

## Delineation of Geomorphic Regions of the Pairi Basin, Chhattisgarh and Odisha

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**Abstract:** *Delineation of geomorphic regions provides an insight of hydrogeomorphic condition of an area. Using Pairi basin, a tributary of the Mahanadi, as a case study, geomorphic regions are extracted using Landsat-5 TM and ASTER GDEM data. The delineated regions include hills and ridges (469 km<sup>2</sup>, 400–970 m), uplands (381 km<sup>2</sup>, 500–700 m), piedmonts and pediments (1933 km<sup>2</sup>, 350–470 m), and river valleys (480 km<sup>2</sup>, 280–365 m).*

### Introduction

Delineation of geomorphic regions of an area is of great importance as it provides some idea on geomorphic evolution and hydrogeomorphic condition of the area besides helping environmental management (Cooke and Doornkamp, 1990). A map of geomorphic regions is also essential for proper environmental planning and development (Chorley *et al.*, 1985). The history of geomorphology-related mapping is old, but its techniques have changed a great deal after the advection of space-based imaging and computer-based processing of many layers of information (Verstappen, 1983:255). Modern geospatial methods have enabled cost-effective processing of a large amount of data as well as their synoptic viewing and analysis. For example, Sharma (1989) attempted to delineate the morphogenetic regions and land system of Rajasthan on the basis of uniform morphometric characteristics with consideration of climate, geology, soils and vegetation.

Geomorphic mapping divides the terrain into various regions and units depending

upon the homogeneity of terrain character. Geomorphic divisions provide an insight of the genetic origin of landforms of a region and shows the areal distribution of geomorphological features.

In this study, geomorphic region mapping of the Pairi basin is carried out using Landsat TM satellite data and ASTER GDEM elevation models.

### Study area

The 7th Order Pairi river is one of the major tributaries of the Mahanadi. It covers an area of 3,262.62 km<sup>2</sup>, mostly in Chhattisgarh and partly in Odisha (Fig. 1). Geologically, the basin dates back to the Archaean, belonging to the peninsular India. Indications of tectonic events are found in the easternmost part of it. The basin has been subjected to erosion since its formation and the Archaean basement complex is exposed in some areas of the basin which gave rise to several elongated, circular and semi-circular shaped hillocks. The lithology of the basin is shown in Fig. 2.

