

## **GEOMORPHIC FEATURES AND THEIR RELATION WITH AGRICULTURAL LAND QUALITY : A CASE STUDY OF CHAHANIA BLOCK, CHANDAULI DISTRICT, U. P.**

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**ABSTRACT :** The Paper attempts to assess various geomorphic features and their association with agricultural land quality in Chahania Block (Chandauli District) of Eastern Uttar Pradesh using remote sensing techniques. The results of the present investigation reveals that a very deep relationship exists between geomorphic features and various quality of agricultural lands. Some of the geomorphic features like palaeochannels, new flood plain etc. are characterised with good to very good quality of agricultural lands and encompasses high to very high agricultural productivity. On the other hand, old flood plain features are contemplated with a varying nature of agricultural land quality ranging from poor to good, depending on their spatial location and technocultural development.

### **INTRODUCTION**

The agricultural practices in a region depend on natural (climate, soil, availability of surface and subsurface water for irrigation etc.) as well as socio - economic factors including agricultural technology, irrigation facilities, inputs, marketing and transport facilities. The geomorphic features directly or indirectly affect all these factors. As such, they play a vital role in controlling the selection of specific cropping system and land utilisation in a particular region.

Geomorphic processes leave their distinct imprint upon the evolution of land forms and create specific terrain conditions. Landforms are the most common features to be considered as 'better clues' for understanding the various land uses / land covers, cropping pattern and crop - production, and underground hydrological conditions. They present a basic

platform for all human activities including agriculture. The geomorphic features, slope, drainage etc. help in the demarcation of the characteristics and productivity of soil (Mishra and Chaubey 1999 : 42). The terrain conditions determine land use as well as the growth and distribution of crops in those areas where relief encompasses complex and diverse lithology and landforms (Singh 1976 : 34). Existing land use pattern is the result of a continuous interplay of physical elements like topography, climate, soil and human efforts (Sharma and Coutinho 1983). It also helps in understanding the causal relationships among physical environment, socio - economic and technological level of society (Shaban and Bhole 1997). Keeping in view these facts, the present paper attempts to assess different geomorphic features and their association with agricultural land quality in the Chahania block (25° 19'N - 25° 31'N and 83° 5'E - 83°

18'E, area : 220.52 Km<sup>2</sup>, population : 1,42,622 persons in 1991) of Chandauli district of the Middle Ganga Plain by applying remote sensing technique and ground truth data.

### STUDY AREA

Chahania Development Block (*Vikash Khand*) is located in the north-west part of the Sakaldiha Tahsil, District Chanduli, U. P. It is situated at a distance of about 20 km from the District Headquarters. It forms a part of the fertile Middle Ganga Plain extending from 25° 19' N to 25° 31' N and 83° 5' E to 83° 21' E. Occupying an area of 220.52 km<sup>2</sup>, it is bounded by the river Ganga in the south - west to west and north. Administratively it is governed by Ghazipur district (Saidpur) in the north, Dhanapur, Sakaldiha and Niyamatabad blocks of Chandauli district in the east and south - east and Varanasi district in the west. There are 176 revenue village (including 21 uninhabited) grouped into 12 *Nyaya Panchayats* and 80 *Gram Panchayats*.

### METHODOLOGY AND DATA BASE

Remote sensing technique has largely been applied for mapping and analysis of geomorphic features and quality of agricultural land. The primary and secondary data used in the present investigation can be listed as : (i) Survey of India (SOI) Sheet No. 63 O (1:250,000), 63 O/2, O/3, O/6 and O/7 (1 : 50,000). (ii) IRS - 1 B, LISS - 1, FCC (B, 2, 3, 4) February 1993 and IRS - 1 B, LISS - IIA, FCC (B, 2, 3, 4) covering Path 23 and Row 50 on scale 1 : 250,000 (acquired on 14 Nov. 1995). (iii) IRS - 1 B, LISS-II, FCC (B, 2, 3, 4) Geocoded (63 O/3 and O/7) covering Path 23 and Row 50 on scale 1:50,000 (acquired on February 1993). (iv) Black and White Panchromatic vertical aerial photographs at scale 1:40,000 (approx.), season 1993-94.

