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Research Paper Applied Geology

Study of Fluvial Geomorphic Features of the Lower Subansiri Basin, North-East India using Remote Sensing and GIS.

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ABSTRACT

Fluvial features of the Lower Subansiri basin are associated with the dissected piedmont plain and flood plain deposits. These are point bars, channel bars, ox-bow lakes, cut-off meanders, abandoned channels, channel fill deposits and back swamp lakes. Abundance of these fluvial landform features indicates the active and composite nature of the alluvial plain. Presence of these fluvial features is indicative of older flood plains which are very promising from the hydrogeological standpoint

Keywords : Fluvial feature, flood plain, braiding, abandoned channel, point bar

1. Introduction:

Most fluvial landforms are created by two major types of fluvial actions. One is erosive, tending to create landforms of degradational sculpturing. The other one is constructive, tending to create landforms of aggradations. As the initial gradients of flow are steep and irregular, the fluvial action during the early stage of rivers is essentially erosive in nature with dominant downward erosion. As the gradients decrease and become smooth, the velocity of flow is reduced and more uniform, at which the stream tends to acquire and maintain a gradient that is just sufficient to move the sediment that it receives. This may be considered as the first stage of maturity during which the river is ready for development of its first major fluvial constructive landforms. The erosive action, however, still goes on even though fluvial constructive action becomes dominant. This is the stage where the depositional-erosive or deposional landforms are created.

The present study is an attempt to identify the fluvial geomorphic features of the Lower Subansiri Basin (Fig.1-A) evolved in response to the combined inter-fluvial processes of the rivers viz. Subansiri, Ghagar, Jiyadhol, Koran and Sisi along with their numerous tributaries. These rivers emerge from the hilly terrains of Arunachal Pradesh usually through deep gorge sections (Fig. 1-B) and are primarily responsible for the development of vast pile of alluvial deposits in the plains which is being continually changed and modified by fluvial processes. Due to periodic and frequent shifting of channels, these rivers are leaving behind their imprints in the form of Ox-bow lakes, cut-off meanders, abandoned channels, channel fill deposits and back swamp lakes. The abundance of these and other fluvial landform features in the Lower Subansiri Basin is indicative of the active nature of the alluvial plain.

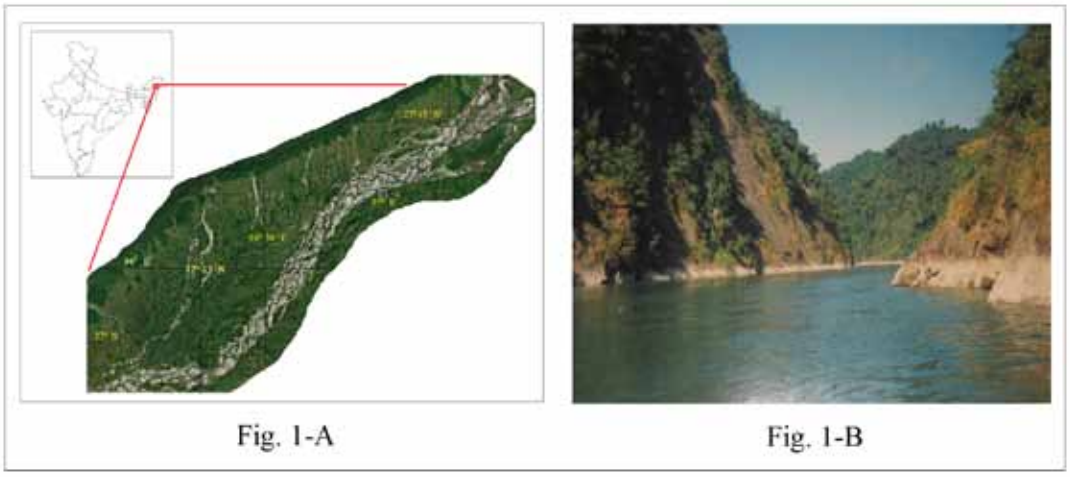


Fig. 1-A Fig. 1-B

Fig. 1-A: Location map of the Lower Subansiri Basin, Assam 1-B: The Subansiri flowing through gorge section in the mountains

2. Source of data and methodology:

Survey of India Toposheets of 1:50,000 scale of 1969-70, LANDSAT of 1990, 2000 and IRS LISS P6 of 2007 constitute the primary database for the present study, supplemented by field checking at various points of interest. The remote sensing data have been analyzed utilizing some simple techniques of GIS.

