GEOMORPHOMETRY 2020 PERUGIA, ITALY JUNE 22 - 26 2020

# Suspected signature of active tectonism in Palghat Gap, India

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***Abstract*- The present study is an attempt to identify the signature of ongoing tectonic adjustments within a major watershed, peninsular India, which has experienced several earthquakes including a M=6.0 event. Previous studies have also identified an active fault within the watershed. This watershed is criss-crossed by several lineaments in which NW-SE and NE-SW trending lineaments are regionally more conspicuous. In the present study quantitative analysis of 29 sub basins of Bharthapuzha watershed is carried out by analysing their Hypsometric curves and hypsometric integral. The study found that the basins east of the epicentre of 1900 earthquake, northeast of lineament 4 (NW-SE), apparently indicating higher relative uplift, which is further supported by the ongoing seismicity observed in the north eastern side of the lineament.**

## I. Introduction

Studies conducted in last few decades have identified a number of evidences for neotectonism within the cratonic region of Peninsular India, which was once considered as tectonically stable [1,2,3,4]. In some part of Peninsular India drainage networks are also considered to be tectonically controlled [5]. Studies conducted, using the geomorphic indices and morphometric tools, in peninsular India had identified several potential seismogenic structures as a first step of seismic hazard assessment [6,7,8,9]. Studies elsewhere in Peninsular India also suggest that the damaging earthquakes in this region can occur at places where it is least expected, due to long return period [1]. Thus, the present study is focused to identify evidence of active tectonism through morphometric analysis.

The Coimbatore earthquake M=6.0 is the largest event reported in the southern peninsular India falling with in the major watershed called Bharthapuzha [10]. In the present study, quantitative analysis of Bharthapuzha watershed using Hypsometric curve and Hypsometric integral for the individual sub basins were carried out to understand the ongoing tectonic activity.

## II. Study Area

The E-W trending Palghat Cauvery shear zone is one of the prominent Precambrian shear zone in peninsular India. The Palghat Gap, a conspicuous geomorphic break, is also coincides with this shear zone [11,12,13]. Bharathapuzha and its tributaries constitute the drainage network in the gap area, which is generally controlled by E-W trending lineaments [14]. The Gap region consists of 250-km long and 30-km wide low land ('gap') bordered by ridges and hills. The structural elements in the gap region are consistent with a ductile shear zone (Palghat-Cauvery Shear zone), defined by a large E-W dextral oblique-slip component, which may have been associated with Proterozoic tectonic events [15]. Based on thermobarometric studies large-scale exhumation of lower to mid-crustal rocks is identified in the Palghat gap region [16]. The exhumed low-mid-crustal basement rock in the area suggests a north south compression during late Proterozoic (900-550 Ma) [16]. Earlier studies identified a NW-SE trending fault located in the south western corner of the Bharathapuzha watershed as active [6,17].

In this region some of the NW-SE lineaments are defined by emplacement of basic dykes connected with Deccan volcanism [18,19]. There are four prominent NW-SE trending structures in the basin. The F1 is identified as active fault [17]. The lineament L1 is continuing from the central part of Kerala state called Idamalayar lineament which is also the location for dyke emplacement. The lineament L4 is merging with L2 and is spatially associated with the epicentre of M=6.0 earthquake. Historical and recent data also suggest that several earthquakes have occurred in the Palghat Gap between 1865 and 2007, (e.g. [20]).

## III. Methodology

The present study used ASTER (Advanced Spaceborne Thermal Emission and Reflection Radiometer) DEM as basic elevation data. For analysis DEM and other available data reprojected to make similar projection. Drainages, watershed and sub watershed boundaries were extracted from ASTER data using Arc GIS 10.6. Spatial analyst tool. Baharthapuzha watershed and sub basins within the watershed are derived based on the largest flow accumulation points in the area. On the basis of third and fourth order drainage, 29 sub watersheds were derived for the present study. The derived sub watersheds are converted to the features for calculating the area and other parameters. The elevation and area were calculated using the modelling tool of the Arc GIS. The lineaments are demarcated using the Landsat 7 data.

