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Identification of Lineaments in the Pravara Basin from ASTER-DEM Data and Satellite Images for their Geotectonic Implication

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Abstract

Lineaments are long, linear to slightly curvilinear, geological features with regional to local extent. These are considered to be zones of structural weakness and are important from geological, geomorphological and hydrological perspective. The minerals and water bodies are seen to play along lineaments. Hence, their identification and mapping assumes social and economic significance. Earlier, lineament identification was ambiguous and not too accurate, due to overemphasis on visual interpretation of toposheets and contour maps. These are however filled with cultural bias in terms of man-made drainage lines and anthropogenic land use practices. This lacuna is being overcome by using remote sensing images and interpreting shaded relief, slope, and aspect images, created with Geographical Information System (GIS) software and ASTER-DEM data. The results demonstrate that the lineament detection from Remote Sensing (RS) data and GIS techniques achieves better accuracy compared to traditional sources of lineament identification methods. It has provided better geotectonic understanding of Deccan trap terrain. The imprints of western Ghat orogeny are seen in upper stream section of Pravara basin. Line of crustal dislocation is also identified. The study will help in understanding the geomorphological features and geotectonic implications for Pravara basin.

Keywords: Lineaments, ASTER-DEM, GIS, RS, Pravara Basin.

Introduction

Lineaments are long linear features which are manifest on the surface, identified especially through satellite imagery, in different geomorphologic attributes. They are studied for economic, structural, hazard assessment, seismogenic and tectonic reasons. The most acceptable definition of a lineament is given by Richards[1] and O'Leary[2] implying linear topographical feature suggesting structural weakness and whose features are distinctly different from its surrounding geology. Lineaments are seen to crisscross the entire Deccan Traps terrain[3-8] and are under close scrutiny to identify their seismotectonic implication[9]. Lineaments are also studied for their economic and social significance implied in manipulating the mineral and water resources found in abundance around these features. They also help in understanding the structural and tectonic framework of an area helping plan mitigating efforts of any hazards arising out of their response to neotectonic activity, if any. Lineaments are considered to be a structural response to lithospheric emplacement or displacement, cratonic activity, ocean formation, seismicity, orogenesis, plutonic activity and metallognesis[10].

Lineaments are difficult to identify in field and require enormous time and efforts, apart from the accessibility. They are normally hidden from human view due to presence of soil and vegetal cover, erosion as well as changing urbanized land use pattern. Traditionally lineament features were identified with the help of topographical contours[11]. However, they are seen to contain enormous bias, which is seen to minimize in ASTER-DEM data and its derivatives. The main objective of the present effort is to detect and map lineaments in the study area by using RS data and GIS technique. The ASTER-DEM and GIS software is found to be very useful in lineament studies.

Study Area: The study area is located between 19°15' 00' to 19° 45' 00'' north latitude and 73° 37' 30'' to 75° 01' 52'' east longitude (figure-1). Pravara is a tributary of Godavari River, one of the most important rivers of India. Pravara originates in western part of Ahemadnagar district at Ratangar Hill at an elevation of 1205 M.-ASL, which joins Godavari River near Pravarasangam (Newase-Ahemadnagar)[12]. Geologically, the basin area belongs to Deccan Traps region wherein Khandala and Poladpur formations, situated close to the Western Ghats escarpment having moderate relief, is drained by tributaries of the Pravara River. The basalt flows in the studied area are nearly flat-lying and mainly belong to the Thakurvadi formation of the Kalsubai Subgroup[13]. The western part of Basin is connected to the highest pick of Maharashtra (Kalsubai-1646 m). The north-western part has undulating topography, etched out by erosional processes unleashed by air and water. The lower section of Pravara stream contains fluvial deposition.

