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GEOMORPHIC ASSESSMENT OF THE PROBLEM OF LAND DEGRADATION AFFECTED BY HUMAN ACTIVITIES USING LANDSAT ETM +7: A CASE STUDY OF LONAR CRATER LAKE, INDIA

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ABSTRACT

The Lonar crater (diameter as 1830 m) is a simple impact crater in basaltic target rocks (Deccan Traps). In the present research paper geomorphic assessment was done for the Lonar impact crater lake. Therefore Remote Sensing and GIS technology have been effectively utilized. Now a day's it is an emerging technology to solve various geomorphic problems. As for Lonar crater is concern various hygienic activities are carried out by the local people in the freshwater spring. The nuisance of tourists; untreated domestic water and garbage are thrown from the city surrounded at the crater rim. The ejected cover extending outward from the crater's rim has progressively been brought under cultivation, the crater lake has a continuous cover of alluvium of silt to clay grain size around the saline lake. The ejecta blanket of the crater degrading very fastly since from the last four to five decades. So the present research paper provides RS and GIS techniques applications utilised in the assessment of the problem of degrading lonar crater it also assesses the environmental issues and ecological imbalance of the Loanr crater. Neither any technique nor any plan has been prepared for the Lonar crater conservation. Most of the observations were made during the recent fieldwork by the authors.

Keywords: Lonar crater, Land degradation, Remote sensing, GIS

INTRODUCTION

Lonar crater is one of the largest meteoritic impact crater in the basaltic rock of India. It is one of the unique morphological meteoritic features of the world. (Therefore, it is known as a natural wonder of the world.). The majestic Lonar Crater of Buldhana District, Maharashtra, India is a remarkably circular and bowl-shaped depression. The inner and outer rim of the crater co-inside approximately 460 m. and 610 m. elevation contours respectively. Because of its morpho-climatic uniqueness, it has attracted so many geomorphologists from all over the world. Many attempts were made in the past to establish the origin of this crater. The circularity and the age of the structure gain more importance to interpret for an impact or a volcanic origin **[1]**. This 1830 m diameter (rim-to-rim) and 130m deep crater, centring 19º58'50''N Lat. and 76º30'50''E, has been a focus of research for the earth scientist across the globe for its youthfulness. (1, 2, 3,4) It was suggested that it represents a meteorite impact crater, which according to fission track dating took place about 50,000± 6000 years ago. This is the only unique impact crater in basaltic rocks in the world **[5], [6]**. (A. Dube and Sengupta, unpublished report, GSI, 1984)

A Panoramic view of the Lonar crater lake, India

STUDYAREA:

The study area is a unique craters field, is situated near Lonar city i.e. tahsil place of Buldhana district. The Geographical location study area extends between 19°57'30" North latitude to 20°2'30" North latitude and 76°27'30" East longitude to 76°32'30" East longitude. Painganga River is the main tributary of Godavri River. The Lake has perfectly located in between the Penganga and Purna rivers of the Godavari River. The surrounding area is characterised by the Deccan traps of the Maharashtra plateau.

