Use of geoinformatics in lineament studies for best site for hydro electric project - A case study from Sach Khas, Chamba district, Himachal Pradesh, India

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Abstract

Among other parameters geology and lineament pattern of an area plays most important role in deciding as to which is the best site for hydroelectric project. Satellite data clubbed with topographic sheets do provide detailed requisite information about these parameters. The paper deals with deriving geological and information about structural linear features to find out the possible impact of lineaments on the upcoming hydroelectric power project in the vicinity of the upper Himalayas a study was undertaken. The area falling in toposheet number 52 D/5 at 1:50,000 scale is between upstream Purthi and the downstream Duggar with the diversion located between across the river Chenab. The project envisages the construction of a 90 m high concrete gravity dam, about 1100 m upstream of the Cheni nala confluence with Chenab falling in the Chamba district of Himachal Pradesh. To demarcate lineaments satellite data of LADSAT 7 ETM+, September 2000 were used. The study areas falls in the vicinity of the Great Himalayan Range and is characterized by rugged mountainous topography. The general trend of the rocks is NNE-SSW & NE SW. Deep steep rising hills with intervening dissected valleys are common. The rocks include Quartzites, phyllites, slates, schists and limestones of Batal and Mazri formations. The Chenab River flowing from south to north direction with dendritic to trellis type of drainage pattern. From the study it is concluded that geology and structural features pose no threat to the upcoming dam site.

1. Introduction:

India is endowed with a rich hydropower potential which is mainly located in northern and northeastern regions of the country. This is due to the presence of 2400 km long Himalayas which have a rugged topography and perennial river systems: the Indus, mighty Ganges and Brahmaputra. The Government of is India is actively encouraging the exploitation of this renewable source of energy in an environment friendly manner.

The lineaments are the most important structural deformities in addition to other geological structures such as fractures, folds, faults, joints etc. which could affect hydroelectric projects. The lineaments are the linear or curvilinear feature pattern and play a vital role particularly in geomorphic and structural analysis. Since Hobbs (1904) introduced the term lineament, it was used in different fields (e.g. petrology, geology and hydrogeology) as indicator for remote detection of the respective objects of interest. The definition of lineament as given (by O'Leary et al) "is a mappable, simple or composite linear feature of a surface, whose parts are aligned in a rectilinear or slightly curvilinear relationship which differs distinctly from the patters of adjacent features and presumably a subsurface phenomenon". Lineaments can be identified using remotely sensed imagery based on Tone, color, texture, pattern. Satellite data are low cost and have non-invasive approach. Photo lineaments generally represent the surface traces of features in bedrocks, projected more or less vertically upwards. The remote sensing data, which offer synoptic view of large area, helps in mapping the lineaments both regional and local scale.

Lineament analysis of the area from remotely sensed data provide important information on subsurface fractures.

In general they develop due to tectonic stress and strain and provide clue on surface features. Since these features serves as pathways for water, are responsible for infiltration of water into subsurface and thus destabilize an area. Presence of lineaments is most undesired in hydroelectric projects

2. Study area:

The study area popularly known as Sach Khas is upcoming Hydroelectric Project of L& T H.E. It is a river project located between the upstream Purthi and the downstream Duggar with the diversion located between 76°25'30.143" E, 32°57'55.123" N to 76°25'3.8" E, 32°58'7.5" N across the river Chenab. The project envisages the construction of a 90 m high concrete gravity dam, about 1100 m upstream of the Cheni nala confluence with Chenab falling in the Chamba district of Himachal Pradesh (figure 1). The study area falls in toposheet number 52 D/5.

