CHAPTER-4

4. Materials and Methods

4.1 Materials and Methodology

This chapter gives the overview about the materials and methods followed in the research work for the study of badlands while the specific methodology has been discussed in each chapters separately. The systematic methodology adopted for the hydrogeomorphological study of forms, patterns and processes of the development of badlands is shown in Figure 4.1.

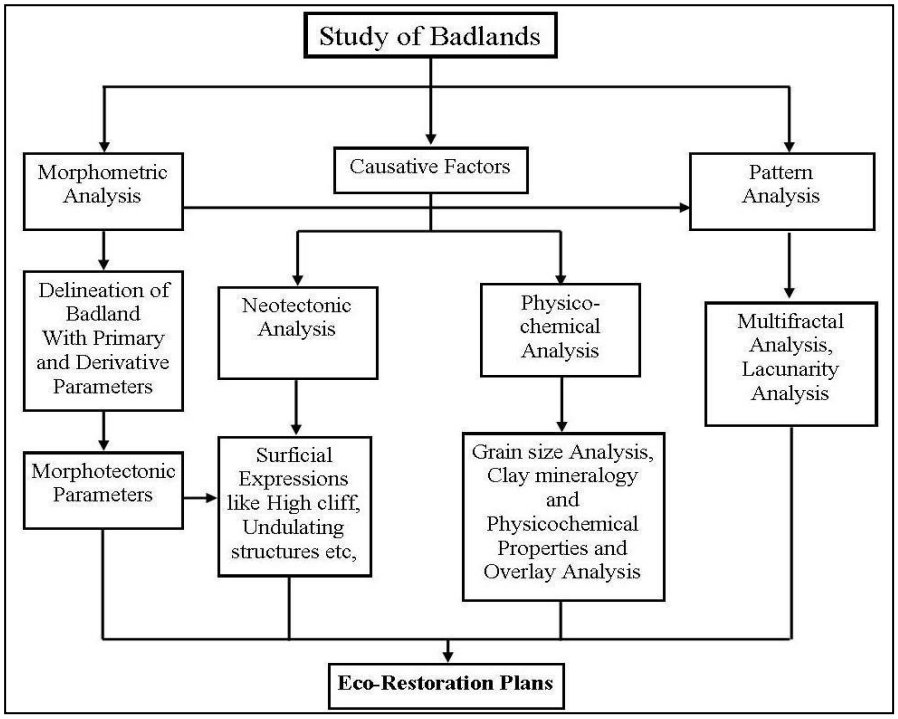

Figure 4. 1 Flow chart of the methodology of the present study

The morphometric analysis was performed to map the erosional process that is operating in the watershed. The data extraction was carried out by using Survey of India toposheet No. 63C/16 on the scale of 1:50000 in the ArcHydro tool of ArcGIS software (10.6). For the extraction of drainage lines, SRTM DEM (30 m resolution) was used. SRTM DEM was further used in the study for preparation of slope maps, river profile and 3-D DEM preparation of the study area. The land use and land cover map was made by the supervised classification method (Lillesand et al., 2004) in ERDAS Imagine software using Landsat-8 imageries.

The same data extraction method was followed for the study of morphotectonic parametersthat gives the information about the neotectonic influence over the study area.

The study remains incomplete without the study of the intrinsic properties of soil. The study of physico-chemical property of soil was carried out with the representative soil samples, which were collected from various land use and land cover units by 9 cm auger for the analysis of physico-chemical properties of soil. The soil samples were taken up to the depth of 30 cm from the surface. The analysis of soil was carried out by following Indian Standard Codes for Civil Engineering.

To study the repetitive patterns of gullies networking both in coarse and fine resolution, multifractal and lacunarity analysis were conducted. The study of patterns of the badlands using multifractal and lacunarity analysis has been carried out in NIH's (National Institutes of Health ofUnited State) ImageJ software (version 1.53e) along with binary images.

4.2 Field Visit

Extensive fieldwork was done four times during the entire research period during the pre monsoon and post monsoon seasons to understand the field conditions of the study area and collection of the data. During the of field visits the reconnaissance survey of the area was done which was followed by the detailed geological and geomorphological survey of the area. Field observationsshow various stages of badland formations such as rills, gullies, shallow holes and pipingrepresenting badland topography (Figure 4.2, 4.3). Measurements of the width, length, depth andslopes of the gullies were made in the field (Figure 4.4). In order to work out the physico-chemical,organic content and nutrient contents of the soils of the study area, soils samples were collected from various land use and land cover sites following standard methods which were further analysed in the laboratory. Based on the discussions with the local people and farmers various types of information were gathered regarding the land use pattern, cropping pattern, erosion problems, extension of gullies in farms etc which were helpful for the research work andassessment of the vulnerability of the area (Figure 4.5).