The use of the above has further led to :

- i. Preparation of base - map using SOI sheets. The base - map and the maps containing village - boundary were available on different scales, so the village - map was enlarged by coinciding the boundary of base map and selected control points through the enlarger machine.
- ii. Visual interpretation of satellite imagery and aerial photographs (under mirror stereoscope) have been carried out using various 'photo-elements' such as tone, texture, shape, size, location pattern, association etc. geotechnical elements and 'convergence of evidence'. The results obtained through image - interpretation pertaining to quality of agricultural land and land forms were later transferred on base - map.
- iii. Ground truth collection and selective field - checks were made to verify the ultimate results obtained through satellite image and air - photo interpretation.

### RESULTS AND DISCUSSION

#### Geomorphic Features

The whole of study area consists of relatively leveled ground formed by gradual development of sediment deposits brought by river Ganga. Geomorphologically this terrain may be considered as most dynamic part where both constructional and destructional activities of streams are experienced. The flood plain surfaces can geomorphologically be defined as landform composed primarily of unconsolidated depositional materials derived from sediments being transported by the related stream (Schmudde 1968 : 362). The development of flood plain takes place by

eroding and depositing activities of master stream and its tributaries under which erosion is more or less equalled by deposition. The area under study is characterised with fluvial landforms as explained below.

### **New Flood Plain**

Active or inner flood plain also known locally as '*Khadar*' or newer alluvium is the area which is inundated by the flood water annually / periodically. This is the nearest zone of area attached with the river Ganga and the Banganga channel. Such areas receive sediment deposition during each flood. The surface materials are coarse to fine textured depending on the distance from the stream as well as local sediment character. Various sub-groups of new flood plain have been demarcated on the basis of satellite image interpretation such as N, N<sub>1</sub>, N<sub>2</sub> which characterise the local variation.

### *Old Flood Plain*

Old or outer flood plain features (locally known as *Bangar* or older alluvium) are topographic surfaces generally located far from the channels and characterised with higher ground. Such flood plains are composed of a series of layers of clay, silt, loam, sand, cobbles and boulders, the coarser sediments and fragments occupying the bottom near the bed rock, while surface layers ranging from sand to clay vary horizontally, i.e., coarser particles occur nearer the stream and finer ones away from it (Ahmad, 1985 : 125). Major portion of the Chahania block comes under old flood plains which is sub-divided as O, O1, O2 etc. depending on the variations in height and micro - level characteristics (Fig. 1). Due to lack of drain, water logging and salinity problems can be observed in the south eastern part.

### *Natural Levee*

Natural levees are the low ridges or narrow

belt of upland developed in a parallel mode to river. They are marked on satellite imagery by light tone. The formation of natural levees occurs in those areas where the channel has stable banks with slow lateral movement. Such banks attain higher position by regular and repeated additions of materials. As a result of such depositions, the natural levees have highest ground near the river and slopes gradually away from it. They are formed by the alluvium deposited by the rivers during flood when rivers overflow their banks. During overflow as the current is partially dissipated, velocity and carrying power are decreased, so the rivers start to deposit their loads in the form of ridges, i.e., natural levees. The coarser materials of the alluvium are deposited near the channel whereas the finer materials are carried out over the flood-plain (Worcester, 1961 : 156). Since, the natural levees are more or less established landforms, they are occupied by the human settlements while the land immediately behind the levees or on the shelving banks opposite are easily inundable and are devoid of settlements. However, temporary hutment dot these lands which support the parent villages due to the high fertility of the silted-over soils for *Rabi* crops which compensate the loss of the rainy season (Singh 1971 : 218). Some of the prominent settlements are extensively marked to be located on old natural levees formed by the earlier courses of river Ganga such as Chahania, Ramauli, Ramgarh, etc. while Balua, Tanda Kalan, etc. are settled on natural levees of existing course of Ganga (Fig. 1 and Table 1).