*Yogendra Singh, Biju John and KS Divyalakshmi (2020) Suspected signature of active tectonism in Palghat Gap, India:*

*in Massimiliano Alvioli, Ivan Marchesini, Laura Melelli & Peter Guth, eds., Proceedings of the Geomorphometry 2020 Conference, doi:10.30437/GEOMORPHOMETRY2020_42.*

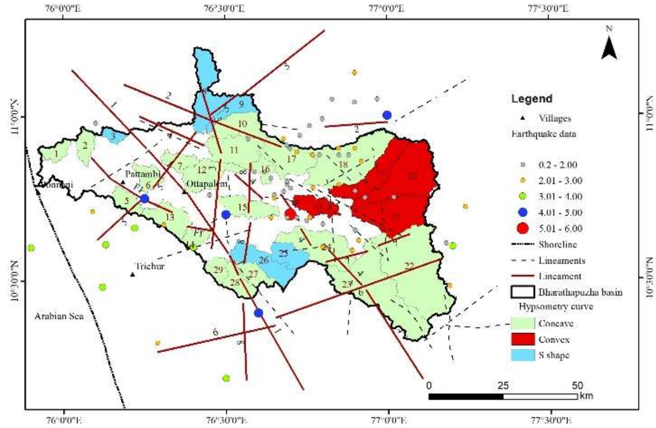


**Figure 1.** Map showing the spatial distribution seismicity and basin with different shapes of hypsometric curved obtained.

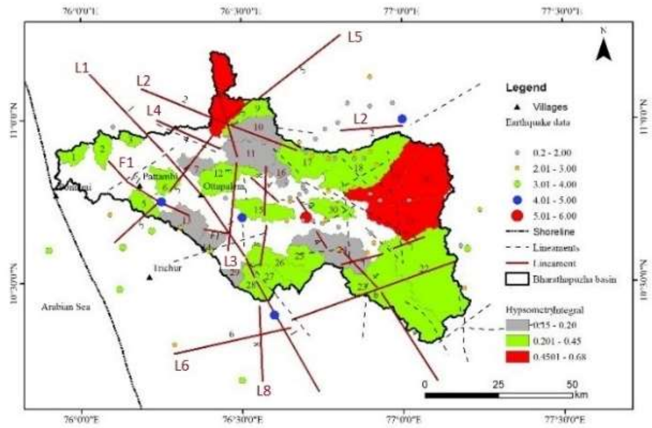


**Figure 2.** Map showing the spatial distribution seismicity and Hypsometric Integral values with in the study area.

## IV. RESULTS AND DISCUSSION

### *A. Hypsometry Curve*

Hypsometric curves are non-dimensional measure of the proportion of the catchment area above a given elevation. The hypsometric curves are related to geomorphic and tectonic evolution of drainage basins in terms of their forms and process [23]. Three types of landforms, namely, young, mature and monadnock were identified on the basis of hypsometric curve shape [21, 23].

Hypsometry curves derived for 29 sub watersheds of Bharthapuzha drainage system indicates that 62% sub watershed are concave upward, indicative of old stage topography [23]. The studies carried out by John and Rajendran 2008 have identified a NW-SE trending active fault (F1, Desamangalam fault) which is the source of ongoing seismicity, since 1989 in this area.

Three sub-basins (19, 20 and 21) in the eastern side of the watershed are in convex upward, which represents the youthful stages (Fig. 3) [21, 23]. The basin no. 30, which is located very close to the epicentre of 1900 Coimbatore earthquake is also showing convexity in the profile. Apart from this there are several 'S' shaped curves observed in the area which are located between L1 and L4 lineaments. The basins 12, 15, and 22 falling between L1 and L4 also show convexity in the upper part of the curve. Similarly, basins 2 and 3 located at the northwest of Desamangalam fault also show convexity in the profile (fig 1 & 2).