3. Results and Discussion

Various fluvial features of the Lower Subansiri basin may be broadly grouped into following two groups:

(A) Landforms associated with the dissected piedmont plain

(B) Landforms associated with the flood plain

3.1 Features associated with the dissected piedmont zone:
The piedmont zone forms a sloping ground from the foothill extending up to the flood plain of the present river system. This zone generally stands high above the stream bed dissecting it, and occurs as a narrow and almost continuous belt fringing the Himalayan foothill. The characteristic depositional landform feature of the piedmont zone is the alluvial fan.

(a) Alluvial Fans and Piedmont Zone: Alluvial fans are formed by the fluvial constructive action of heavily loaded mountainous streams. When a loaded stream debouches from a steep valley-side onto a relatively flat area, the abrupt change in slope causes a reduction in velocity and partial deposition of stream load in the form of alluvial fan. Gradual lateral extension leading to coalescence of the adjacent alluvial fans gives rise to a blanket of narrow but elongated piedmont deposits, obliterating the original fan-shaped deposits of mountainous streams coming out of the Arunachal Himalayas. Having a general N-S trending slope, these piedmont deposits merge with the southern flood plain deposits. These deposits are beautifully exposed at the river beds of a number of streams flowing across the piedmont zone (Fig. 2). The characteristics feature of streams with such deposits is dry river bed due to temporary disappearance of stream flow which ultimately oozes out as springs and seepages at the base of these fan deposits (Goswami, 1997).

Fig. 2 : Alluvial fans and piedmont deposits developed in different rivers of Lower Subansiri basin

3.2 Features associated with the flood plain:
The relatively smooth strip of land bordering the river channel, embracing the river pattern, and inundated at times of high stage is described as the flood plain area of a river. Flood plain characteristics are depended upon the stream channel pattern. Meander plains composed largely of meander scrolls (bar deposits) and covered plains consisting of overbank deposits (levees and backswamps) are associated with meandering rivers, whereas bar plains develop around braided river channels with no levees or meander scrolls (Melton, 1936). The type of flood plain formed also depends to a large extent on the dominant type of floods which the stream experiences. If the graded stream is frequently subjected to "bankfull" floods, it will engage in lateral erosion and lateral deposition, creating a meander flood plain. Predominantly frequent "over-the-bank" floods usually create vertical deposition with a covered flood plain. Combination of the two types of flood will result in the formation of composite plains (Leuder, 1959).

River channels of some important tributaries to the Subansiri like Gragar, Jiyadhol, Koran and Sisi draining the area are sinuous and meandering in nature. These rivers develop characteristics fluvial landforms all along their flood plains. The channel pattern of the Subansiri, however, cannot be described by a single term since the river at some reaches shows well developed braiding while at others it exhibits distinct meandering. Although the river shows an apparent transition of the overall channel pattern from meandering to braided (Goswami et. al, 1999), the river at towards downstream still maintains distinct meandering pattern with sinuosity index more than 2.0. The upstream part of the Subansiri near to the foothills is characterized by well developed braiding. The meandering flood plains associated with meandering streams show well developed point bars and other characteristics landform features while the braided reach of the Subansiri gives rise to typical bar plain. These features together with the covered plain landform features like levees and bachswamps suggest the composite nature of the Lower Subansiri flood plain. A general description of the landform features associated with flood plains of the study area is presented below.

(a) Point Bars: Point bar deposits, an important fluvial landform feature of the Lower Subansiri basin, are formed as a result of concomitant erosion on the concave bank and deposition on the convex side of river bends. These deposits grow by lateral accretion as the meander moves downstream and an accretion topography results with successive meander scrolls. Most of the rivers, having sinuous courses, are associated with point bar deposits of varying size ranging in area from 0.03 km2 to 0.15 km2. The notable exception is the Koran river where open meander loops have not allowed development of point bars in most part of its course. The meandering reach of the Subansiri is associated with relatively large point bars ranging in size from 0.15 km2 to 1.93 km2. Fig. 3-A shows some typical point bar deposits of smaller rivers like Dirgha and Boginadi.

(b) Channel bars: Channel bars are the characteristic deposits of braided rivers. Gradual increase in braiding intensity of the Subansiri causes an increase in the frequency of channel bars (Goswami et al., 1999). The development of braiding in Subansiri may be due to the reduced velocity caused by sudden decrease in slope near foothill area. Supply of additional bedload material by tributaries like Dulung and Dirpai is also contributing to braiding in the upstream reach of the Subansiri. Mid-channel bars of the Subansiri (Fig. 3-B) vary widely in shape and size, the largest covers an area of 1.29 km2, while those associated with smaller rivers like Boginadi are relatively smaller and transitory in nature.