Figure 4. 2 Field photographs showing badland topography

Figure 4. 3 Field photographs showing various stages of Badland formation (a) Shallow gully; (b)Headward erosion; (c) Shallow holes; (d) and (e) Piping

The soil parameters like, grain size, bulk density, total porosity, plastic limit, liquid limit, plasticity index, Electrical Conductivity of soil, Soil Organic Matter, pH, Sodium Absorption Ratio, nutrients and other cations, gives an idea about the property of soil and the processes operating in the region (Table 4.1).

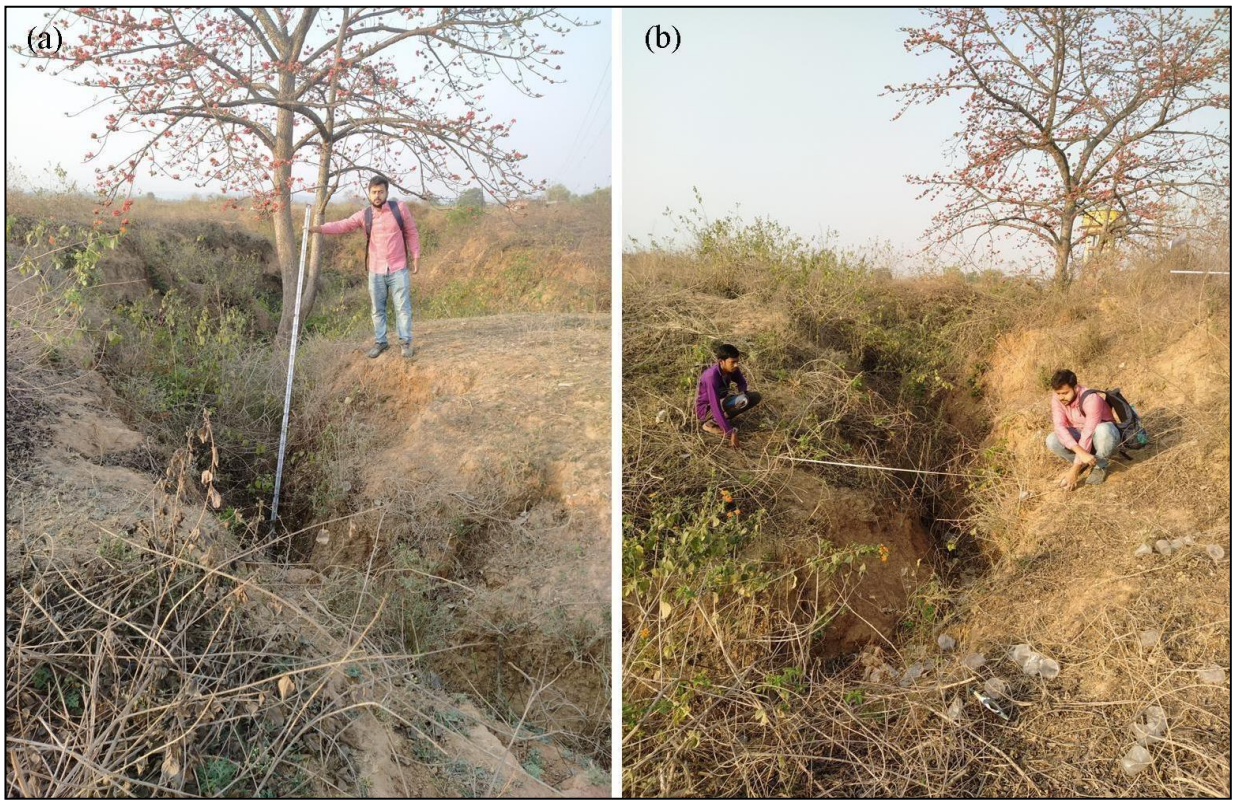

Figure 4. 4 Field photographs showing measurement of gully in the area

Figure 4. 5 Field photography showing eroded road due to the rejuvenation of a gully

Table 4. 1 Showing different parameters of the soil samples and their reasons for measurements

Parameters of the soil samples	**Reason for the analysis**
Grain size analysis of the soil	To analyse the dispersive nature of the soil
Bulk density	To measure the compactness of the soil
Total porosity	To estimate available void spaces in the soil
Plastic limit	To depict minimum water content of a soil to crumble
Liquid limit	To depict minimum water content of a soil to flow like a liquid
Plasticity index	To observe the plasticity state of the soil
Electrical Conductivity	To perceive amount of salt in the soil and internal drainage
Sodium Absorption Ratio	To perceive amount of salt in the soil and internal drainage
Soil Organic Matter	Acts as a binding agent of the soil, also enhances total porosity, nutrient and aeration and strengthen the soil structure
pH	Influence the mobility of the trace elements and indirectly controls the growth of the vegetation.
Nutrient (N^+, P^+, K^+)	Provides primary nutrients for the vegetation which helps to hold the soil structure
Other cation (Ca^+, Mg^+, Na^+)	Provides secondary nutrients for the vegetation