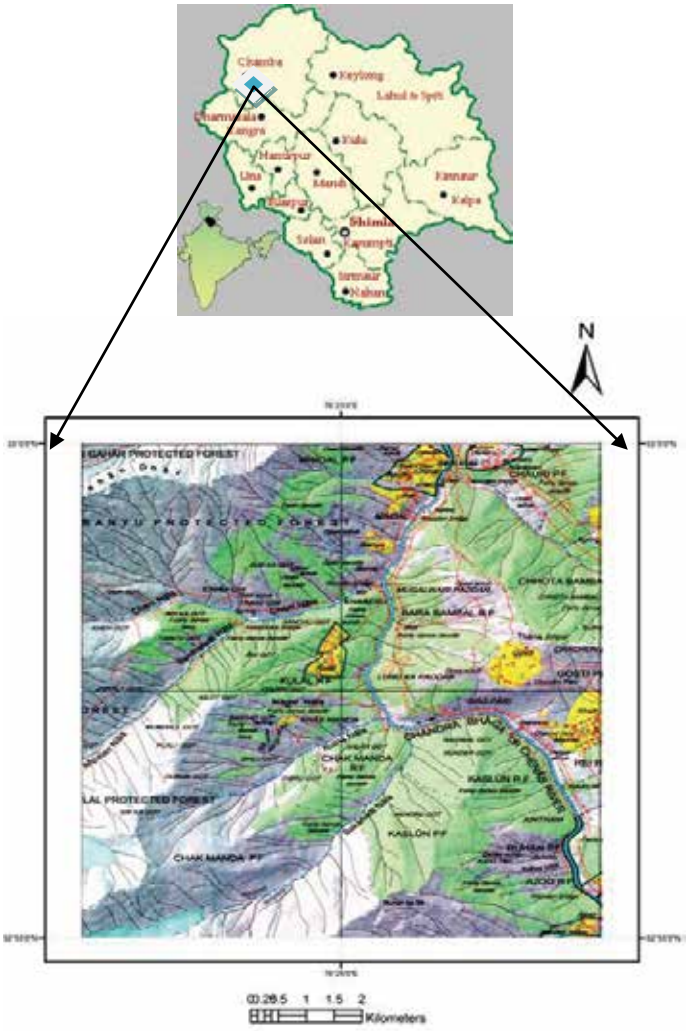

Figure 1 Location map of the study area, Sach Khas, Chamba District, H.P.

3. Methodology:

SOI toposheet numbered 52 D/5 at 1: 50,000 was used for preparing base map of the study areas. Information on general topographic details i.e. drainage, its direction, geomorphic units etc were derived from the SOI maps. Digital scene of the study area of LANDSAT 7 ETM+ of September 2000 close to 1:50,000 scale was used to demarcate lineaments of the study area. Pre-existing geological maps were referred for understanding lithological and other information on the geology of the study areas (GSI, 1994).

3.1 Study of Lineaments:

Lineaments are directional geological data and show preferred linear pattern in their spatial spread. The most obvious structural features that are important from water and destabilizing an area apart from major structural deformities point of view are the lineaments.

In the present study, a lineament is considered a surface expression of fracturing in the form of topographic alignments (i.e., valleys and cliffs), alignments of streams, rivers, and other drainages, linear trends in vegetation and truncation of rock outcrops. Thus a study was undertaken to map lineaments, geology and understand their possible impact on the best site selected for hydroelectric project

4. Analysis of Results and Discussion:

4.1 Geomorphology and Geological setting: Geological input is most important for hydropower projects located in complex Himalayan terrain. The study area falls in the vicinity of the Great Himalayan Range and is characterized by rugged mountainous topography with high hills, deep valleys, escarpments, valley fills and cliffs. The rocks are generally trending NNE-SSW & NE SW direction with steep slopes. Deep steep rising hills with intervening dissected valleys are common feature of the study area. The rocks include Quartzites, phyllites, slates, schists and limestones of BATAL and MAZRI formations (GSI).

4.2 Drainage: The Chenab River is the main river flowing from south to north direction across the strike of the various formations. The river together with various tributaries define dendritic to trellis type of drainage pattern

4.3 Satellite data Interpretation: The lineament studies were carried out by integrating satellite interpreted details with topographic sheets at 1:50,000 scale. This included identification of lineaments from the satellite data in conjunction with basic information derived from topographic sheets.

Satellite remote sensing provides an opportunity for better observation and more systematic analysis of lineaments following synoptic, multispectral repetitive coverage of the terrain. However, in the present study only one digital scene covering study area was used for detailed studies. The sub set covering the study areas was cut from the main digital geo-referenced satellite data of LADSAT 7 ETM+ as shown in study area 1 (figure 2).

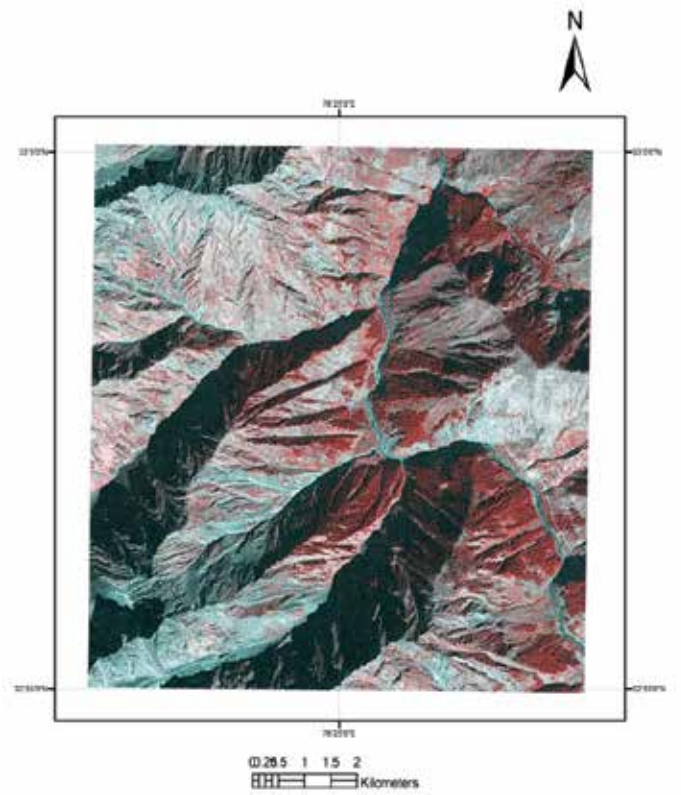

Figure 2. Landsat 7 ETM+ image of the study area

This file was then brought in the ARC / GIS platform for further analysis. First, satellite digital sub set of the study area was exactly overlaid on topographic sheets to ensure compatibility using swipe module. Keeping topographic sheets in the background digital satellite data were visually interpreted. The lineament map was prepared by digitizing linear features on screen from digital data included both the categories drainage or topographic. Thus, each category was stored as different layer in ARC/GIS. The lineaments of the study areas were picked up on the basis of tonal, textural, topographic and drainage linearities, curvilinearities and rectilinearities

It is observed that one set of lineaments controlled the major river in the study areas and general trend is towards NS. Another set of lineaments identified in structural hills, pediments and valley fill zones in the study areas are controlling the river channel and nallah runs across the previous one.

