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Middle to late Holocene paleochannels and migration of the Palar River, Tamil Nadu: Implications of neotectonic activity

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ABSTRACT

Geomorphic, tectonic and sedimentary investigations have been carried out to understand the landscape evolution of the Palar River basin, Southern Peninsular India. For this purpose, satellite data interpretations coupled with field investigations, fluvial architecture and optically stimulated luminescence (OSL) dating methods were adopted to infer climatic variations and neotectonic deformation that took place during the mid to late Holocene period. Several paleochannels have been identified in the Northern part of the present day Palar River. The distribution pattern of the Palar paleochannels and its present course indicate its migration towards the south, leaving behind the old Palar River streams as paleochannels. Significant changes in the morphological characteristics, channel width and river pattern in the successive paleochannels reveal evidences of channel movement by avulsion largely controlled by reactivation of pre-existing lineaments and intensified NE monsoon. Based on OSL ages, two major phases of migration have been identified that occurred between 4.83 ka to 1.88 ka. First phase occurred between 3.59 ka to 3.26 ka due to intensified monsoon accompanied with small scale neotectonic activity. The second phase took place between 2.42 ka to 1.88 ka which occurred probably due to the rapid upstream avulsion. This rapid avulsion is due to the close proximity of MPA and the reactivation of the pre-existing lineaments. Moreover, the present Palar River basin exhibits evidences of neotectonic activity such as soft sediment deformation structures, anomalous drainage deflections and reactivation of lineaments and faults further indicating that the Palar River is still draining a tectonically active region. Thus, neotctonics and fluctuations in the intensity of monsoon are largely responsible for sculpting the present landscape.

1. Introduction

Tectonism and climate are the major factors affecting any fluvial system (Holbrook and Schumm, 1999; Mather, 2000; Tooth et al., 2002; Vandenberghe, 2002; Bookhagen et al., 2005; Whipple et al., 2013; Kothyari, 2015). The responses of fluvial systems to tectonically active areas include stream beheading and diversion (Wells et al., 1988; Cox, 1994; Bishop, 1995; Gupta, 1997; Clark et al., 2004; Salvany, 2004; Schoenbohm et al., 2004) causing landscape evolution (Seeber and Gornitz, 1983). In response to climatic oscillations and associated environmental changes; the intensity of the participating processes can be delineated using fluvial archives (Gao et al., 2007; Miall, 1985, 1996). However, the drainage basins that typify the contemporary landscape in many areas of the world have developed through significant tectonic (Bishop, 2007; Latrubesse and Rancy, 2000) and paleoenvironmental changes through geological time-scale (Paillou et al., 2009). Several case studies, the Mississippi River (Aslan and Autin, 1999; Rittenour et al., 2007), the Nile River (Williams and Williams, 1980; Salama, 1987), Amazon River (Latrubesse and Franzinelli, 2002) and some other African Rivers (Hsü et al., 1973; Rubino et al., 2007) have evolved through; due to remarkable changes in tectonics, climate and even sea level fluctuations since the Cretaceous period but dramatic shifts took place during the Quaternary period.

In India, several studies on the late Quaternary fluvial systems is confined to the Northern and Western India with special reference towards channel avulsion, tectonism and paleoclimatic

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reconstruction (Srivastava, 2001; Goodbred, 2003; Jain and Tandon, 2003; Gibling et al., 2005; Sinha et al., 2006; Chakraborty et al., 2010; Bhattacharya et al., 2014). However, limited studies on large rivers in southern peninsular India (Ramasamy, 1989, 1998, 1999; Ramasamy and Balaji, 1995; Ramasamy et al., 1992, 1999, 2011; Subramanya, 1996; Vaidyanathan, 1971; Valdiya, 1998; Murty et al., 2002) have been carried out with a focus on evolution and subsequent migration. However, the role of regional tectonic instability in triggering channel migration has not been sufficiently explored in this region. For that we suggest an understanding of long-term regional tectonic history providing information regarding the regional stability and climate change which is essential for interpreting the influence of both the factors in initiating the migration of the river channel. Remote sensing technique (Hayakawa et al., 2010) combined with the fluvial archives (Miall, 1985; Zieliński and Goździk, 2001; Neves et al., 2005) and optically stimulated luminescence (OSL) dating (Jain et al., 2005; Juyal et al., 2006; Jaiswal et al., 2009; Kale et al., 2010, 2014) have great potential to provide information on the evolution history of fluvial system particularly with reference to the channel migration and understanding the factors that have influenced its evolution through the geological time.