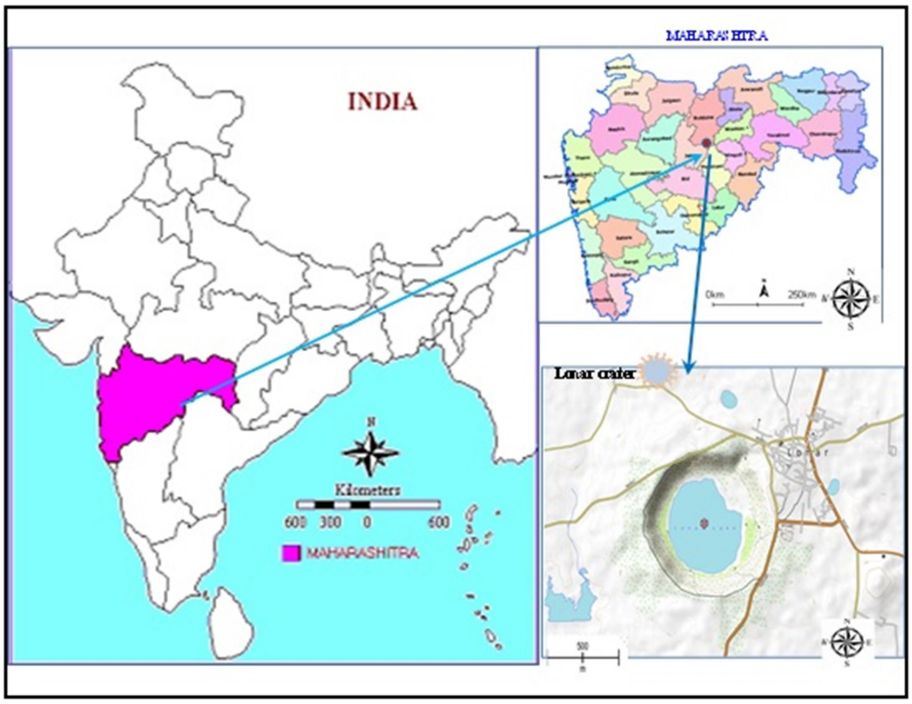

Fig.No.1: location map the Lonar Crater Lake

OBJECTIVES OF THE PRESENT STUDY

1. To bring RS and GIS technology in the mainstream to reduce the land degradation and geomorphic problems of the Lonar, crater.
2. To provide the interpretative information of lonar lake morphological changes and imbalance of lake ecosystem.
3. To assess the impact of lonar city, sewage water tank, agricultural activities and deulgaon dam on the lake ecosystem.

METHODOLOGY

1. DATA ACQUISITION

Data for the present study is acquired from the following sources;

TOPOSHEET: SOI topographical map on 1:25000 scale was used as a base map. The Lonar Lake lies in the SOI toposheet. 55D/8/SE, 55 D /12/SW, 56A/5/NE and 56A/9/NW. These toposheets were used for analysis.

FIELDWORK: Frequently field survey is organized during the pre-monsoon and post-monsoon seasons. Detailed profile observation was done during the field visit.

GPS SURVEY: The entire study area was tracked with the help of GPS.

LANDSAT AND ASTER IMAGE: The images were acquired from the NASA US govt. department. These layers were used for further analysis.

ARTICLES AND PAPERS: A large collection of articles and research papers clippings used to write this research.

MAPPING:

BASE MAP PREPARATION: This was done using toposheet no. 55D/8/SE, 55 D /12/SW, 56A/5/NE and 56A/9/NW (1:25000) covering the study area. The data from topographical was processed in surfer and global mapper (version-12 and 13) software. Rectification of the base map was done in global mapper software.

DIGITIZATION OF LAYERS: The contours, streams etc. layers were digitized from the toposheet in Global Mapper

PREPARATION OF THEMATIC MAPS: various thematic maps and DEM have been prepared in the surfer software by the technique of spatial interpolation

RESULT AND DISCUSSION:

Lonar Crater Lake is one of the meteoritic impact craters. Now a day it has recently been declared as an eco-sensitive zone due to its ecological importance. For the last 50 years it's facing various environmental problems due to the great pressure of manmade activities. For a better understanding of the Lonar ecosystem geomorphic and physiographical assessment is required. For that quantitative analysis is required to understand the topographical influences on the lonar crater ecosystem. So for further assessment and to understand the application digital maps becomes very important tools. Remote Sensing data offers morphological mapping and understanding of the geomorphic process.

Lonar crater has a Paleo geomorphology. It shows evidence of sedimentological and depositional environment (Fudali *et al* 1980, Komatsu *et al*. 2014).

The DEM map **(Figure 2)** of the lonar Crater Lake indicates ejected blanket of the crater which is characterised by the number of gullies and streams. So crater floor is characterised by alluvial and colluvial deposits by the debris flow mass wasting process. It also indicates altitudinal variation in the region.

Lake Ecosystem disturbed slowly because of siltation or sedimentation. It reduces the life span of the lakes. Crater wall collapse due to illegal manmade activities and interference. Ejecta blanket of the crater extended 2 to 4 km away from the crater rim. So the Northeast side of the crater ejecta was brought under the city development. The crater is having a centripetal drainage pattern. All streams collect the silt at the foot of the hill or rim. The deposited silt reduces the capacity of the lake and it disturbs the ecosystem balance of the crater i.e. vegetation life, animal life, decomposers or microorganisms and birdlife [**6, 7, 8**].