### Materials and methods

In this study, largely following the

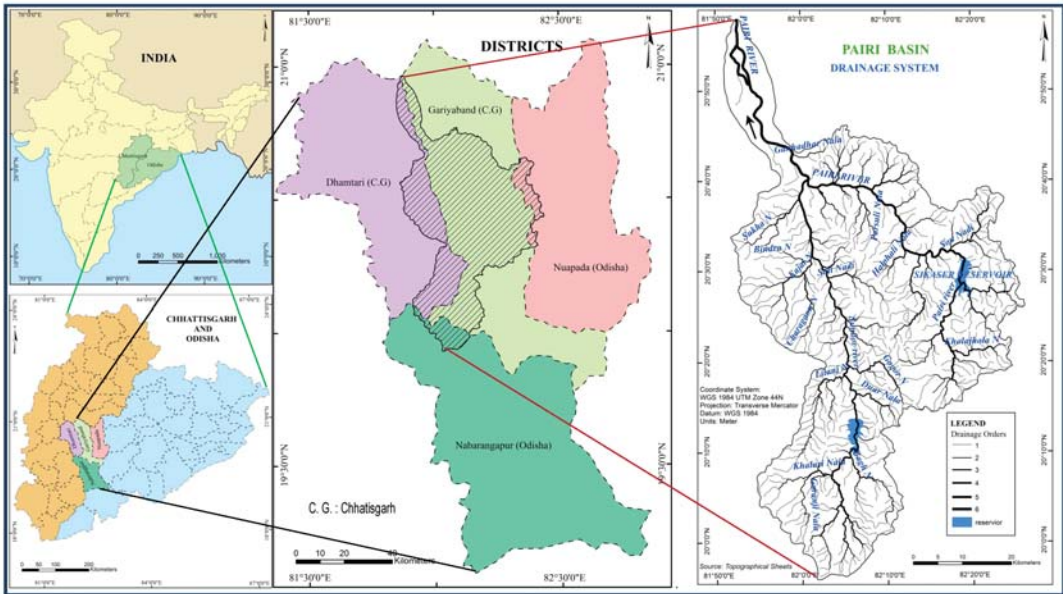


Figure 1. Location of the Pairi basin

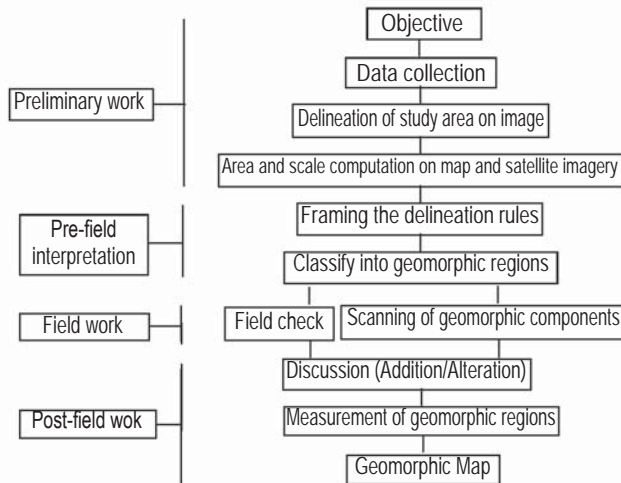


Figure 3. Stages in geomorphic mapping

methods shown in Fig 3, geomorphic regions have been delineated with the help of one arc second ASTER GDEM elevation data and 30-m Landsat-5 Thematic mapper (TM) satellite standard false colour composite (FCC) of Path-142, Row-146 (Date of Pass: 30.11.2009), both sourced from United States Geological Survey (<http://earthexplorer.usgs.gov>). Identification and delineation of landforms of the Pairi basin have been carried out on the basis of physiography,

slope, hill-shade (Fig. 3–5) and homogeneity in image properties as detailed in Table-1. Images and elevation data were processed using Erdas Imagine v13 and ArcGIS v10.3 software, aided by visual image interpretation techniques.

### Geomorphic regions delineated

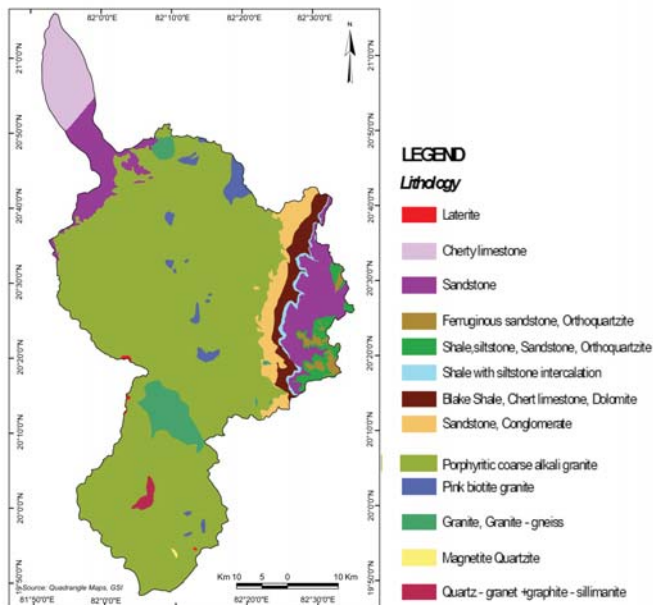
The whole Pairi basin is classified into four geomorphic regions of hills and ridges, uplands, piedmonts and pediments, and river

valleys, as shown in Table 1 and Fig. 8.

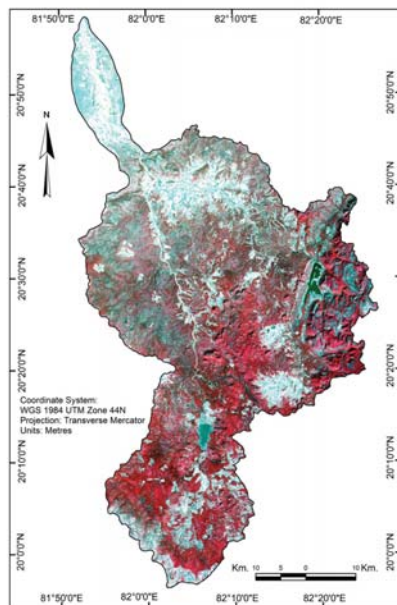
**Hills and ridges** (469 km<sup>2</sup>, 400–970 m)

This kind of geomorphic region is found in the eastern part and southeastern parts

of the Pairi basin. The hills and ridges are characterized by red to deep brown tone in the Landsat TM standard FCC (Fig. 4) due to presence of dense forest. The texture of this geomorphic region is moderate with



**Figure 2.** Pairi basin: Lithology



**Figure 4.** Pairi basin: Landsat-5 TM Standard FCC

**Table 1.** Image characteristics of various geomorphic regions of Pairi basin.

Geomorphic regions	Tone	Texture	Shape	Size	Pattern	Characteristics
Hill and ridge (469.36 km <sup>2</sup> , 400–970 m)	Red to deep brown	Moderate	Irregular	Large	Contiguous	Numerous small streams, highly dissected, narrow valleys, high altitude, dense vegetation, dendritic radial, rectangular, and herringbone drainage patterns.
Upland (380.56 km <sup>2</sup> , 500–700 m)	Light brown to green	Coarse	Irregular	Large	Continuous	Bear terrain with dissection, scrubs, grass with limited trees, some hillocks, dense forest in lower part of the upland, Some dissections are also found.
Piedmont and pediment (1932.96 km <sup>2</sup> , 350–470 m)	Light brown to green and Deep brown to greenish	Very coarse to moderate fine	Irregular	Large	Continuous	Forest as well as rocky surface, less relief variation, small patches of agricultural land,
River valley (479.75 km <sup>2</sup> , 280–365 m)	Greenish to white	Fine	Regular	Large	Straight to sinuous and contiguous	Agricultural field besides the track without forest cover, low relief

