

Geomorphology and Land Use Mapping of Northern Part of Rangpur District, Bangladesh

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Abstract The study area selected for the present research work was Kaunia upazila of northern part of Rangpur district, Bangladesh located between 89°18'0"E to 89°30'0"E longitude and 25°42'0"N to 25°50'0"N latitude. The aim of the study was to identify geomorphic unit and prepare geomorphic and land use map with the help of remotely sensed data. Remotely sensed data provide a synoptic view of landscape on images. Geomorphic units were identified on the basis of tone, texture, size, shape, color and extract the precise information from the Landsat TM (FCC) images. Landforms were mainly active channel deposits, abandon channel deposits, natural levee deposits, flood plain deposits and flood basin deposits in the study area. From these geomorphic units together with land use were mapped using SPOT (band 4) panchromatic satellite image with visual interpretation technique along with field observation. The land use mapping will help to provide geo-scientific information for future development plan. Remotely sensed data recommend identifying, evaluating and time-costing effective technique to fulfill the study objectives.

Keywords: geomorphology, land use, remote sensing, SPOT and Geo-science

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land use mapping for future development plan in the study area.

1. Introduction

The earth's surface forms are primarily due to hypogene or endogenous processes [1]. Landforms on the earth surface are expensive to map or monitor [2]. Currently, all land use planning processes in most of the countries are based on geomorphological units [3]. Land use plan is needed for local government authority to provide suitable land for human activities which based on geomorphic survey in the study area. Geomorphic units are dynamic in nature as they are affected by various human activities, including the expansion of cultivated and irrigated lands, industrialization, urbanization and others because it need to monitoring, mapping for land use planning [4]. Morgan and McIntyre [5] first studied on the Quaternary Geology of the Bengal Basin. Sultana et al., [6] studied geomorphology and land use element of Nawabganj sadar, Chapai nawabganj, Bangladesh. Number of works was carried out at regional scale in geomorphology study using remote sensing data in Bangladesh [7-12]. But no attempt has been made of detail geomorphology and land use mapping in the study area. In this regards, the present research work was aimed to identify geomorphic unit and prepared geomorphic and

2. Methodology

2.1 Study Area

The study area is situated in the Kaunia Upazila of Rangpur district, Bangladesh. The total area of Kaunia Upazila is occupied 147.6 sq. km [13]. The study area is located within the geographical co-ordinates 89°18'0"E to 89°30'0"E longitude and 25°42'0"N to 25°50'0"N latitude. Kaunia upazila is bounded by Gangachara and Lalmonirhat sadar upazilas on the north, Pargacha upazila on the south, Rajarhat upazila on the east, Rangpur sadar upazila on the west (Figure 1). The study area is well communicated with other parts of country by highways and railways. The basic means of transport available in the study area are bus, rickshaw, tempo etc (Figure 2). Physiographic point of view, the study area falls in the Old Himalayan piedmont plain. Geologically, the study area is lies on the north-northwestern part of the Bengal basin. The surficial of the area is classified as recent flood plain deposits [14]. The recent flood plain deposit consist of clay, silt, fine and medium grain sand and are of relatively loose and more friable in nature [15].