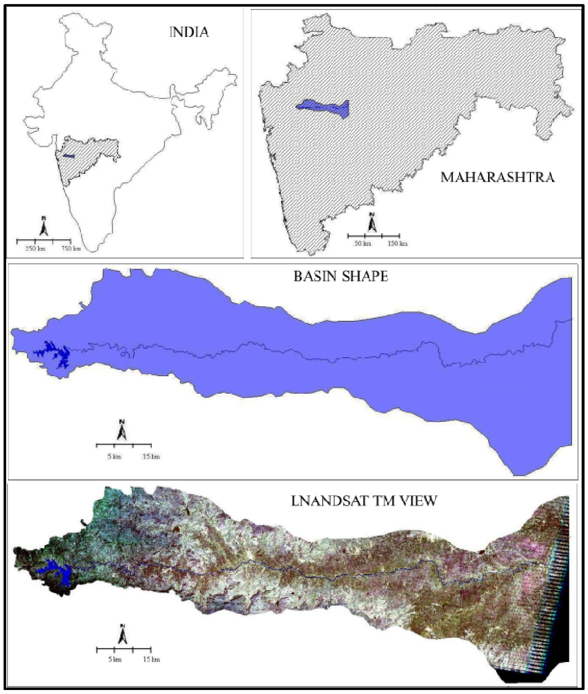

Figure-1
Location of the study area marked on the India and Maharashtra state map, exhibiting the morphological shape of Pravara Basin, and its satellite imagery

Methodology

ASTER-DEM data and its derivative maps likes HSV shader, shaded relief, slope map and such are used to identify the presence of lineaments. The identification was attempted by on-screen visual interpretation of the aforesaid maps. They were then verified in field by actually locating their presence in-situ. The techniques adopted and related analysis carried out involved the following steps: i. ASTER-DEM data of central Maharashtra region was downloaded from www.glcf.org website. (Global land cover facility, center). ii. Digital Elevation Model was constructed using GIS software and the elevation data thus retrieved was used to etch out shaded relief, slope and other parameters. Map preparation was done in GIS software. iii. Lineaments were detected on screen by visual interpretation and extracted manually by digitizing all the linear features and near-straight stream segments that could be observed in the maps obtained from ASTER-DEM. iv. The demarcated lineaments were then superimposed on Landsat satellite images for ascertaining the occurrence of missed features. v. Lineaments thus identified were also verified on ground to avoid bias. vi. Final lineament map of Pravara basin was then was then obtained.

ASTER DEM data: The Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) was launched in December 1999 to map land surface temperature, reflectance and elevation. This imaging instrument is kept onboard Terra and is a joint endeavor between NASA and Ministry of Economy, Trade and Industry (METI) Japan. ASTER captures high spatial resolution data in 14 bands, from the visible to the thermal infrared wavelengths, and provides stereo viewing capability for digital elevation model creation[14]. The data pertinent to the study area was downloaded and map of elevation was created as depicted in figure-2.