(c) Natural levees: Natural levees are characteristic fluvial landform feature of a covered flood plain. The levee deposits are thickest and coarsest at the crest along the river bank and rapidly becomes thinner and finer away from it. As compared to other rivers of the basin, the natural levees of the Subansiri are very broad.

Fig. 3-A: Point bars of Dirgha and Boginadi rivers 3-B: Channel bars of the Subansiri river.

(d) Abandoned channels, cut-off meanders and ox-bow lakes: these are geomorphologically similar features which differ only by their respective shapes. These fluvial landform features are present in abundance in the area and can be readily demarcated on the satellite imagery. An abandoned channel is an old channel filled with water which is abandoned dur-

ing flood plain development due to lateral shift of the original channel (Leopold et al., 1964). Rivers like Subansiri, Jiyadhol and Sisi (Gai) have given rise to numerous abandoned channels (Fig. 4-A). Cut-off meanders and ox-bow lakes (Fig. 4-B) are water filled meander cut-offs which are abandoned by the original channel and are mostly associated with the relatively smaller, meandering streams of the basin. Horse-shoe shaped cut-off meanders are usually termed as ox-bow lakes.

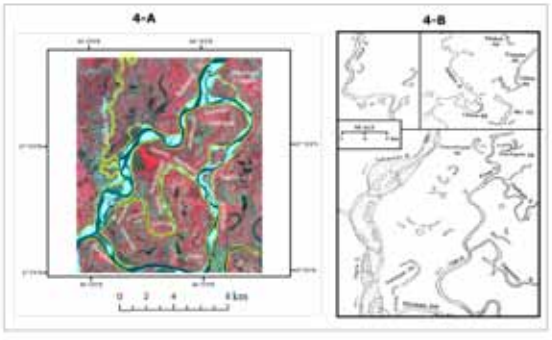
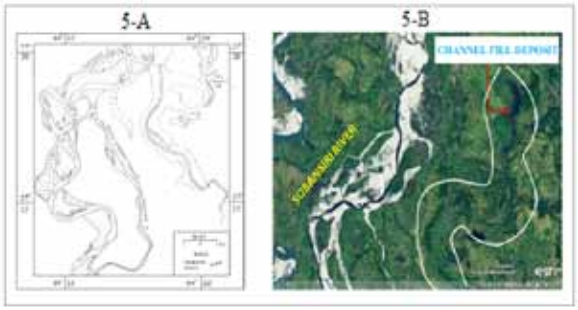


Fig. 4-A: A nearly abandoned channel of the Subansiri 4-B: Cut-off meanders and ox-bow lakes

(e) Channel fill deposits: Abandoned channels are filled up in due course with surface materials like clay, silt or sand towards top and coarser fractions at depth. Though filled up to various extents and culturally modified, these deposits are recognizable on satellite imagery by their characteristics shape and landform. A few large channel fill deposits along the middle reach of the Subansiri are presented in Figs. 5-A & 5-B. Presence abandoned channels, cut-off meanders, ox-bow lakes and channel fill deposits are indicative of older flood plains which are very promising from the hydrogeological point of view.



Figs. 5-A & 5-B: Channel fill deposits associated with the Subansiri river

(f) Backswamps (Flood basins): Low lying areas of the flood plain beyond the natural levee are known as backswamps or flood basins which are generally narrow, elongated in shape and is characterized by a network of drainage inherited from older drainage system. The low lying nature of the Lower Subansiri basin combined with frequent shifting of stream channels have given rise to numerous and extensively developed backswamp areas. The ones that contain perennial water are popularly known as 'bils' in local parlance. The marshes and swamps are generally known here as 'Jalah', 'doloni', 'pitoni', 'hola' etc.

4. Conclusion:

Point bars of the Subansiri are larger than that of the other rivers, while the channel bars are relatively stable and vary widely in shape and size. The meandering flood plains, braided bar plains together with the covered plain landform features like levees and bachswamps suggest that the flood plain of the lower Subansiri basin is of composite type. Periodic shifting of channels leave behind their relicts in the form of abandoned channels, cut-off meanders, ox-bow lakes, channel fill deposits and backswamps/flood basins. Abundance of these landform features in the Lower Subansiri basin suggests the active nature of the alluvial plain and their presence is indicative of older flood plains which are very promising from the hydrogeological standpoint.

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