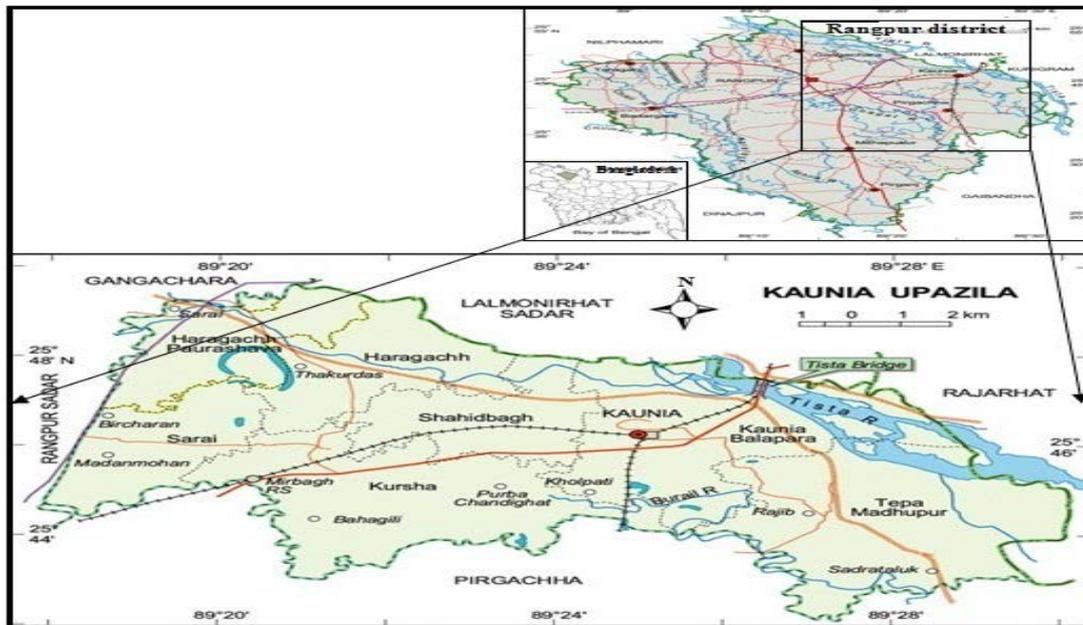


Figure 1. Location map of the Kaunia Upazila of Rangpur District, Bangladesh

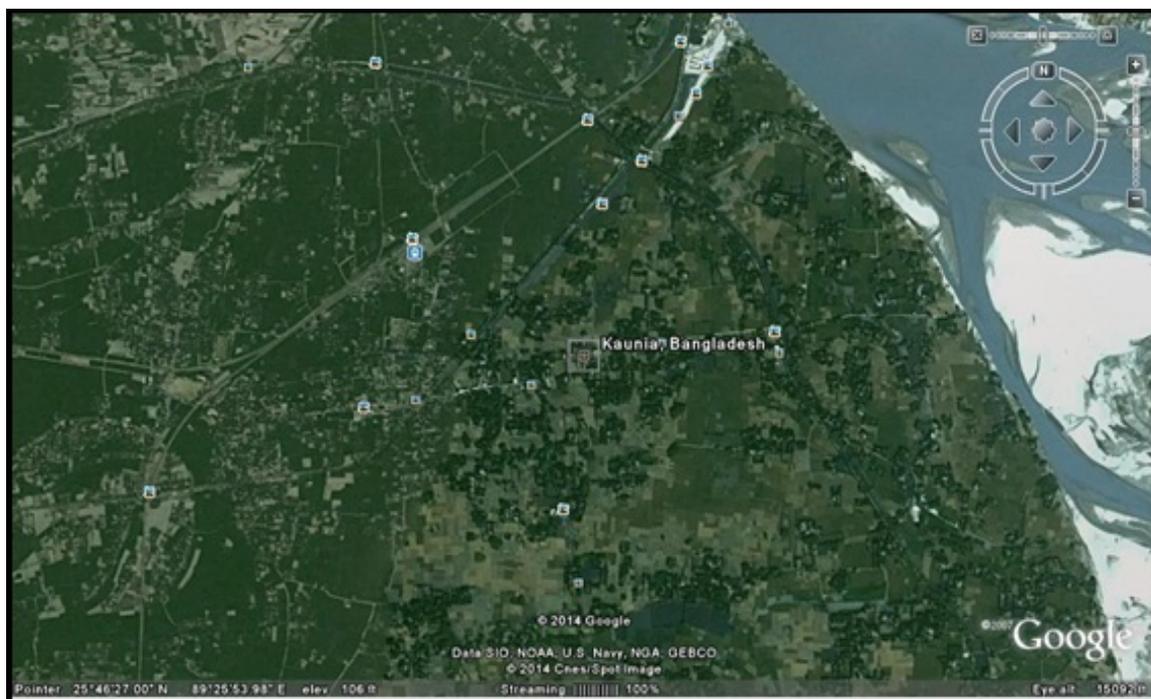


Figure 2. Satellite image of the study area

2.2. Materials

The materials, information and data is collected from the different organizations such as SPOT (System Probatoire de l'observation de la Terra; French Satellite) image from "Google Earth". TM (FCC) images with scale 1: 50,000 [16]. Base map of scale 1:50000 (2001) was collected from Local Government Engineering Department (LGED). Toposheet with scale 1:50,000 (1968) was also collected from Bangladesh survey.

2.3. Methods

For the purposes of this study the data from satellite imagery, topographic sheets and base maps (LGED's) were incorporated first to prepare a morphological map.