### *Backswamp*

Backswamp deposits are those that were laid down in the flood basins back of natural levees (Thornbury 1969 : 169). Such areas have relatively poor surface and sub-surface drainage. They possess extensive layers of silt

and clay with finer texture. Due to the finer underlying materials and good underground water potential, backswamp areas are accounted for better cultivation (Mishra 1997a). Area of backswamps are usually marked by darker tone on imagery as well as on B & W pan aerial photographs. However, the backswamps attached with few natural levees could only be marked through satellite imagery and aerial photographs such as near Tanda Kalan and Ramgarh. The expression of such features at other places is obscured with other objects because of anthropogenic features. The backswamp areas attached to the natural levees at Balua and Chahania could not be delineated as these areas are largely occupied by shifting courses of river Ganga (Pc) (Fig. 1).

### **Meandering and Braiding of Ganga**

Meandering and braiding are the characteristics of Ganga which bears varying modes of channel flow due to seasonal variations in discharge. Meandering may be observed as general feature of this river during flood or rainy season when the river flows with the bank full discharge. The river shows the empty channels with their exposed beds as braided during dry season. The existence of braiding and meandering is directly related to the nature of underlying materials of the areas through which the river flows. Meandering is the most common forms of the eroding and depositing activity of rivers Ganga. It is easily identified on imagery being prominent at various places such as near Rauna, Kurahana, Balua, Mahuar, Gangapur, Tanda Kalan and Mohammadpur villages. (Fig. 1).

Bank erosion, bar deposition and the helical flow are the responsible factors for making of the meanders. With the rise in water flow during accompanying flood, there is an increase in velocity and shear stress in the bed (Leopold

et. al. 1963 : 227). The continued helical flow activates the erosion process at scour pools formed beneath the concave banks of meandering channels. Such scour pools deepen with rising stage and the detached sediments are promptly deposited down stream forming bars along the bank and into the channel (Singh 1973 : 28).

### **Point Bar and Channel Bar**

Channel bars (or sand bar) are the geomorphic features formed by the deposition of huge amount of sand in between the channels. Bar building takes place within the channel, creating islands and splitting the stream into several channels (Schmudde, 1968 : 361). In due course of time, the island becomes the part of the flood plain when the fingering channels become dry and are filled with sediments. Channel bars can be observed at many places in the channels of the river Ganga. Point bars are formed on the convex sides of meanders and grow by individual increments outward into the meander curve (Thornbury, 1969 : 165). Such features can be observed near north west of Balua Ghat extending from Mahuwar to the south of Tanda Kalan and near Bhusaula and Nadinidhaura in northern part of the study area. These point bars have been formed due to the deposition of sediments. The sediments are carried out through the erosional work of river Ganga at the opposite concave sides or upstream at few kilometers of distance.

### **Abandoned channel / Palaeochannel**

The satellite images provided a very clear vision of palaeochannels and earlier river routes whereas they are not visible in the field by naked eyes. As a matter of fact, the satellite imagery and aerial photographs have largely been utilised for mapping of palaeochannels and shifting river courses (Mishra 1989, 93, 97a and b). The mapping of earlier courses of

CHAHANIA BLOCK  
 GEOMORPHOLOGICAL MAP  
 (BASED ON IRS-1B, LISS-II A,  
 FCC, B-2,3,4)