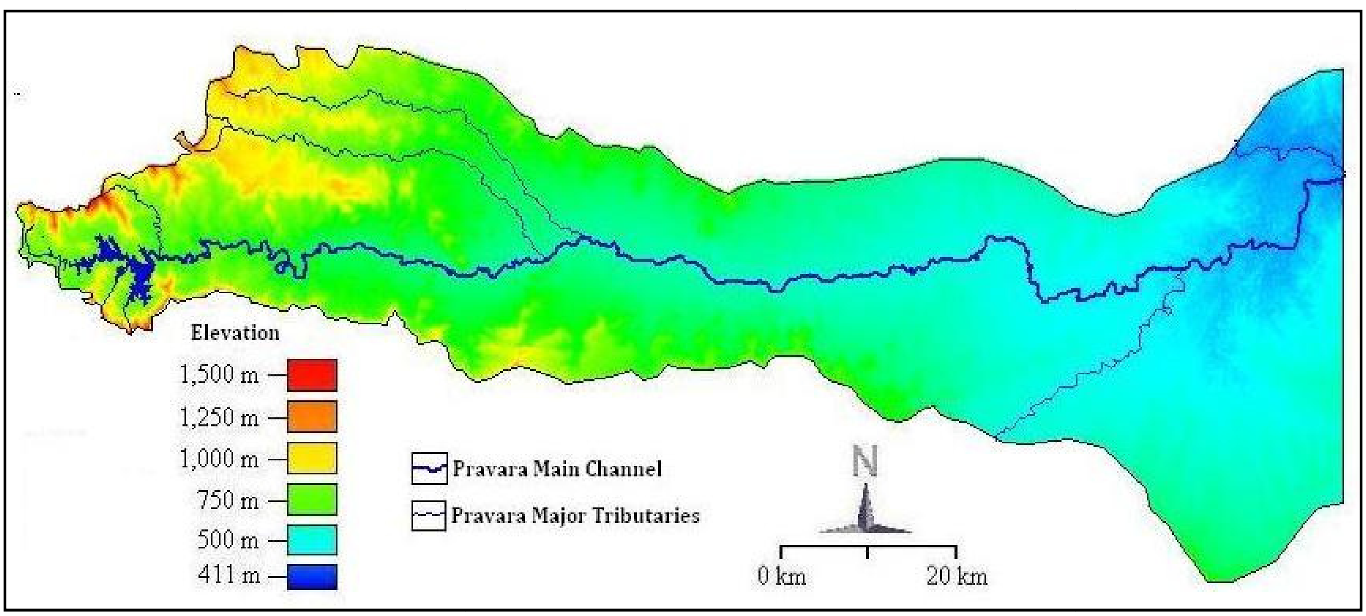

Figure-2
ASTER-DEM data for elevation of Pravara Basin was created on which main channel and tributaries were superimposed

Results and Discussion

Many geological and topographic maps, on closer scrutiny, can reveal features resembling lineaments. These can also become obvious on aerial or satellite photographs. The topology created from ASTER-DEM data was scrutinized diligently for linear features which were then verified from Lands at TM data (RGB-456) and ground authenticity testing. The results obtained by adopting this strategy are as follows:

DEM data:T his data of the area (figure-2) reveals general topography of Pravara Basin decreases from west to east (figure-3). The highest elevation inferred is 1646 m above sea level whose location coordinates are 19° 36' 04' north latitude and 73° 42' 34'' east longitude. The lowest point, as expected, is where Pravara joins Godavari at Pravarasangam (470 m-ASL). Thus, the relative relief prevalent in Pravara basin is 1176 meter. The map shows nearly 35 % of the total area is hilly terrain, which forms a part of Western Ghats on its eastern side.

Landsat TM data: On the satellite images, lineaments usually appear as straight lines or edges. Frequently, lineaments may have gaps due to stream erosion, deposition and masking by surficial material[15,16]. From Landsat TM data, straight lines or edges at the 456-RGB spectral band can be inferred (figure-3-iii). The filtering (sharpen) exercise with Eridas software gave good quality results enabling proper lineament detection.

Aspect: The resulting view in Aspect showing the general direction of slopes of lineaments (figure-3-i). Aspect refers to direction of the slope. This fact serves as an evidence for specifying general direction of stream flow in a straight line.