The information obtained from the satellite imagery by the process of manual image interpretation techniques. SPOT image gives a good detail of different geomorphic features of classify different geomorphic units, depending upon different visual photographic elements. However, there is a disadvantage of this image, that it shows almost same shades of gray for water body and vegetation. This drawback has overcome by delineating these two phenomena by the fact that water body shows no texture and vegetation shows different texture. Digital data registered with Bangladesh survey toposheets and identified different geomorphic units, mapping with image interpretation techniques, digital image processing and geomorphologic map using Arc GIS software. The integration of spatial data, manipulation and analysis were also carried out using Arc GIS software (version 3.3).

Extensive field work was carried out to observe the geomorphological and various geo-environmental conditions. Finally the land use mapping was prepared from the geomorphological map in the study area.

3. Results and Discussion

3.1. Geomorphic units

The geomorphological units are identical on the basis of the fluvial features and their sedimentary characteristics formed in the areas. On the satellite image these are identical on the basis of the interpretation of the image elements such as the tonal variation, texture, size, shape, association etc. Geomorphic units are classified on the basis of differential erosion processes [17]. Remotely sense data have capability to mapping geomorphic units [18]. Most units are characterized by their distinct textural and sedimentological characteristics; however some units either lack of distinct sedimentological characters or the characteristics have been modified by post depositional process such as weathering and biological activities.

The study area has been sub-divided into five distinct morphological units based on geomorphological expression, slope characteristics, surface elevation

characteristics, flooding, vegetation, surface sediment, drainage systems and genetic aspects of deposit.

3.1.1. Active channel deposit (Ac)

Active channels have permanent water flow throughout the year. The Tista River is the main active channel in the study area which is meandering river. On the spot panchromatic imagery, the active channel deposits have been identified by their light tone, smooth texture and morphologic position (Figure 3). This active channel was observed in the Teesta bridge at kaunia point (Figure 4 a).

3.1.2. Abandoned channel deposits (Abc)

The abandoned channels are elongated narrow depressions and shallow discontinuous streams with or without water. On the spot imagery the abandoned channels are marked by gray to dark tone, smooth texture and linear shape (Figure 3). Surface deposits are clay or silty clay which underlain by silty sand to fine sand deposits. Vegetation is also present. These channels are flooded in the rainy season and water logging persists more than six months almost every year. Thick layers of organic clay and peat are common. Organic remains in abandoned channels are found. Other abandoned channel found in Haragach, Kursha and northern part of the study area (Figure 4 b).

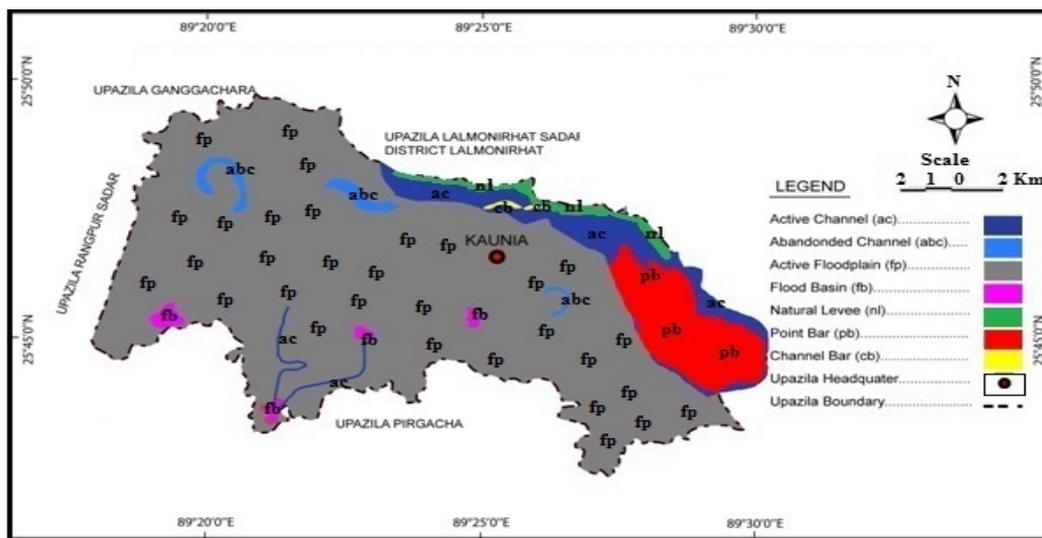


Figure 3. Geomorphological map of the Kaunia Upazila, Rangpur District of Bangladesh