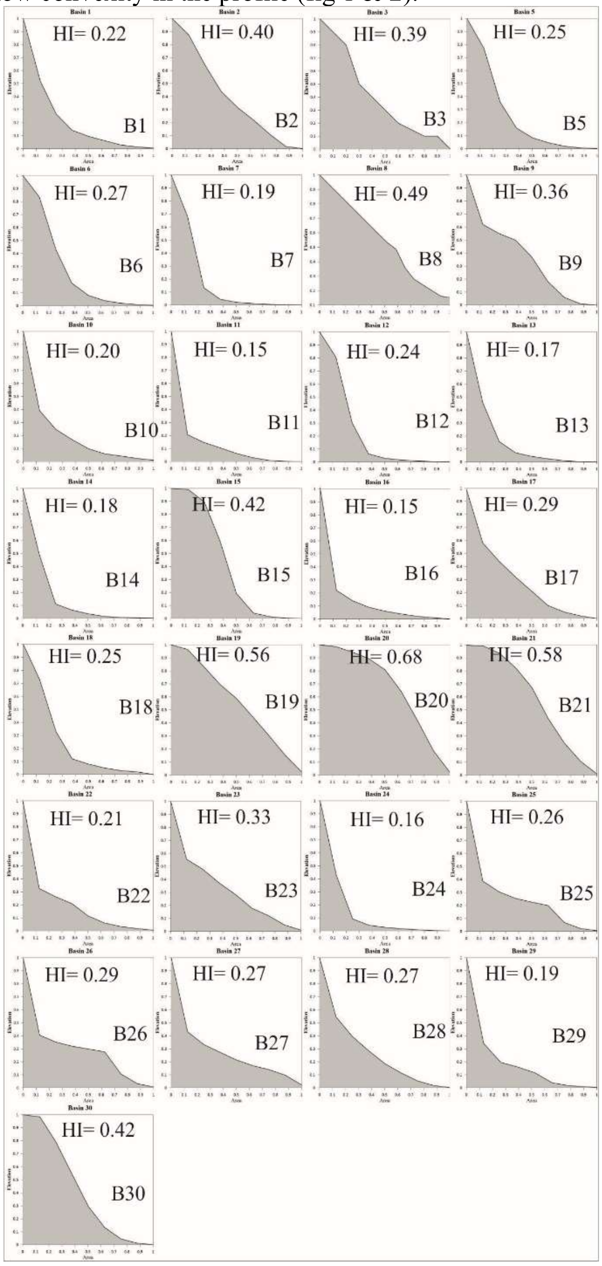


**Figure 3:** Hypsometric profile & HI for 29 sub basins

### *B. Hypsometric Integral (HI)*

Hypsometric integral controls the shape of a hypsometric curve and thereby provides clues for landform evolution [21]. The high value of hypsometric integral related to youthful topography, active tectonics. The intermediate value of HI indicates the mature stage. The low values of HI are related to the older landscapes, which got more eroded and doesn't reflect any activity in terms of recent tectonics [22].

In this area HI values are ranging from 0.15 to 0.68 and mean value is 0.312. Considering 0.312 as a mean value the entire basin is divided into three categories <0.20 is considered as lower values and 0.20 to 0.45 is considered as the medium values and above >0.45 is considered as highest values. The 48.27 % (14) basins are falling in the intermediate region and 31.03% (9) basin are flowing the trend of very low HI and 20.68 % (6) basin are flowing the high HI index. It is observed that along the lineament 4 which is spatially associated with M=6.0 earthquake shows as older landscape where as high values are observed in the basins located in the north eastern side of this lineament. Between the lineaments 1 and 4 most of the basins are observed as mature. It is also to be noted that the basins close to the debouching area (Arabian sea) in the line of Desamangalam fault show a mature stage than an old stage that observed in the central part of the catchment area (Fig 1 & 2).

## V. Conclusion

Bharathapuzha watershed in an unique drainage system flowing through a low lying terrain within western ghats. The occurrence of several low magnitude earthquakes and a magnitude of 6.0 (in 1900) and an identified active fault signifies the need for detailed study. The present study identified basins indicating the youth stage and also high values of HI in the northeast of the NW-SE trending lineament passing through east of Palghat. Between the lineaments L1 and L4 most of the basins are observed as mature where it shows selective convexity (uplift) in hypsometric profile. Tectonic adjustment of Desamangalam fault also appears to be reflecting as basins of mature values and also have convex in the hypsometry profile. Thus, the present study suggests a detailed investigation in this area is required to understand the nature of active tectonic adjustments.

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