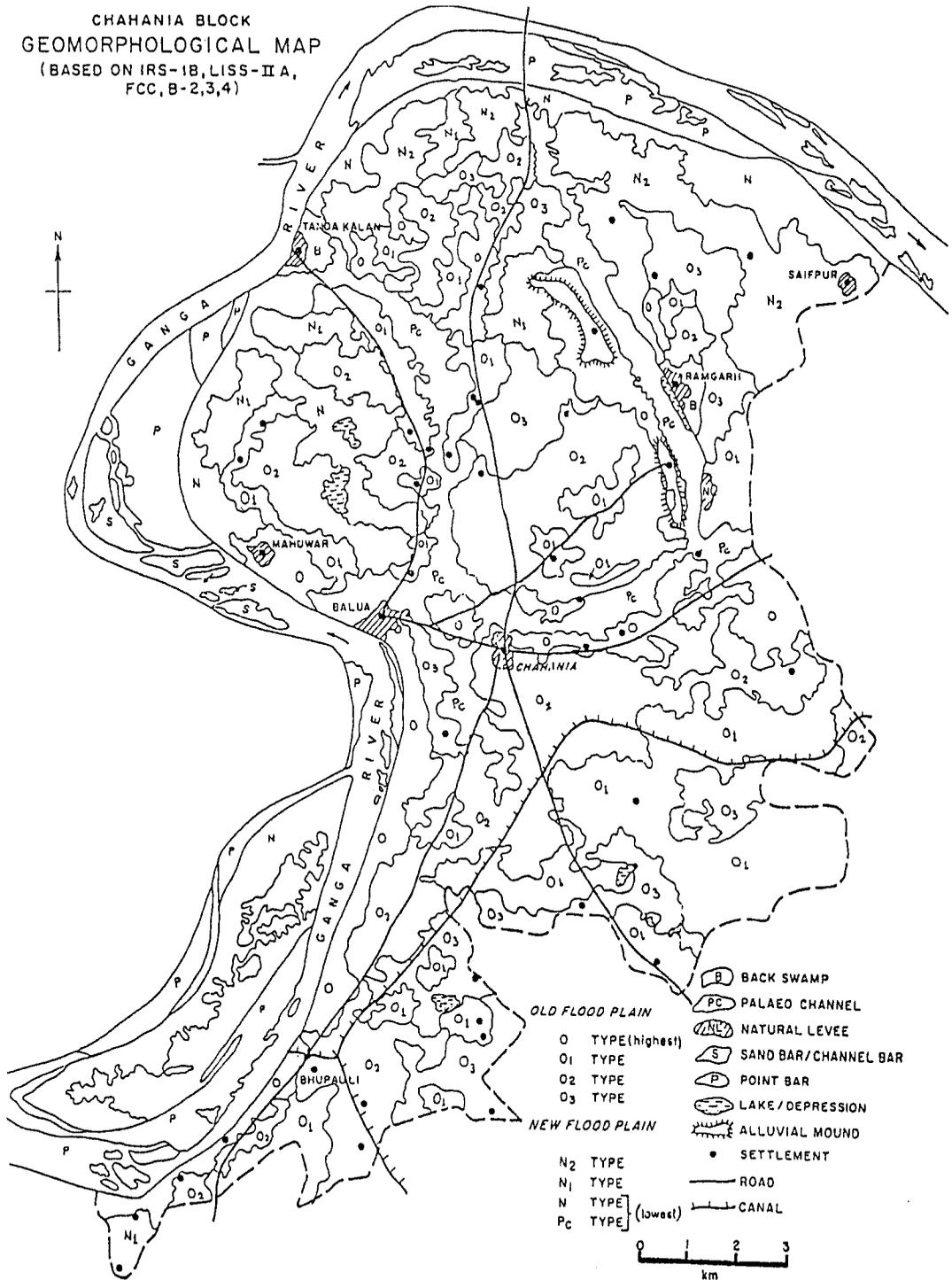


Fig. 1 : Chahania Block — Geomorphological Map

**Table 1**  
**Image and General Characteristics of Geomorphic Features / Units based on IRS - IB Imagery**

Geomorphic features/unit	Map Code	Tone	Texture	Shape	Landuse	Remarks
Old flood plain	O, O <sub>1</sub> , O <sub>2</sub> , O <sub>3</sub>	Medium to light red, grey, white, mixed tone	Coarse to medium	Irregular	Cultivation settlement, road, canal, moderate to good cultivation in southern part)	Occupy higher surface (generally water logged in rainy season)
New flood plain	N <sub>1</sub> , N <sub>1</sub> , N <sub>2</sub> and PC	Very dark red to dark red, medium to dark grey	Smooth	Irregular	Intensive cultivation, water logging, garden and groves	Occupy lower surface, generally inundated during rainy season
Paleochannel	PC	Very dark red	Smooth	Regular crescentic	Intensive cultivation, water logging, lake	Occupy lowest land
Natural laeve	NL	Light to grey	Coarse	Irregular	Settlement	Occupy highest level
Sand bar	S	Very light	Coarse	Elongated		Sandy patches
Point bar	P	Very light	Coarse	Crescentic	None to dry cultivation especially in summer	Sandy patches attached to river bank
Alluvial mound	AL	Light to medium red / grey	Coarse	Elongated	Open scrub, bushes, settlement	Highest surfaces

the river Ganga through satellite imagery has been found encouraging. Due to its specific terrain and underlying materials, the earlier river courses bear their distinct appearance with dark tone. However, crescentic shape, tone, texture and location factors have been taken into consideration for mapping of previous river channels through imagery interpretations. A very clear cut route of Ganga has been identified after Balua. The major changes in the courses of Ganga towards right hand side can be marked from Tanda Kalan to Salempur. Several villages such as Samundpur, Bela, Lachhanpur, Kaithi, Chahania, Ramauli, Surtapur, Bairath and Ramgarh are settled along this abandoned channel. The present Banganga channel which is usually filled with water during rainy season may be the part of earlier courses of Ganga (Fig. 1).