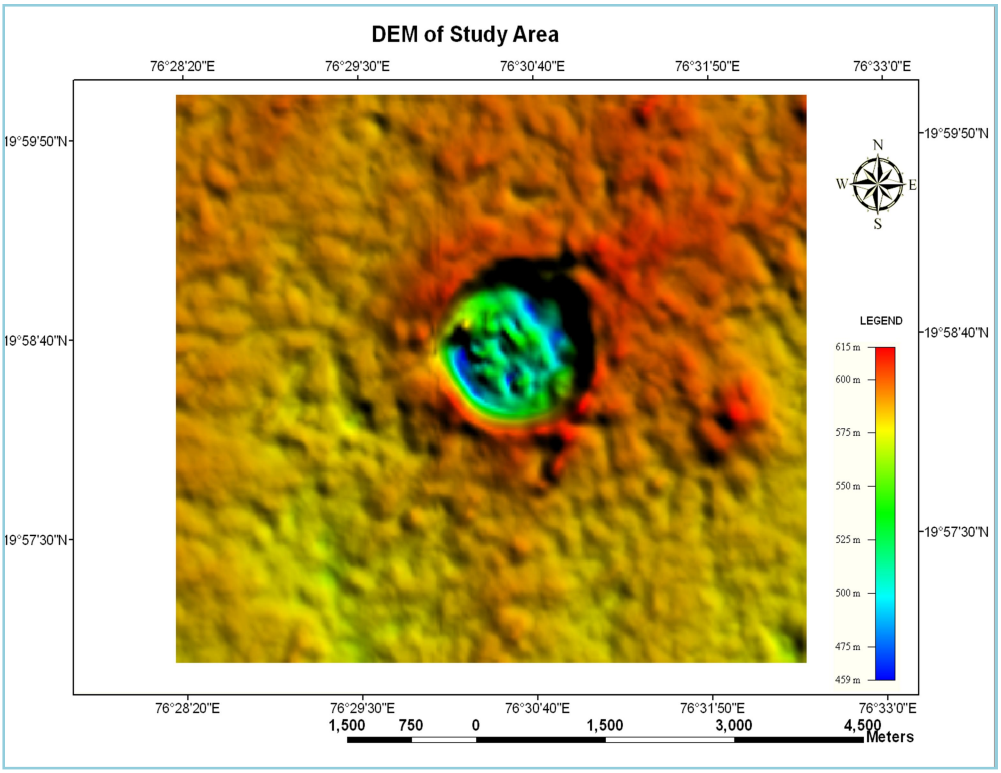

Figure 2

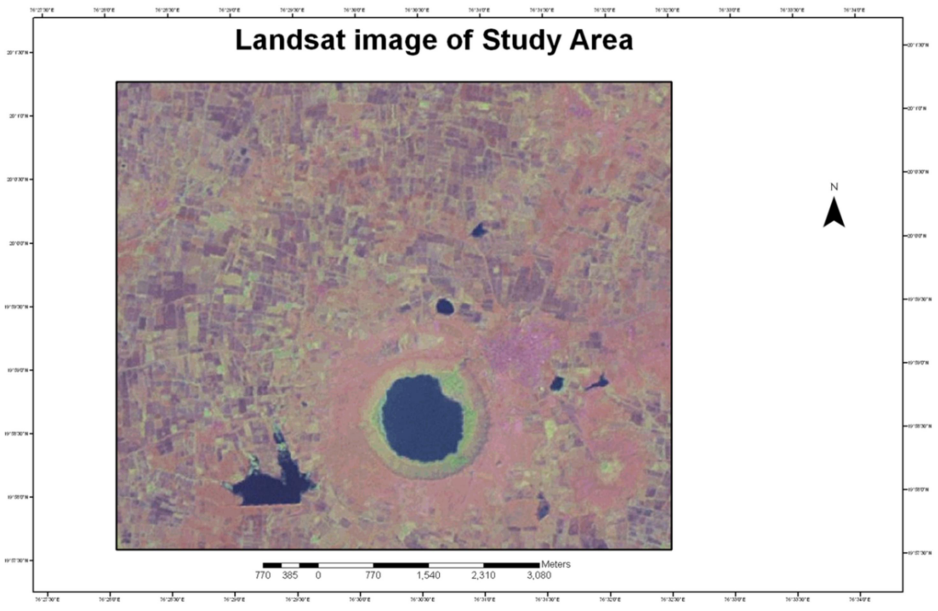

Figure 3: False-colour composite LANDSAT +7 image

The above LANDSAT ETM + image gives detailed information about the lonar crater lake. Ejecta blanket is shown by dark pinkish colour which is occupied by various manmade activities, therefore, scenic beauty and the eco-balance of the crater is decreasing. The Crater

rim wall is characterised by hydrological processes. Thus due to hydrological processes i.e.discharge of streamflow, surface runoff, sheet wash etc processes the crater wall is facing a high rate of soil loss, erosion and mass wasting phenomena and the floor of the crater find a high rate of sedimentation processes. Especially towards the NE side of the basin is characterised by alluvial and colluvial delta features created due to the deposition process. So silt deposited inside of the lake reduces the depth of the lake.