In the present study, we focused on the Palar River, a major river draining a large part of the southern peninsular India. Earlier studies in this region are limited to the identification of paleochannels of the Palar River (Nandini et al., 2013). The Palar River reveals several signatures of channel avulsion that took place many times during its history (Rao, 1989; Narasimham, 1990; Subramanya, 1996; Valdiya, 1998). Subramanya (1996) suggested that the migration of the Palar River is due to the reactivation of the Mulki Pulicat Lake axis (MPA). Further, a wide spectrum of undocumented fluvial morphologies could provide crucial information on neotectonism and the magnitude of geomorphic changes within the extensive drainage network of the Palar River basin. The Palar River has migrated towards the south, leaving behind the traces of paleochannels on the Northern side (Narasimham, 1990). Yet these migration episodes are not chronologically constrained, and could provide an important contribution towards understanding the neotectonic history and the variability in the intensification of the monsoon of this region. A detailed and comprehensive information on the migration of the Palar River forming paleochannels and a chronology for these migration episodes has been lacking. The migration episodes of the Palar River is a good source to record tectonic perturbations and providing data on the long-term stability of the region. For this purpose a more detailed identification of paleochannel morphologies coupled with DEM and satellite image analysis of the present-day channel is required to provide information regarding the causes for channel migration through time. Towards this end our objective is i) To delineate the paleochannels of the Palar

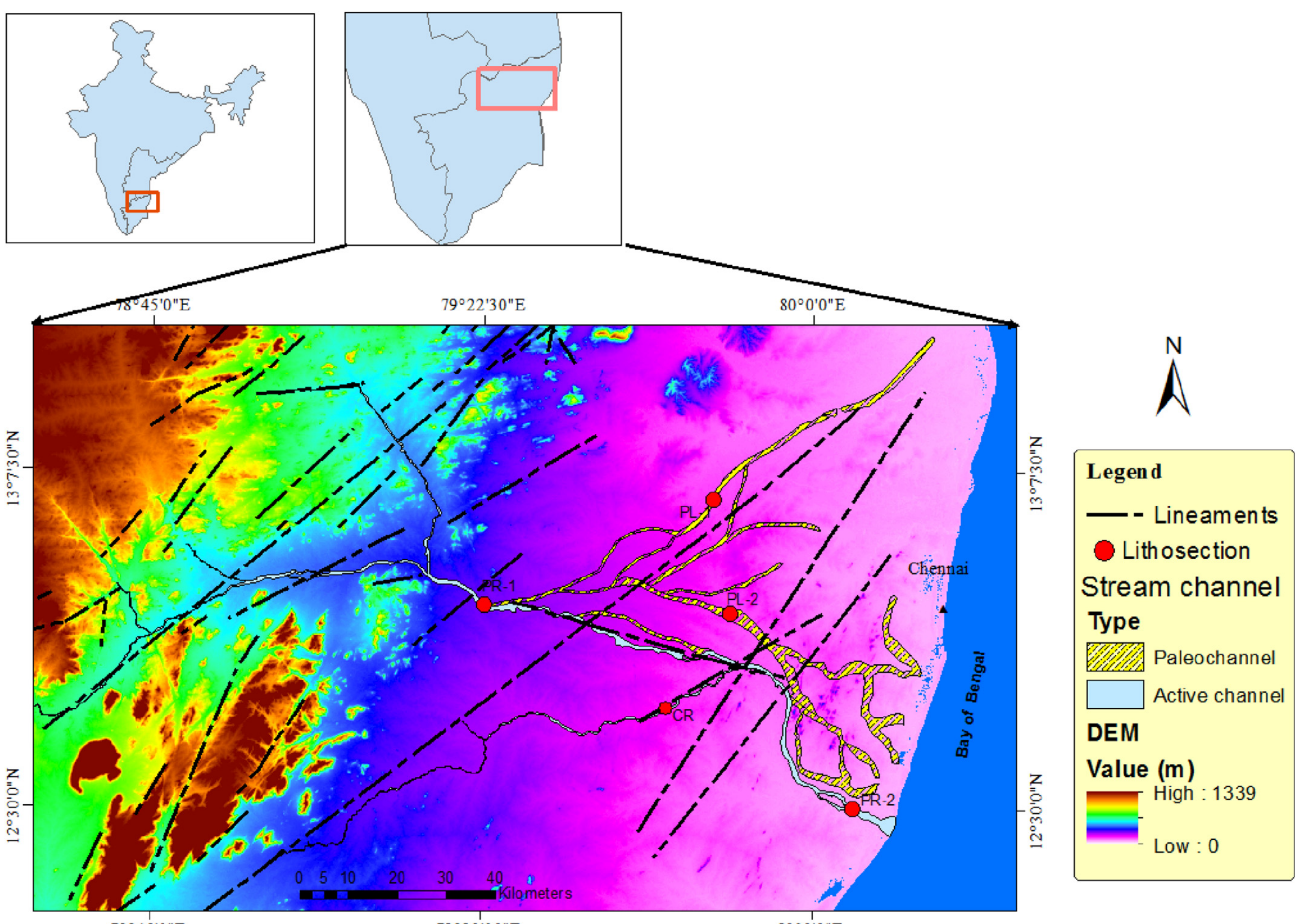

Fig. 1. Location map of the study area with Palar River, paleochannels, lineaments and locations of the lithosections.

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