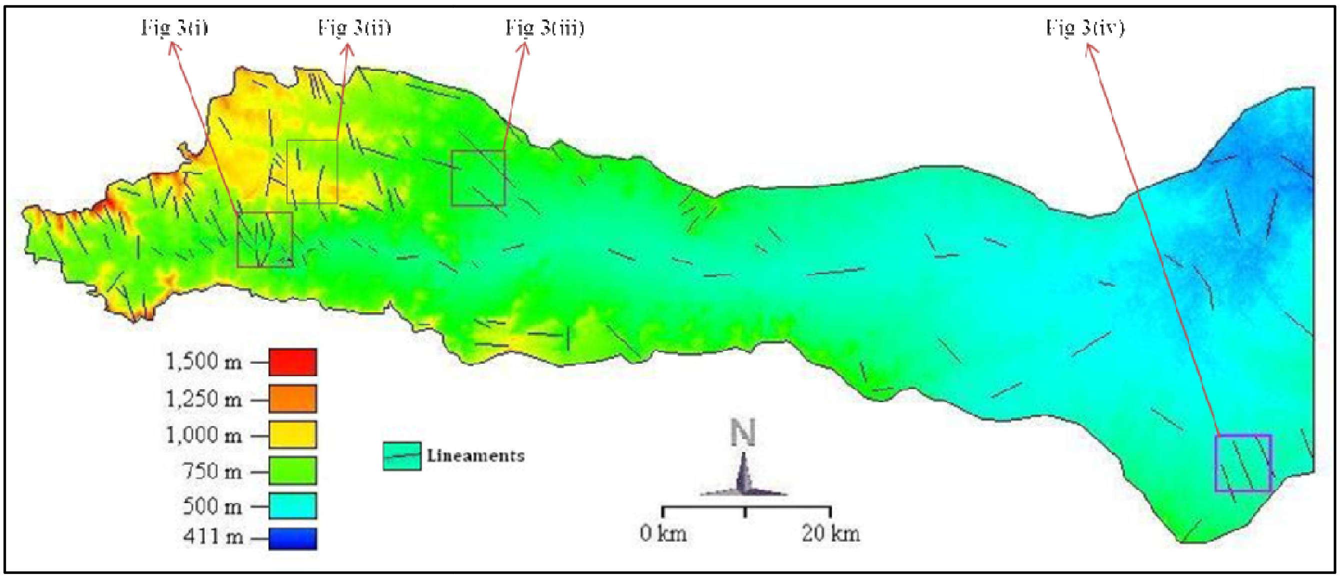

Figure-3
DEM of Pravara Basin over which are superimposed Lineaments

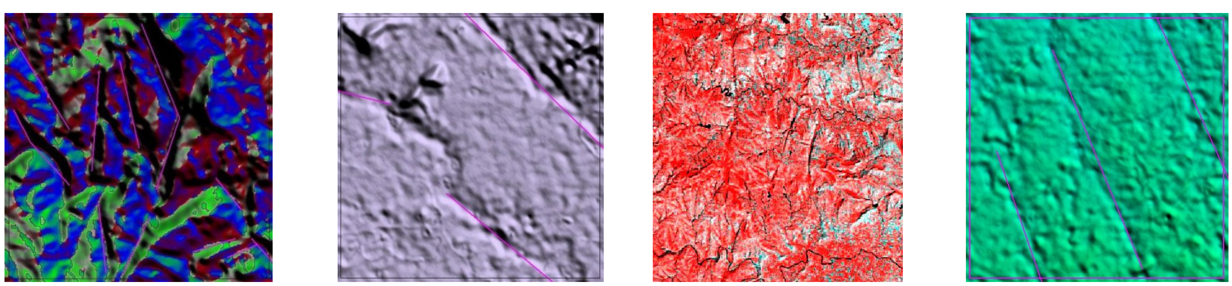

Figure-3(i) **Figure-3(ii)** **Figure-3(iii)** **Figure-3(iv)**

Figure-3
(i) hint of lineaments along the Pravara main channel; (ii) HSV shade showing flow of tributaries along the middle basin; iii. straight, linear lines(lineaments) inferred from Landsat TM data; (iv) Lineament alignment with one another in lower Pravara basin.

Slopes: The slope analysis of Pravara basinclearly shows presence of highest slope angles in its western part and some isolated pockets of steep slope along the drainage side of basin. The downstream section of basin has the minimum slope. Nearly, 35% of the basin area has slopes greater than 40°.

Ground Truthing: Field observation and verification of the inferred linear features from satellite imagery is a very important feature of such studies. The accuracy of inferences need to be tested on ground for verification of lineaments. Our field excursion revealed trunk stream of Pravara flowing in a very straight direction (figure-4). Similarly, at the top of plateaulinear cracks in basaltic rocks were encountered (figure-5). This goes to prove that the lineaments seen on SRTM-DEMare present in the field as well.