Sewage disposal is another threat to the ecosystem. The crater is a depression, attracts water coming to it. By gravity, the polluted water enters the crater. Some areas of ejecta blanket beyond the rim walls are either under cultivation or some authorised or unauthorized construction. This is disturbing the natural atmosphere of that area. For this use, the excavation of soil and rocks is done, which is undesirable.

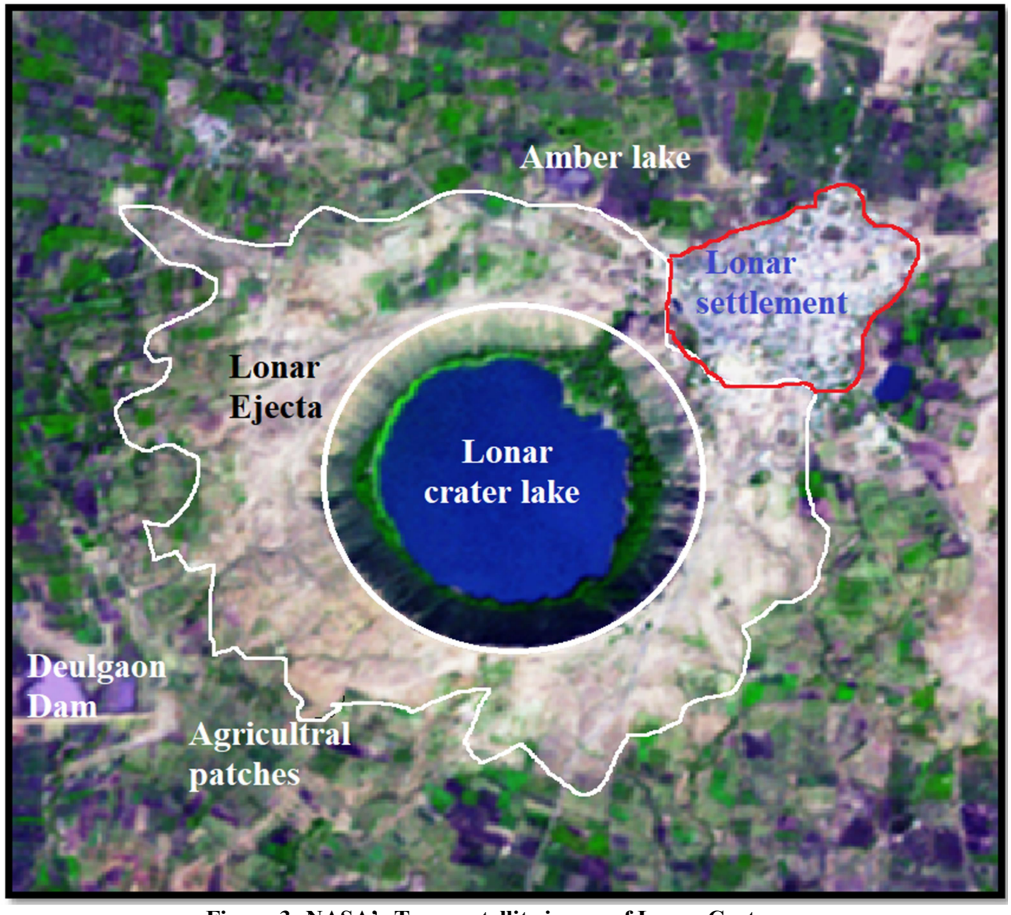

Figure 3: NASA's Terra satellite image of Lonar Crater

The above NASA's Terra satellite image of the lonar lake indicates the problem of ejecta blanket degradation. it indicates that the ejecta blanket is facing problems from all directions

of the crater because of the unauthorised activities of the local people.