Lower order streams viz. first order and second order streams are controlled by lithology and shows typical sub parallel, parallel and dendritic pattern and interestingly meet river Chenab almost perpendicular in the study areas. It is evident that major drainage is structurally controlled and could be in tune with Himalayan major deformation i.e trending NW and SE direction (figure 3).

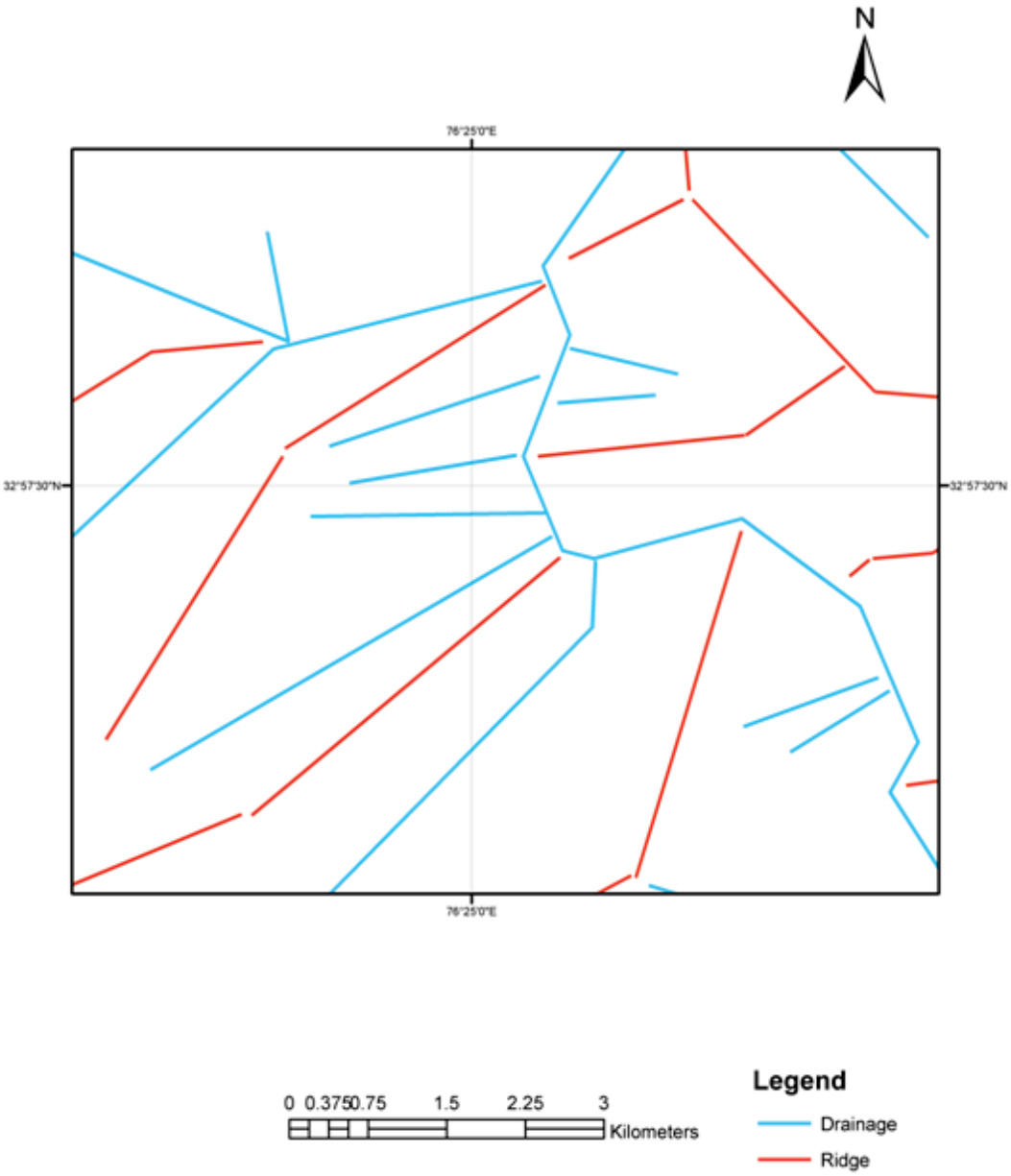

Figure 3 Lineament map of the study area

5. Conclusions:

From the above study it is concluded that in the absence of major structural lineaments in the study areas, drainage and topographic related lineaments being small in extent and running parallel to the Chenab river or meeting perpendicularly to it shall pose no threat to the upcoming structure on the proposed site across river Chenab.

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