Figure-4
River flow in a rigidly straight direction

Figure-5
Linear cracks seen in basaltic rock

Conclusion

GIS technique and RS data are very useful in identifying regional features like lineaments. This is a very efficient tool to delineate features susceptible to tectonic machinations capable of inducing natural hazards or accruing economic and social benefits. The present study reveals ASTER-DEM can provide better geotectonic understanding of even a rigid litho unit like Deccan traps. The lava flows have masked all the earlier formations and the weak planes are beyond human gaze. The neotectonic imprints are also hard to identify and interpret. But, this technique can reveal many hidden aspects of this terrain.

The occurrences of lineaments aregreater in the upper stream section of basin. This could be due to the imprints left behind by the western Ghat orogeny. The lineament direction of most of them is from north-west to south-east (figure-6). Sub-tributaries of Pravara, such as Mhalungi and Adhala are seen to meet at right flank along the central part of Pravara basin. This is the line of crustal dislocation which is easily identifiable in figure-4. These two sub-tributaries, Mhalungi and Adhala, are aligned almost in a straight line, running north-west to south-east for over 35 km. Ample geological and geomorphological evidences were observed during the field verification of lineaments (figures 4 and 5). Based on all the inputs derived from ASTER-DEM and allied features the lineament map of Pravara basin was compiled (figure-7). This will help in understanding the geomorphological features and geotectonic implications for the area studied.

References

1. Richards J.P., Lineaments revisited, Soc Econ Geol, **42**, 13–20 **(2000)**
2. O'Leary D.W., Friedman J.D. and Pohn H.A., Lineament, linear, lineation: some proposed new standards for old terms, *Bull GeolSoc Am*, **87**, 1463–1469 **(1976)**
3. Agarwal P.K., Pande O.P. and Chetty T.R.K., Aeromagnetic anomalies, lineaments, and seismicity in Koyna-Warna region, *J.Ind.Geophys.Union*, **8(4),** 229-242 **(2004)**
4. Srinagesh D., Srinivas T.V.N., Solomon Raju P., Suresh G., Murthy Y.V.V.B.S.N., SatishSaha, Sarma, A. N., Vijay Kumar T., Causative Fault of Swarm Activity in Nanded City, Maharashtra, *Current Science,* **103 (4), (2012)**
5. Manjare B.S., Mapping of Lineaments in Some Part of Betul District, Madhya Pradesh and Amravati District of Maharashtra, Central India Using Remote Sensing and GIS Techniques, *International Journal of Advanced Remote Sensing and GIS*, **2(1),** 333-340 **(2013)**
6. Herlekar M.A. and Sukhtankar R.K., Morphotectonic Studies along the Part of Maharashtra Coast, India, *International Journal of Earth Sciences and Engineering,* **4(2),** 61-83 **(2011)**
7. Peshwa V.V. and Kale V.S., Neotectonics of the deccan traps province: Focus on the Kurduwadi lineament*, Journal of Geophysics,***5(1),** 77-86, **(1997)**
8. Gawali Praveen B. Waghmare S.Y., Carlo L. and Patil A.G., Geomagnetic secular variation anomalies investigated

through tectonomagnetic monitoring in the seismoactive zone of the Narmada-Son lineament, Central India, *J.Ind.Geophys.Union,* **15(2),** 61-76 **(2011)**

9. Pal S.K., Majumdar T.J. and Bhattacharya A.K., Extraction of linear and anomalous features using ERS SAR data over Singhbhum Shear Zone, Jharkhand using fast Fourier transform, *International Journal of Remote Sensing*, **27(20),** 4513–4528 **(2006)**

10. Bhave, K.N., Ganju, J.L., and Jokhan, Ram, Origin, Nature and Geological Significance of Lineaments. In: Qureshy, M.N., and Hinze, W.J (Ed.), Regional Geophysical Lineaments their Tectonic and Economic Sgnifivcance, *Mem. Geol. Soc. India,* **12**, 35-42, **(1989)**

11. Pawar R.D., Kale V.S., Sengupta S., Identification and mapping of geoclinal lineaments in the Kaveri basin from SRTM-DEM data, *Proceedings of national conference on recent trends in Geoinformatics,* **(2008)**