As regards the mapping of palaeochannels and related geomorphic features, it was very difficult to delineate the exact routes of earlier shifting courses of Ganga because of its frequent changes in the area under study. However, attempt has been made to map out the shifting courses with the help of multiple data sources such as IRS-1B, LISS - 1, FCC at Scale 1:250,000, IRS - 1B, LISS - II, FCC Geocoded (1:50,000), IRS - 1B, LISS - II (1:25,000), and B & W pan aerial photographs. The results of the interpretations made through these remotely sensed data were then transferred on one base map and the final map of shifting river courses was prepared after selective field - checks.

The major changes in the course of Ganga can be observed in the north of Chanhania market which is evident from the higher surface / grounds at the junction of older and newer alluvial tracts and numerous depressions / lakes. It can be marked (Fig. 1) that alternate belts of new flood plain and old flood plain

mostly oriented in NW - SE or N - S are existing in the north of Chanhania market. The belts of old flood plain are occupied by settlements and by roads running from Chanhania to Saidpur or Chahania to Tanda Kalan. The flood plain areas in the lower parts (new flood plain) are mostly cultivated lands / grass lands which are generally inundated during rainy season. The lakes near Chanhania, Ramgarh and *Tals* in west of Samundpur village may be accounted to be formed as a result of the shifting river courses. Apart from these long and narrow *Tals* / lakes, the availability of sandy loams, existence of *nalas* mostly flowing in E-W direction which receive spill water through Ganga during flood also confirm the ancient routes of Ganga.

### AGRICULTURAL LAND QUALITY ZONES

The quality of agricultural lands in Chahania block is generally influenced by various physico - cultural factors. Physiography, drainage, geomorphic features, soil etc. are the controlling factors which contribute enough to govern the nature of agricultural land and the intensity of cultivation. The cultural aspects, on the other hand, are related to the establishment of settlements and their expansion, canal and road network, garden / groves / tree plantation, choking of natural drains and resulted problems of water logging and *usar* formation etc. Different agricultural land quality zones have been identified taking into account the various physico-cultural facts. These are : (i) very good, (ii) good, (iii) moderate and (iv) poor zones of agricultural land quality (Fig. 2 Table 2).