Source : Based on Landsat-5TM FCC

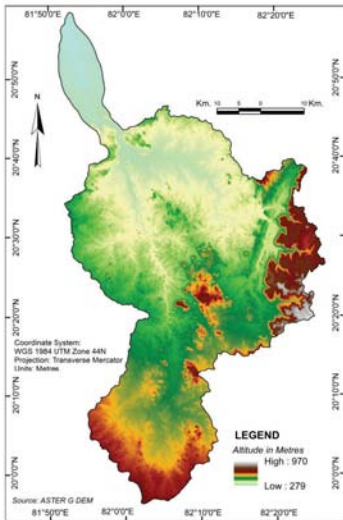


Figure 5. Pairi basin: Physiography

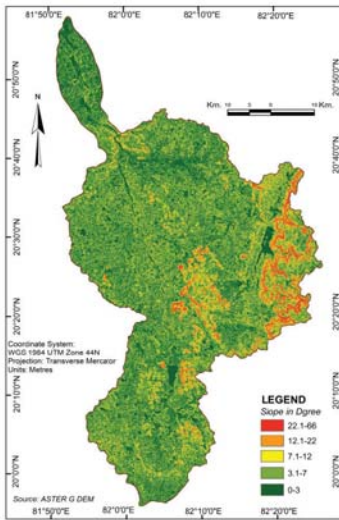


Figure 6. Pairi basin: Slopes

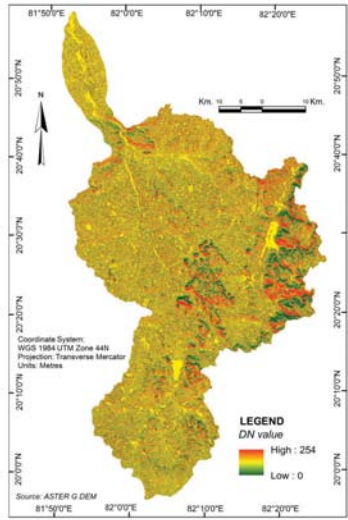


Figure 7. Pairi basin: Hillshade

contiguous pattern. Hills and ridges are large in size with irregular borders. It is primarily characterised by high altitude, numerous small streams, highly dissected narrow valleys, dense vegetation (mostly *Shorea robusta*), dendritic, radial, rectangular, and herringbone drainage patterns.

**Uplands (381 km<sup>2</sup>, 500–700 m)**  
 The upland geomorphic region is represented by coarse texture and irregular shapes of light brown to green tone because a part of the region is characterised by vegetation and the rest of the area is bare surface. Broadly, the upland region is characterised by wide terrain

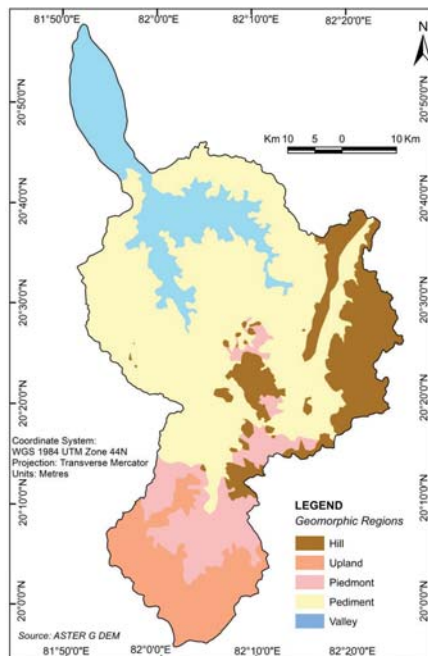


Figure 5. Pairi basin: Geomorphic regions

with dissection, scrubs, grass with limited trees, and isolated hillocks. Some dissection is also found due to small streams.

*Piedmonts and pediments* (1933 km<sup>2</sup>, 350–470 m)

This geomorphic region appears as light brown to green and, at places, it is deep brown to greenish or grey in FCCs. The texture of piedmont and pediment is very coarse to moderate fine with irregular shape. They appear continuous as well as large in size. This geomorphic region is characterised by forests as well as rocky surfaces, less relief variation and small patches of agricultural land.

*River valleys* (480 km<sup>2</sup>, 280–365 m)

This geomorphic region is mainly associated along the course of the Pairi and its tributary, the Sondur. It appears greenish to white colour in the image due to the presence of some flattish rocky outcrops, and sediments with shallow water. This tract is represented by fine image texture, regular in shape with straight to sinuous and contiguous in pattern. Agricultural fields are common in this the tract.

## Conclusions

It can be summarised from the study that the eastern and southeastern part of the Pairi basin is characterised by high altitude with hills and dissected by streams. Southern part of the basin comes under the upland category. The elevation and slope are gradually decrease from east to west and south to

north. Maximum height and slope are found in the east and minimum height and slope have been noticed in the northern part of the basin. Shallow and buried pediments cover the largest area among all the geomorphic regions where most of the wastelands of the basin are located. These wasteland should be developed to address the socio-economic problems of this area.

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