Use of SRTM data for a quick recognition of active tectonic signatures

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*Abstract*ð **Peninsular India is considered tectonically stable even though a few damaging earthquakes occurred here. However, region around Wadakkancheri has been a site of microseismic activity since 1989. Studies, subsequent to 1994 M= 4.3 earthquake, had identified a prominent NW–SE structure overprinting the E–W trending lineaments associated with Palghat–Cauvery shear zone. The right angled turn of Bharathapuzha River at Desamangalam and a waterfall near this structure shows the influence of the structure to the drainage system which is identified as a south dipping reverse fault. The hanging wall side of the fault is characterized by abandoned river courses due to the river shift. The network of paleochannels was identified through SRTM data. Distance elevation profiles were also drawn from SRTM data to observe the influence of fault on the drainage system of the area. Near the coast both paleochannels and the river is flowing approximately at the same elevation. The data generated in the present study indicates, that a marked correlation between channel morphology and the proximity of the fault in the Bharathapuzha river basin.**

INTRODUCTION

Cratonic areas in continental interiors in general are characterized by low rates of stress accumulation and smaller slip rates. Recognizing active structures from such plate interiors is not easy. However, various studies in the cratonic hinterland show that the damaging earthquakes occur on pre-existing faults with a recurrence period of tens of thousands of year [1]. Such faults generally do not develop any dramatic fault scarps. In addition to this, weathering and erosion would neutralize any remnant of physiographic evidence of faulting. Even after these difficulties, various studies have however established that the deformation related with active tectonism can be identified from careful geomorphological studies using topographic maps, aerial photographs, and satellite images and by field investigation and repeat leveling [2] [3] [4].

For several decades, the morphometric analysis of relief is being widely applied for problem solving in various areas of geology and geomorphology [5] [6] [7]. Since SRTM data became widely available, many studies have utilized them for applications in topography, geomorphology, vegetation cover studies, tsunami impact assessment, and urban studies [8]. Using SRTM data and GIS techniques is a, precise, fast and inexpensive way for morphometric analysis [9] [10] [11] [12]. The present study is an attempt to find out whether SRTM data can be used to detect active faults from the slow deforming plate interiors.

STUDY AREA

The region around Wadakkancheri is a part of intraplate region of peninsular India. It lies in the vicinity of Palghat Gap, a major physiographic break in western Ghats. The E-W trending Palghat Gap also coincides with this Gap. Even though no major earthquakes have occurred in this area in the historic past, a few earthquakes are reported in the vicinity of Palghat Gap. Since 1989 this area has been experiencing repeated slight earthquake events. Among them the 1994 Wadakkancheri earthquake of M=4.3 is the biggest one recorded, which is followed by a number of aftershocks.

The E-W trending Bharathapuzha and its tributaries constitute the drainage network of the Palghat Gap. The lineaments within the gap generally trends in E-W direction where as in the southwestern end, NW-SE trending lineaments dominate. The studies subsequent to the 1994 earthquake identified an abrupt change in Bharathapuzha river course near Desamangalam and a

NW-SE trending structure that influences the course of the river down stream from that point [13]. Further studies identified the NW-SE trending structure as a reverse, south-dipping fault, which moved episodically in the present stress regime [14]. Through ESR dating techniques of fault gouge the last movement along this fault is determined as about 430 ka bp [15]

Geomorphic studies based on the topographic maps and satellite images suggest anomalies related with the fault movements. South of Bharathapuzha, signatures of drainage adjustments were picked up from these studies. The width of the present valley of bharathapuzha ranges from 400-700 m. The occurrence of paleochannels south of Bharathpuzha is another anomalous feature in this area. They are interlinked and abut against the coast parallel sand bars. Presently small drainages occupy these wide paleochannel valleys. Trench studies reveal that the deposits in the paleochannels are of fluvio- laccustrain origin. The studies further reveal that these channels were formed when sufficient water was flowing through it to make the valley wide. Due to lack of running water in the channels at present, which might have supplied by Bharathapuzha earlier, it is unable to cut the coast parallel sandbars across it.

Methodology

In order to check whether these signatures can be identified from topography, Shuttle Radar Topography Mission (SRTM) data is used, which have a spatial resolution of 90/90 m. The data has been cropped for the study area using ERDAS. Contours are generated for an interval of 20m using ARC GIS. Triangular Irregular Network (TIN) has been created from the contours using the 3D analyst tool of Arc GIS. The mapped faults are projected in the DEM and distance-elevation profiles are drawn across it. For the identification of paleochannels as well as present channel hydrogeological modeling, (Hydrology Tool) of ARC GIS software has been used.

