges from about 16 °C in the central highlands, to a maximum of 33 °C in low-altitude areas. There are two main climatic zones in Sri Lanka. The mountains and the southwestern part of the country, known as the wet zone, receives ample rainfall (an annual average of 2,500 mm), while most of the southeast, east, and northern parts of the country comprising the dry zone, receives less rainfall (between 1,200 to 1,900 mm annually). When considering the wind patterns, the year can be divided into four seasons, namely the two monsoons (southwest from May to September and Northeast from December to February) and the two inter-monsoonal periods. In most parts of the country, rainfall follows a bi-annual pattern leading to a main cropping season called “Maha” (September to March) and a minor cropping season called “Yala” (April to August). The wet zone receives rainfall throughout the year which is adequate for year-round cultivation. In the dry zone, the rainfall is adequate for crop growth only during the Maha season. Since Sri Lanka’s economy depends mainly on agriculture, understanding wet and dry behavior is important for crop planning and water conservation measures.

In this study, a well-known method, Markov chains, has been used to investigate the wet and dry weather patterns observed in Colombo. The use of Markov chains in describing daily rainfall occurrences became quite popular after the work of Gabriel and Neumann (1962). A number of related studies are available that investigate the applicability of the Markov chain to model rainfall patterns in Sri Lanka (Weerasinghe 1989; Dahale et al. 1994; Punyawardena and Kulasiri 1996; Perera et al. 2002; Piyadasa and Sonnadara 2010). One of the early studies carried out with 35 consecutive years daily rainfall at Mapalana (Weerasinghe 1989) reported Markov chain probabilities for weekly rainfall and rainfall availability in relation to rice agronomy for the Yala and Maha seasons.

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