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Long term spatial and temporal rainfall trends and homogeneity analysis in Wainganga basin, Central India

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ABSTRACT

Gridded rainfall data of $0.5 \times 0.5^{\circ}$ resolution (CRU TS 3.21) was analysed to study long term spatial and temporal trends on annual and seasonal scales in Wainganga river basin located in Central India during 1901–2012. After testing the presence of autocorrelation, Mann–Kendall (Modified Mann–Kendall) test was applied to non-auto correlated (auto correlated) series to detect the trends in rainfall data. Theil and Sen's slope estimator test was used for finding the magnitude of change over a time period. For detecting the most probable change year, Pettitt–Mann–Whitney test was applied. The Rainfall series was then divided into two partial duration series for finding changes in trends before and after the change year. Arc GIS was used to explore spatial patterns of the trends over the entire basin. Though most of the grid points shows a decreasing trend in annual rainfall, only seven grids has a significant decreasing trend during 1901–2012. On the basis of seasonal trend analysis, non-significant increasing trend is observed only in post monsoon season while seven grid points show significant decreasing trend in monsoon rainfall and non-significant in pre-monsoon and winter rainfall over the last 112 years. During the study period, overall a 8.45% decrease in annual rainfall is estimated. The most probable year of change was found to be 1948 in annual and monsoonal rainfall. There is an increasing rainfall trend in the basin during the period 1901–1948, which is reversed during the period 1949–2012 resulting in decreasing rainfall trend in the basin. Homogeneous trends in annual and seasonal rainfall over a grid points is exhibited in the basin by van Belle and Hughes' homogeneity trend test.

1. Introduction

Rainfall is one of the key climatic variables that affect both the spatial and temporal patterns of water availability. One of the challenges posed by climate change/climate variability is ascertainment, identification and quantification of trends in rainfall and their implications on river flows in order to assist in formulation of adaptation measures through appropriate strategies for water resources management. It is also recognised that rainfall is one of the key climatic variables that affect both the spatial and temporal patterns on water availability (De Luis et al., 2000).

In the analysis of trends of rainfall in the Indian Himalayas, Basistha et al. (2009) observed that rainfall has decreased in the Indian Himalayas during last century as a sudden shift, rather than gradual trend. Kumar and Jain (2011) found decreasing trend in the annual rainfall and rainy days in 15 basins out of 22 basins in India. Even, consolidation of recent studies that have been carried out on analysis of rainfall which is the key input into the hydrologic system, there is conclusive evidence that rainfall is decreasing in Asia (Sinha Ray and Srivastava, 1999; Khan et al., 2000; Shrestha et al., 2000; Mirza, 2002; Lal, 2003; Min et al., 2003; Goswami et al., 2006; Dash et al., 2007). Some investigators (i.e. Cayan and Peterson, 1989; Lins and Slack, 1999; Jain and Lall, 2000) have reported evidence of trends (possibly due to anthropogenic influences) and long-term variability of climate. Studies suggest South Asia most vulnerable to climate change.

Analysis of rainfall trends is important in studying the impacts of climate change for water resources planning and management (Haigh, 2004). It has been recognised that global or continental scale observations of historical climate are less than useful for local or regional scale planning (Barsugli et al., 2009; Brekke et al., 2009; Raucher, 2011). Thus, the evaluation of historical trends or future projections on a regional or local scale is needed. In this study, an attempt has therefore been made to study the trends in the annual rainfall series in the Wainganga basin, India to find if there have been any significant changes in the rainfall trends during 1901–2012.

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2. Study area and data used

2.1. Study area

Wainganga basin is a sub-basin of the Godavari River basin which is located from 78°00′ to 81°00′ East longitudes and 19°60′–22°07′ North latitudes as shown in Fig. 1. The total catchment area of the basin is 51,421 km^2 with an elevation ranges from 144 to 1208 m (Fig. 1) above mean sea level. The basin is bounded in the North by Central India hills, in the South and East by the Eastern Ghats and in the West by Maikala hill range. The Chiroli Hills form the watershed dividing the Wainganga basin