12. Aher S.P., Bairagi S.I., Deshmukh P.P., Gaikwad R.D., River Change Detection and Bank Erosion Identification using Topographical and Remote Sensing Data, *International Journal of Applied Information Systems,* New York, USA, **2(3),** 1-7, **(2012)**

13. Bondre N.R., Hart W.K. and Sheth H.C., Geology and Geochemistry of the Sangamner Mafic Dike Swarm, Western Deccan Volcanic Province, India: Implications for Regional Stratigraphy, *The Journal of Geology,* 114, **(2006)**

14. http://asterweb.jpl.nasa.gov/index.asp accessed on 30/05/2014. **(2014)**

15. Pokharel S.B., Remote Sensing and GIS Analysis of Spatial Distribution of Fracture Patterns in the MakranAccretionary Prism, South-east Iran, UnpublishedM.Sc dissertation submitted to College of Arts and Sciences, Georgia State University, **(2007).**

16. Lillesand T.M., Remote sensing and image Interpretation, Published by John Wiley & Sons (Asia) Pvt, ltd, Singapur, **(2009)**

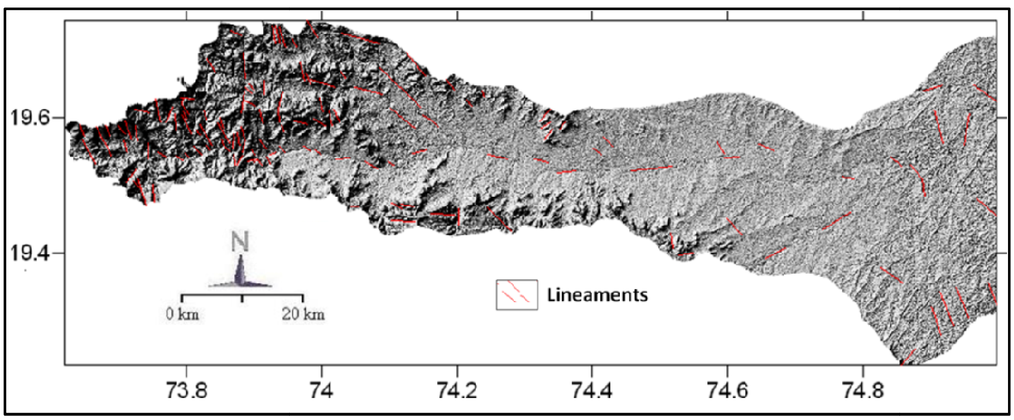

Figure-6
Shaded relief map showing general topography and lineament direction, The central part of the basin defines crustal dislocation

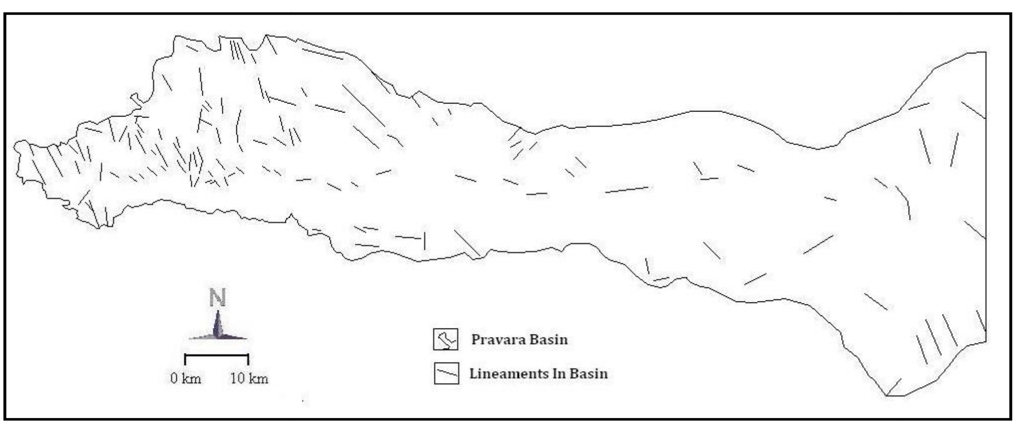

Figure-7
Lineament map of Pravara Basin