#### Very Good Quality Land

The very good quality of agricultural land is characterised with the intensive cultivation

and very good harvesting efficiency. Such areas on satellite imagery can easily be identified and delineated with very dark red to dark red tones and smooth texture. The fertility of soil is higher due to the deposition of fresh soil to be transported during flood. The underground water potentiality is also very high. Such areas are mainly confined in new flood plain and palaeo - channels, but some of the patches may also be seen in old flood plain areas where better crop production is availed through the application of modern inputs and better irrigation facilities.

#### **Good Quality Land**

The good quality of agricultural land have been identified on satellite imagery by red tone and fine to moderate texture. These areas occupy the higher soil fertility with good prospects of underground water and are confined in palaeo channel, new flood plain and fertile areas of old flood plain. Some portion of such areas are generally inundated during heavy flood. Better production of Rabi crops like wheat, potato etc. is obtained in this zone.

#### **Moderate Quality Land**

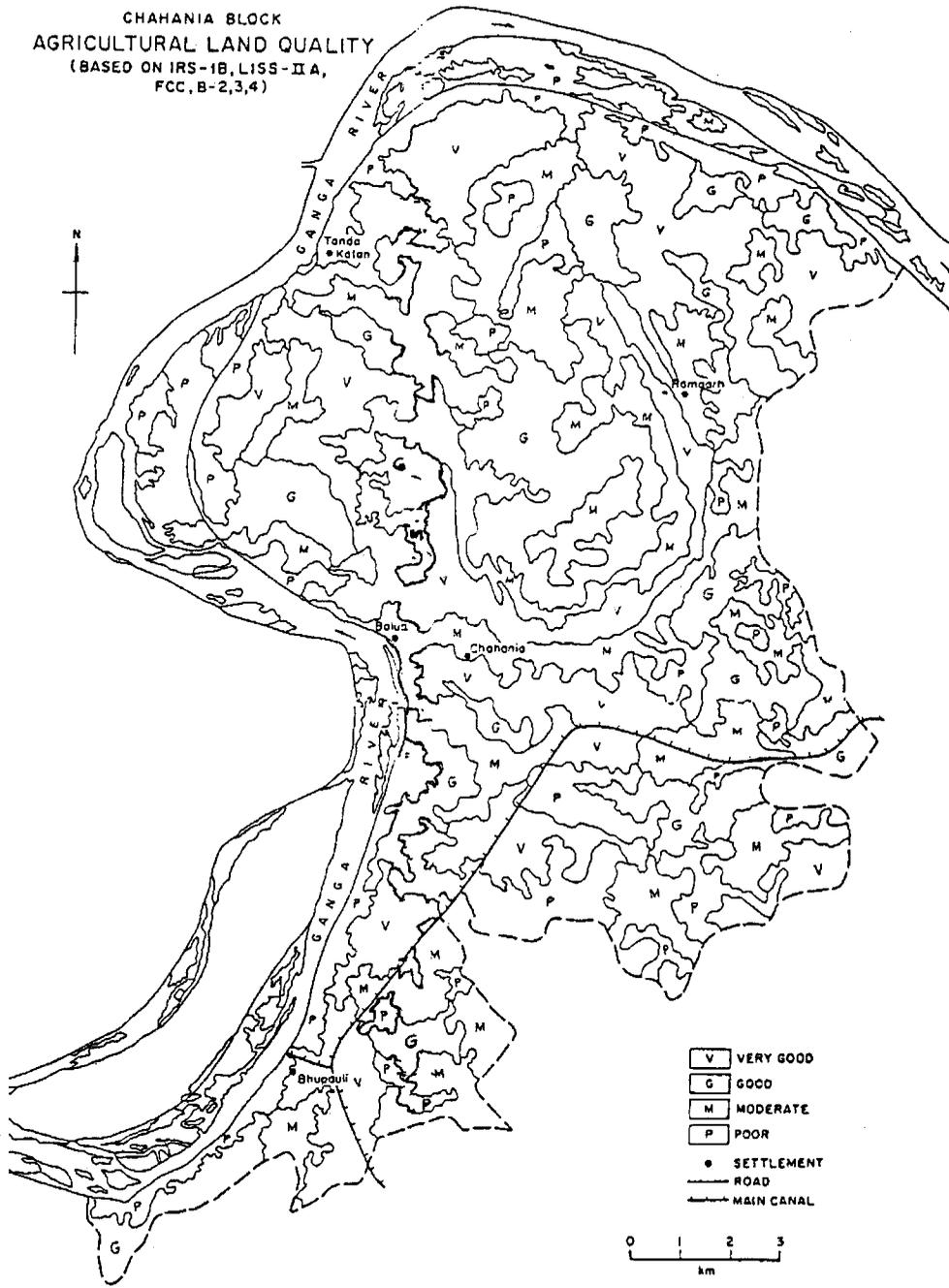
Such areas are mainly confined in between the very good / good and poor / very poor quality of land. In the north of Chahania market, moderate quality of agricultural land is associated with higher surfaces of old flood plains and generally occupied by the prominent settlements. These areas are characterised with gray to red mixed tones because of reflectance variation caused by mixed surface objects such as cultivation / settlements / trees etc. and moderate to coarse texture.