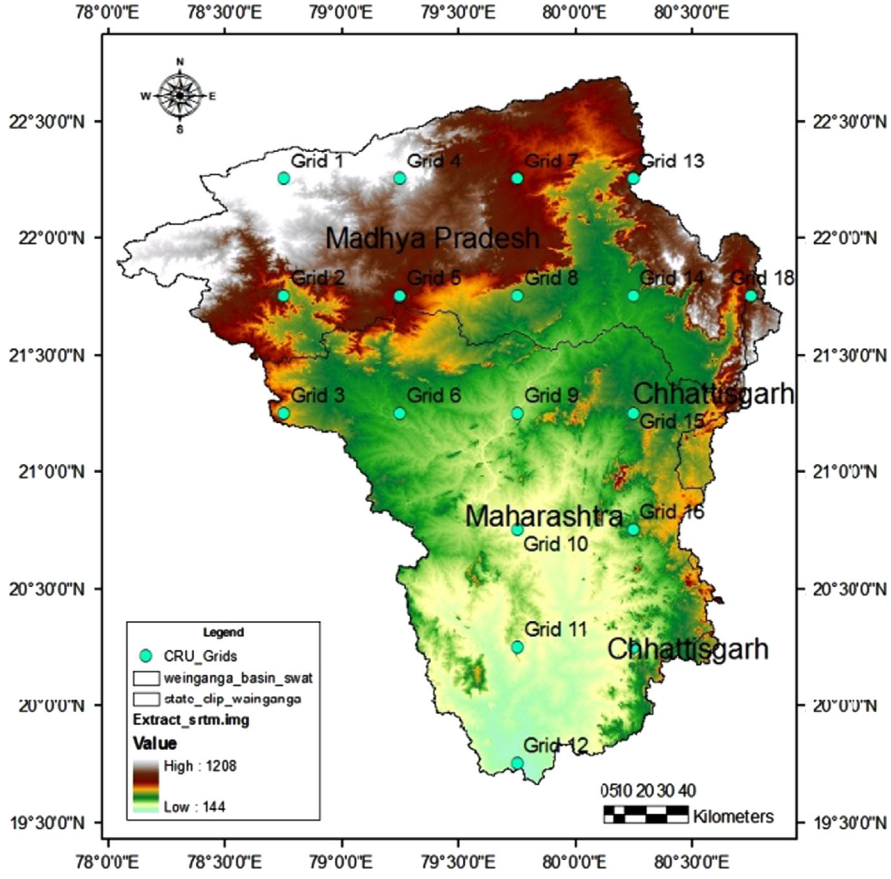

Fig. 1. Location of Wainganga basin and the grid points with DEM.

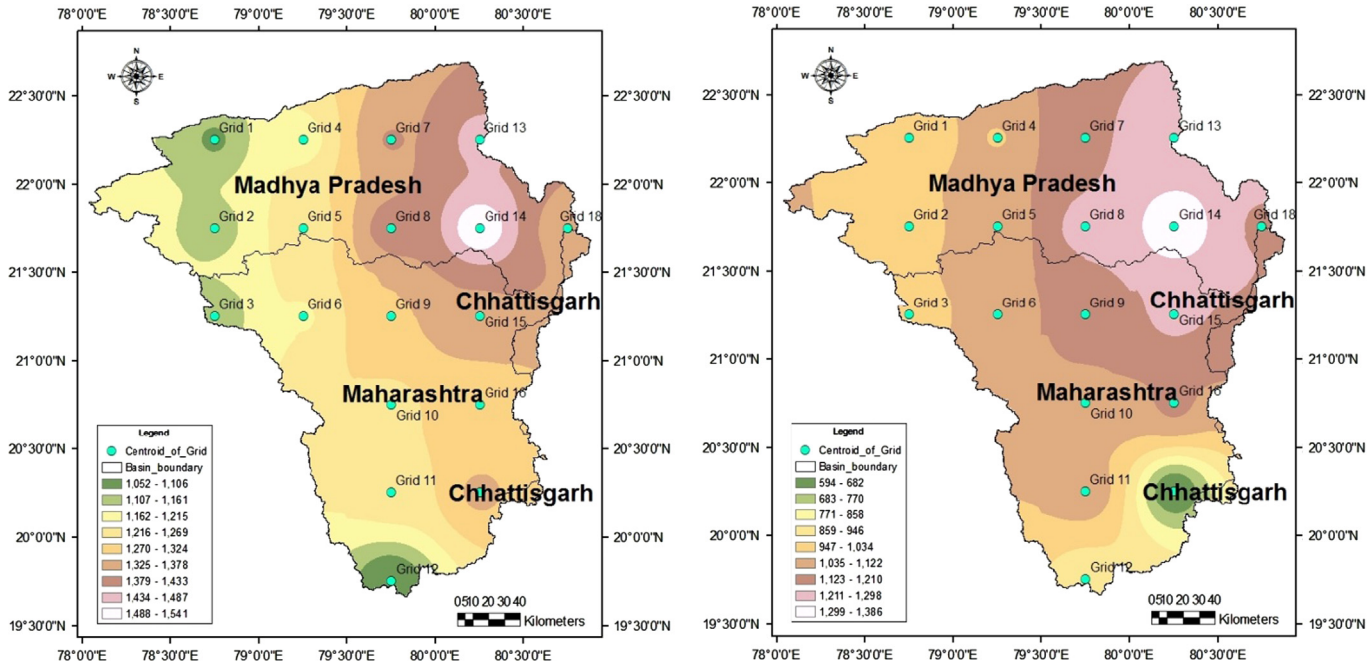

Fig. 2. Rainfall Map in Wainganga basin (a) annual (b) monsoon.