Analysis

Paleochannels are demarcated in the southern side of the river. They occur at an elevation close to the present active channels. From the colour coded map (Fig.1) it can be observed that the central segment of the fault does not have appreciable elevation changes. However, for evaluating the subtle topographic features of the study area, 21 N-S trending profiles were extracted across the river at an interval of 2km. These are numbered from left to right. Two more profiles were drawn parallel to the coast and one profile has been drawn along the river. The profile i has been taken nearly 11 km from the coast. On profile i, the lowest elevation is zero whereever it goes over the paleochannels in the southern side of the river. This situation continue up to the profile no vii (marked as profile 1 in fig. 1) where the paleochannels are located at an elevation close to the present active channels. From profiles viii to xiv the river is controlled by the fault. Profile xiii (marked as profile no 2 in fig. 1) shows the maximum separation between fault and the river within the influenced zone. The paleochannel immediately south of the fault in the hanging wall occupied is at a higher elevation than the ones further south. Profile xiv (marked as profile no 3 in fig. 1) runs close to the N-S turn of the river. The profile xvii (marked as profile no 4 in fig. 1) is passing through the river where fault does not have any influence on it. The profiles further show that the valley through which Bharathapuzha is flowing in the vicinity of Desamangalam fault is very wide. Once it crosses the area of influence of the fault the river flows through a narrow zone or the river cuts down further, compared to the upstream side. The profiles across the fault indicate a sudden increase in elevation in the southern side compared to a relatively flat valley in the northern side.

The analysis shows an interlinking nature of paleochannels with valleys is N-S, NE-SW and NW-SE directions, where remote sensing studies shows that NE-SW trending channels are wide in comparison to other directions.

Conclusion

SRTM data can be used for a quick evaluation of active faults. Bharathapuzha river is controlled by the faults in the study area. Paleochannels of the drainage network in the area are located at the same elevation as the present active channels. Along the vicinity of the fault the drainage flows through a wider valley compared to the region where the faults do not have any influence. The data generated in the present study indicates a marked correlation between channel morphology and the proximity of the fault in the Bharathapuzha river basin and it can be useful in active fault studies if properly employed .

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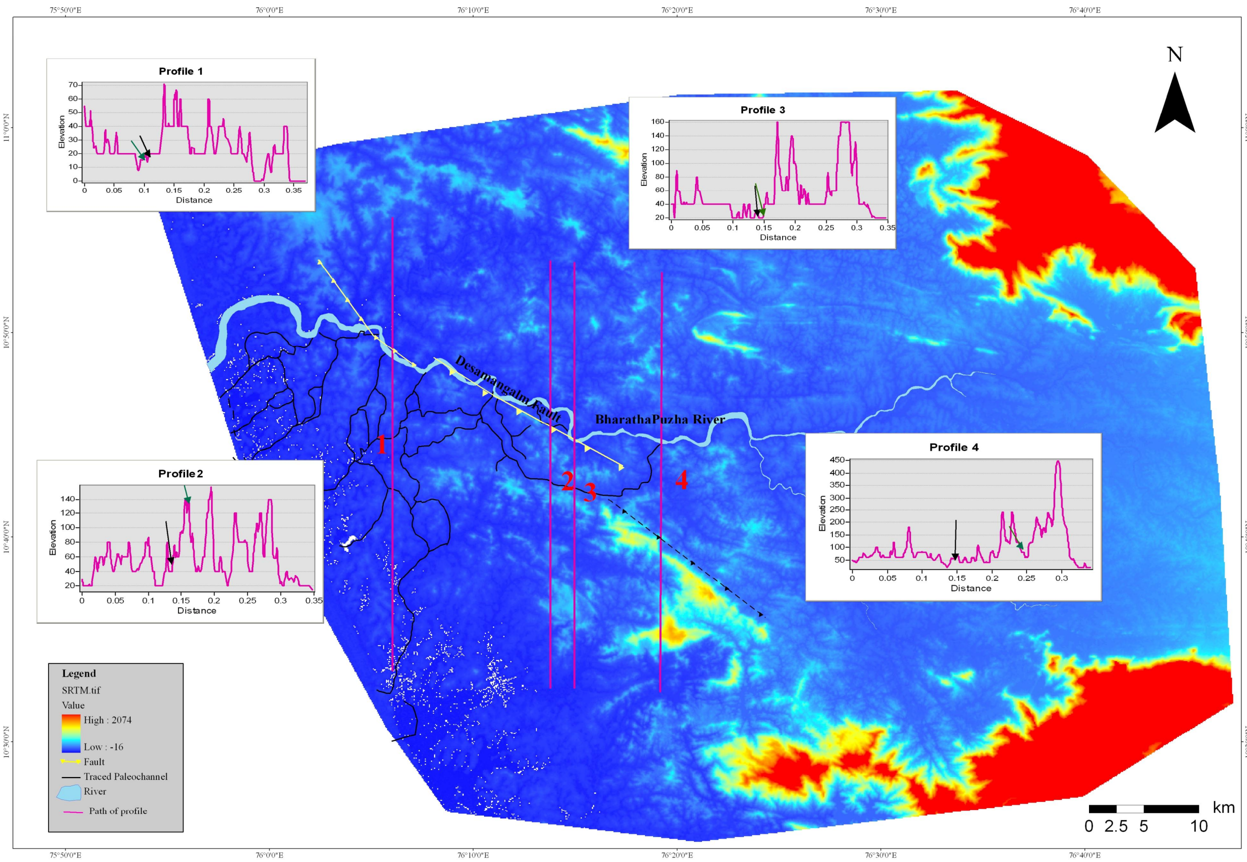

Fig. 1 Colour coded DEM generated from the SRTM data. The faults identified in the area are marked and profiles are drawn across it. The green arrow indicates the location of the fault where as the black arrow indicates the location of the river.

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