The following graph indicates the environmental and the geomorphic problems of the Lonar crater lake towards the west side Deulgaon Kundpal dam is located the location of the dam is a faculty location because water seeps into the crater during the monsoon period. From 2015 to 2018 the level of the crater fluctuated very surprisingly. Therefore salinity of the crater decreases due to freshwater during June to January months. So here it can be said that the location of the Kundapapal dam is faulty, while unauthorised agricultural patches also approach the ejecta blanket of the crater. It decreases the ecosystem of the ejecta blanket. Sewage water disposal goes into the crater lake as well as also decreasing the salinity of the crater.

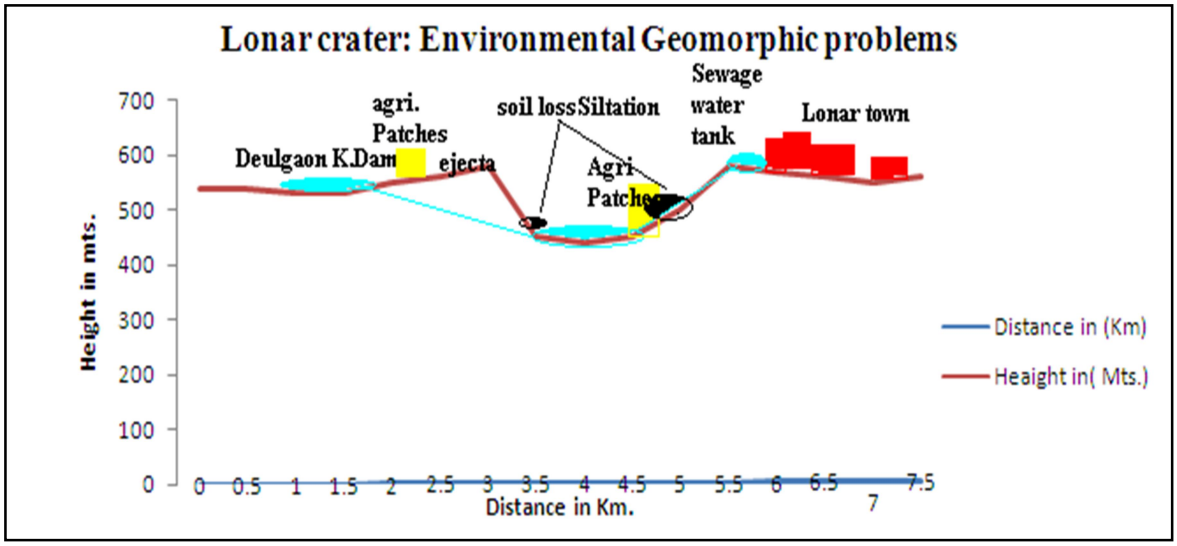

Figure 4

By using RS and GIS techniques we can identify the geomorphological modifications and the morphological processes associated with the ejecta blanket **[9] [10]**

Geomorphological Elements of the Lonar crater lake

It is important to understand the geomorphological elements of the crater to reduce the severity of the problems of the lonar Crater Lake. The image of the crater gives an idea about the tone, texture, shape, size, pattern and association. So it is helpful to understand the modification of the crater. The tone of the Lonar crater and the textural variation is gradual due to the ejecta outside the rim of the crater. The crater specific image signature is discussed.

Circularity index

It is the ratio between the area of the circle which fitted the outline of the crest of the

crater. The Lonar crater's circularity is 1. It indicates the perfect circular in nature.

Circularity Index (CI) = 4*pi*area of the crater / Perimeter of the crater (Fudali, *et al*., 1980

Size of the crater

The North to South diameter of the crater is 1825 mts and the East to West diameter is 1775 mts. So it is perfect circular orbit is well in circular diameter.

Association of the crater

Lonar Crater Lake is associated with the ejecta blanket of the crater which is located the outside of the crater rim i.e. 4km towards the Westside while 2 km towards the Eastside. So this associated feature is important to identify other craters.

The Ejecta Blanket of the crater

The ejected blanket of the impact crater is a very important element because it is the only evidence that indicates the evidence of the impact of the crater. Therefore the ejecta blanket can give more details of the process of formation of the crater as well as give an idea about the angle of impact. Hence Lonar impact crater is having well ejecta blanket but unfortunately from the last three to four decades, it is decreasing due to unauthorized activities by local people.