3.1.3. Natural levee deposits (NI)

Natural levee deposits are linear, somewhat irregular wedge-shaped ridges of silty sand and sandy silt. They are elongated deposits parallel to the channel and developed on both sides of the river. This unit is thickest near the channel margin and thinned towards the floodplain. Slope is steep towards channel and very gently towards the floodplain. Along the bank of the river, these deposits are mostly silt and fine sand become clayey silt at the distal edge of the levee where it merges with the flood plain deposits. A natural levee found in the side of Tista River. (Figure 4 c)

This unit is mostly vegetated areas. The higher elevation of this unit in comparison to the surrounding areas results high settlement. On the SPOT imagery these were identified by medium to dark gray tone, coarse texture and linear shape along the river bank (Figure 3).

3.1.4. Floodplain deposits (Fp)

Floodplain lies between natural levee and flood basin and is lower in elevation than those of natural levee [19]. This is the largest unit in the study area. Floodplains have very gently slope toward the flood basin. Floodplain deposits in the study area are composed of gray silty clay to organic rich clay. Decomposed to partially decomposed grass roots and organic remains are common in the sediments of this unit. On the SPOT imagery floodplains are identified by medium gray tone and smooth texture. Most parts of this unit in the study area have been converted to cultivated lands, which exhibit geometric shape and even textural distribution on the satellite imagery (Figure 3). In the study area these units are commonly observe on side of the Tangon River (Figure 4 d).

3.1.5. Flood basin deposits (Fb)

Flood basins are featureless areas of poorly drained, flat to centrally sloping into stream depressions. Topographically flood basins are the depressed portion of the stream floodplain and oval, semi-circular or irregular in shape. These are small to large depressions in the floodplain having marshy to boggy environment. Most of the areas are usually under water round the year but few become dry during the winter. Marshes have also been mapped as flood basin. In some places of the study area the flood basins have been modified to ponds for fishery.

The flood basin deposits in the study area consists of gray to light gray organic rich clay, dark gray to blackish gray peaty clay with abundant decomposed or partially decomposed vegetal matters. Some alternations of silty layers are present in this unit. On the SPOT imagery the flood basins are identical by dark gray tone, no texture and irregular shape (Figure 3). These are monotonous featureless areas. Most flood basins are found in the eastern side of the Tista River of the study area. However, flood basins are sparsely distributed throughout the study area (Figure 4 e).



Figure 4. Photograph shows the geomorphological feature of the study area (a- e)

3.2. Land Use/Land Cover Mapping

Land use is defined as men's activities on land which are directly related to land. Land use has been seen as a product of interactions between a society's cultural background, skill and its physical needs in one hand and the natural potential of land on the other hand. Land cover refers to natural vegetation, water bodies, rock/soil, artificial cover and other resulting due to land transformations [20]. Land cover association and its temporal change is also one of the most important components of environments. Land use and its change seem to very essential for the development planning and also for a rational use of land space.

To prepare land use map from any kind of image, one suitable classification system is essential. Land use classes are consisting of urban and rural areas whereas the urban areas are subjected by residential, both residential and industrial areas and the rural areas are dominated by settlements and cultivated landscapes.

3.2.1. Land Element-1

This element can be used for human settlement, for the construction of roads and highways; this element is suitable for agriculture (Figure 5).

3.2.2. Land Element-2

This element can be used for human settlement; it is comparatively elevated than the surrounding areas. The river bank erosion, water logging and flood problems are absent or nearly absent. This zone is found in the northwestern, western and in some parts of and southeastern central region of the study area. The settlement density is high and the communication system is also very good in this element (Figure 5).

3.2.3. Land Element-3

This element is less suitable for human settlement than element A and is moderately elevated than the surrounding areas. The soil and land configuration map shows that drainage is moderately well and morphologically this element falls in the floodplain area. This area is used for cultivation. The communication system of this element is also good and settlement density is medium to high. This element is found mainly in the central and with few other areas of the study area (Figure 5).

3.2.4. Land Element-4

This element is unsuitable for human settlement. Morphogeologically this element is deeper part of flood

basin and abandoned channel area. This element is highly flood affected and drainage system is poor [21]. Water covers the areas almost throughout the year and settlement density is nil. This zone is only suitable for agriculture, surface water reservoirs and fisheries land-use (Figure 5).

