IOSR Journal of Applied Physics (IOSR-JAP)
ISSN: 2278-4861. Volume 2, Issue 1 (Sep-Oct. 2012), PP 34-35
www.iosrjournals.org

Tamil Nadu Rainfall Behaviour: Chaotic

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Abstract: *This paper considers the possibility of making a qualitative test on Tamil Nadu rainfall data for chaos from a simple nonlinearity test . we have employed the surrogate data method which gives information on the significance of amount of non linearity involved in a time series data. We have calculated the Lyapunov exponent for the surrogate data and the original data . The distinct results obtained from both the surrogate data and the original data implies that the time series under consideration is chaotic.*

I. Introduction

The understanding and characterisation of the nature of the climate system is critical. There are several models that were developed to study the climatic system of a region. The most widely used method is stochastic method. In the present paper we have employed the method of surrogate data (1) which is an approach that makes use of the substitute data generated in accordance to the probabilistic structure underlying the original data. This means that the surrogate data possess some of the properties, such as the mean, the standard deviation, the cumulative distribution function, the power spectrum, etc., but are otherwise postulated as random, generated according to a specific null hypothesis.
First we discuss surrogate data technique; we then introduce the lyapunov exponent for calculating the quantitative measure of the presence of the chaos in the time series considered.

II. Surrogate Data

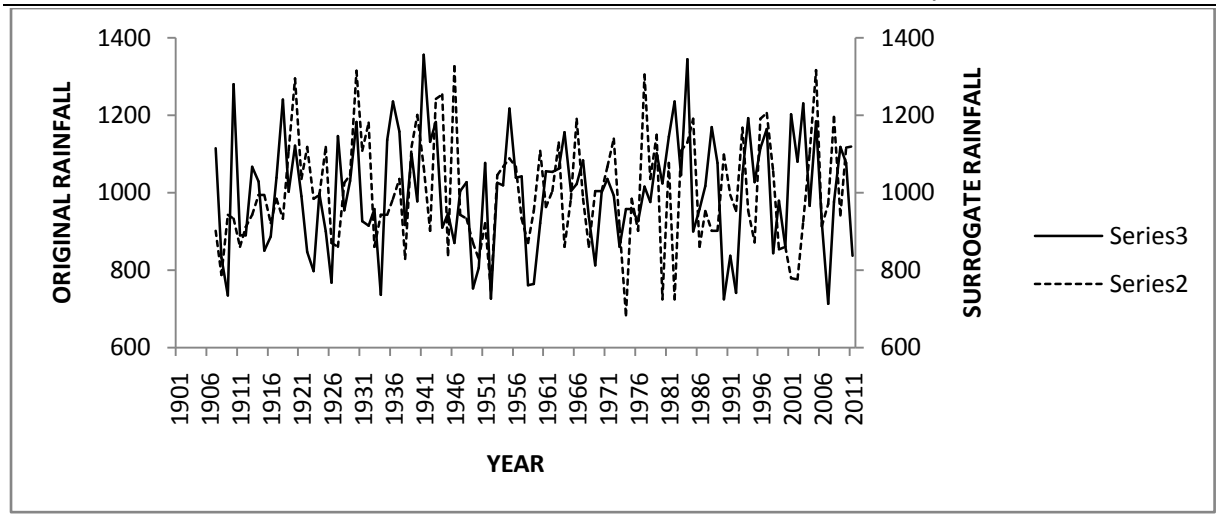
The Surrogate data technique can be used to test the specific Hypothesis: is the data linearly filtered noise; is the data linear; is the data initial value dependent? Here, the null hypothesis consists of a candidate linear process, and the goal is to reject the hypothesis that the original data have come from a linear stochastic process. The rejection of the null hypothesis can be made based on some discriminating statistics. Since the primary interest is to identify chaos in the time series, it would be desirable to use any of the statistics used for the identification of chaos, such as the correlation dimension, the Lyapunov exponent, , etc. If the discriminating statistics obtained for the surrogate data are significantly different from those of the original time series, then the null hypothesis can be rejected, and original time series may be considered to have come from a nonlinear process. On the other hand, if the discriminating statistics obtained for the original data and surrogate data are not significantly different, then the null hypothesis cannot be rejected, and the original time series is considered to have come from a linear stochastic process.

III. Data And Methodology

The rainfall data of Tamil Nadu rainfall data was obtained from IMD, Chennai. We have considered the annual rainfall data for a period of 111 years (from 1901-2011). We have generated surrogate data using FT method (phase randomisation) in matlab software. We then calculated the Lyapunov exponent for both the surrogate data and the original data. the method followed for Lyapunov exponent is asfollows
The current approach is principally based on the work of Sato *et al.* [3] which estimates l1
where dj (0) is the initial distance from the j^{th} point to its nearest neighbour, where Dt is the sampling period of the time series, and dj (i) is the distance between the jth
Pair of nearest neighbours after i discrete-time steps, i.e., $i \times$ Dt seconds.

IV. Results And Discussion

The largest maximum Lyapunov Exponent calculated for the original data is 2.158 and for surrogate data was calculated to be 0.370035. The two Lyapunov exponent values are distinct. This leads to rejecting the null hypothesis that the original data has come from the linear system and the value of the Lyapunov exponent indicates that there is a low dimensional chaos present in the Tamil Nadu rainfall data. FIGURE 1. Shows the graph between the surrogate data and the original rainfall data that was generated



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