Mobility of eject blanket

The mobility of ejecta means nothing but it is run out the distance of eject from the crater. So it can be described as

Mobility of ejecta = Average extent of the continuous ejecta layer / crater radius

Hence degradation of lonar Crater Lake and mobility of ejecta is associated with the degradation of the lonar crater

Shape of the Ejecta-Blanket

The shape of the ejecta blanket depends on the angle of the impact and the mobility of the ejecta blanket. The shape of the ejecta blanket of the lonar crater is elongated due to the angle of the impact

Sharpness of the Lonar crater rim

Lonar crater lake sharpness is well. Here sharpness of the crater describes the maturity of the crater and it is not affected by various geomorphic processes i.e. weathering, erosion, and mass movement and transportation etc. processes. Based on the above geomorphic process it can be said that the lonar Crater Lake is the youngest crater. So Lonar crater lake rim, free face slope and rectilinear slope give detailed interpretation about the sharpness of the crater lake.

Crater Morphology

Lonar crater is characterised by six morphological segments. The ejecta blanket, summital convexity, the rim, the rectilinear slopes of the crater, crater basin or floor and

the saline water lake. Ambar lake and Gagan lake are occupied by agricultural activities. The slope of this region is very steep more than 60ºangle is present there. This region is characterized by Basaltic rock and black soil. The maximum area is under cultivation, free human interference, and excessive animal grazing. This seems one of the major causes of siltation inside the lake. Sewage disposal is another threat to the ecosystem. The crater being a depression attracts water coming By gravity the polluted water enters the crater Some areas of ejecta blanket beyond the rim walls is either under cultivation or some authorised or unauthorized construction. i.e well roads and dam etc. This is disturbing the area. the natural atmosphere of that area. For this use, the excavation of soil and rocks is done, which is undesirable.

Ejecta Morphology

The ejecta of the crater is an important element to understand the impact process. It depends on the angle of impact. (Pierazzo and Melosh 2000). Lonar craters ejecta blanket is characterised by various lineaments and fractures. Northeast fractures are characterised by the biggest spring of the crater which is known as Dhar. While there are five springs are there inside the crater.

Crater rim wall and springs

After the meteoritic impact crater wall characteristics various cracks and faults. Due to faults and fractures springs generates on the wall of the crater because groundwater flow enters from the crack lines. So the inner wall of Crater Lake is characterised by several gullies.

Structural Hills

Structural hills of the lonar Crater Lake are located at the crystal or interfluve sloping region of the crater. They are isolated and characterised by erosional activities due to the number of gullies and streams that originated from them.

Pediment

It is located at end of the rectilinear slope of the crater basin floor i.e. in between the rectilinear slope and the lake of the crater.

Composit Alluvial and Colluvial fan

The Crater basin of the Lonar lake is characterised by the alluvial and colluvial facn at NE side of the crater at the front of dhar stream. Which is the biggest fault line of the crater. It is occupied by mixed evergreen vegetation.

CONCLUSION

Thus lonar Crater Lake faces Geomorphic, anthropological and environmental problems detected by RS and GIS as;

(1) The Lonar Crater Lake is degrading due to human activities and human interference inside the crater.

(2) Geomorphic processes i.e. weathering, mass movement and soil loss are most dominant in the crater due to there is the high rate of siltation is dominant.

(3) The blanket ejecta extending outward from the crater rim has progressively been brought under cultivation, therefor blanket ejecta is decreasing, unfortunately, this agricultural activity close to the crater rim destroying many scientific pieces of evidence which are important for understanding planet Mars.

(4) Although the crater wall is geologically controlled by basalt layer or Deccan trap layers, inside there are several fractures and manmade interference is responsible for the degradation of the crater.

(5) Centripetal drainage and centrifugal drainage patterns are found at the crater which is also responsible for the degradation of the crater externally from ejecta blanket ant and internally due to the high sloping area more than 60 to 70-degree slope.

(6) Lonar city is approaching at the Northeast side of the crater ejecta blanket. Therefore ejecta blanket is destroyed at the NE side of the crater.

(7) Sewage disposal is another threat to the ecosystem. The crater is a depression, attracts water coming to it. By gravity, the polluted water enters the crater. Some areas of ejecta blanket beyond the rim walls are either under cultivation or some authorised or unauthorized construction. This is disturbing the natural atmosphere of that area. For this use, the excavation of soil and rocks is done, which is undesirable.

(8) Remote sensing and GIS are important tools to assess the Geomorphic and environmental changes in the lake ecosystem.

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