3.2.5. Land Element-5

This element is suitable for Industry because this area is highly communicated with rail, river, road etc. So this area is suitable for industrial purpose (Figure 5).

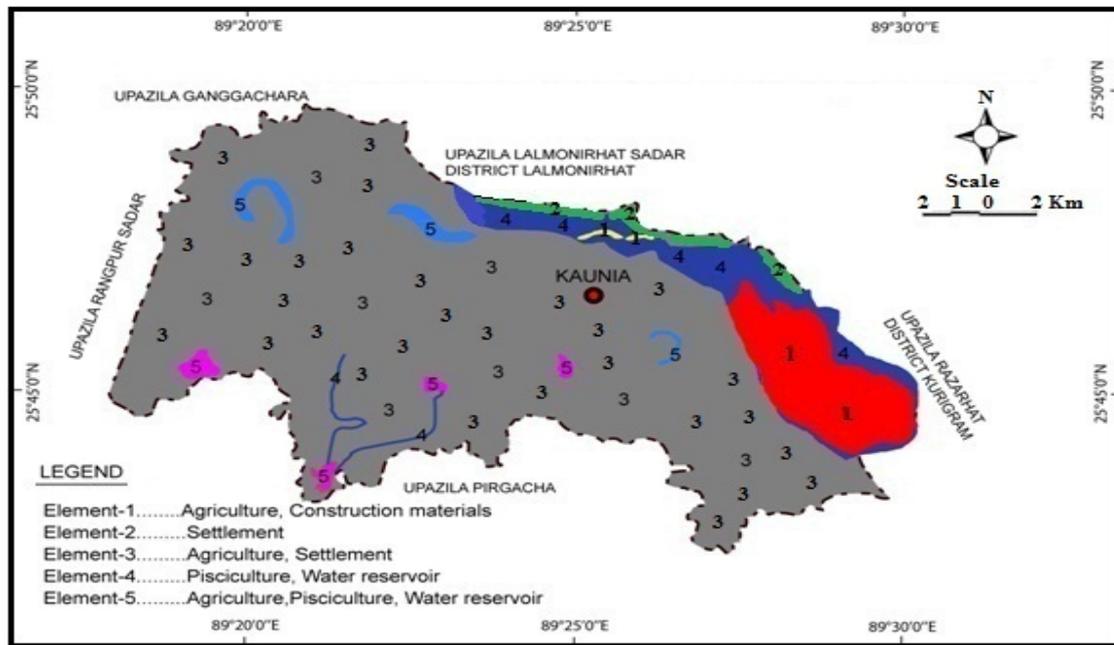


Figure 5. Land use mapping of the Kaunia Upazila of Rangpur District, Bangladesh

4. Conclusion and Recommendation

Development and expansions of land use map depends on various geologic parameters. The geologic parameters include physiography, geomorphic condition, flooding, drainage system, slope elevation and geologic setting etc. It is essential to consider the geologic parameters before taking any developmental planning to avoid any unwanted events that create destruction to the lives or properties of mankind. So, decision maker should concern about the positions where does the planned project suit. The study was made to prepare a morphogeological map of the Kaunia upazila of Rangpur district in northern Bangladesh using remotely sensed data and field data. Physiographically, Kaunia upazilla of the Rangpur District occupy the middle part by Tista River and the land mass of the both side of the river are flood plain. Five geomorphological units were identified from the SPOT (band 4) and Landsat TM (FCC) images. These are active channel deposit, abandoned channel deposit, natural levee deposit, flood plain deposit and flood basin deposit. In consideration of the geomorphologic conditions, a preliminary land use map was prepared. The area is divided into five land elements which designated as no water reservoir, settlement, agriculture, pisciculture and industrial zone. This land use map will provide significant guideline for the better use of the land. The map will be helpful for geologist, engineers, planners, local administrator, agriculturist and farmer in their respective field.

The following recommendation should be taken consideration for future development plan in the study area:

i) It is important to integrate geological information at early stage for land use planning in order to avoid

destruction or damage of properties and lives and to avoid other environmental problem and monetary loss.

ii) The sub-soil conditions of the area should be mapped by the implementation of systematic boring program and extensive sample testing of the soil.

iii) This research work might have some lacking because of limited scope and time. Therefore, a detailed survey should be undertaken for any further development activities in these areas.

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