#### **Poor Quality Land**

These areas are identified and mapped by light and mixed tones with coarse texture on satellite imagery. They occupy generally lower areas / depressions / sandy patches. They are generally characterised with poor crops, bushes, open scrubs or usar land.

#### **CONCLUSION**

The above analysis reveals that a very deep relationship exists between geomorphic features and various quality of agricultural lands. All most whole of the region lying in the north of Chahania market have a higher degree of variations in the land forms and terrain conditions. As a result of such variations, the region occupies moderate to poor intensity of cropping (130 - 150 percent) but there exists some patches of good to very good quality of agricultural land. The agricultural productivity on such land is very high to high. The geomorphic features like palaeochannels, new flood plain zones etc. constitute the better quality of agricultural land while the old flood plain is characterised with varying nature of land quality (poor / moderate / good) depending on their spatial location and techno - cultural development. Poor to moderate quality of agricultural land are generally found in those areas which are characterised with water logging / salinity problems caused by their locations in specific land features. The study also reveals that the IRS - 1 B, FCC imagery both at scales 1:250,000 and 1:50,000 provide better information regarding the geomorphic features and land quality. The geocoded imagery (1:50,000) and aerial photographs (1:40,000) serve the purpose for detail mapping and investigation.



**Fig. 2 :** Chahania Block — Agricultural Land Quality

Table 2 :

## Image and General Characteristics of Agricultural Land Quality Zones

Name of Zones	Map code	Tone	Texture	Shape	Size	Geomorphic characteristics	Landuse/land cover	Remarks
Very good	V	Very dark red to dark red	Fine	Indefinite but crescentic at places	Small to large	Paleochannel, new flood plain	Intensive agriculture	Higher soil fertility, very good under-ground water potentiality
Good	G	Red	Fine to moderate	Indefinite	Medium large	Paleochannel, new flood plain occasionally inundated during heavy flood / old flood plain	Intensive agriculture especially rabi crops	Higher soil fertility, good underground water condition
Moderate	M	Grey to red, mixed tone	Moderate to coarse	Indefinite	Medium	Old flood plain	Moderate agriculture, settlement, garden / groves and water logged at places	Moderate soil fertility, moderate underground water potentiality at depth
Poor	P	Light to light red mixed tone	Coarse	Generally indefinite but crescentic at places	Small to medium	Lower areas / depressions / point nar, sand bar, higher flood plain, natural levee, sand mound	Poor agricultural land, bushes, open scrub or waste land	Sandy or poorly drained soil

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