

THE EFFECT OF MINING ON GEOMORPHOLOGY (Detection of changes by using Remote Sensing techniques)

Author name: FALAK NAWAZ * faalak@yahoo.com
Co-author: PROF. DR. HAMIDULLAH ** hamidu@brain.net.pk
ARSHAD FAYAZ*** sajeelarshad@hotmail.com

Affiliation & Official Address:

* & ** National Centre of Excellence in Geology, University of Peshawar, Pakistan.

*** Geological Survey of Pakistan, Islamabad, Pakistan

KEY WORDS

Geology, Geomorphology, Geographical Information System, Remote Sensing, monitoring, change detection, 3-dimensional

ABSTRACT

The study focuses on the use of Remote Sensing techniques for the detection of changes and effects of mining on Geomorphology, especially the use of sequential images allow us to detect changes taken place from time to time. Nowadays, GIS and Remote Sensing are emerging as powerful techniques widely applicable in natural resource management and development. These techniques, not only enable a manageable storage and prompt access to large volumes of data, but also provide efficient tools to extract information/knowledge for logical decision making. Recent developments in Remote Sensing, Aerial Photography and GIS make it possible to detect changes and devise strategies based on these changes.

For this purpose, the Margalla hills range are selected where the aerial photograph of 1953, 1986 and 1999 are available. This area lies at a distance of 30 km from the Capital City; Islamabad. From the last 30 years when the Capital city came into being, after that time, the Margalla hills remained the main supplier of limestone for the construction of buildings, roads and bridges to the Islamabad and surrounding areas. Geologically, the rocks in the area range in age from Jurassic to Paleocene and are of sedimentary origin. It mainly comprises of sandstone and shale, which is very suitable for construction of building and bridges. That is the reason that the beautiful and green Margalla hills are being eaten up by limestone mining and crushing activities which in addition to the destruction of the natural landscape is causing large scale environmental degradation and air pollution. The site is exposed on the main Grand Trunk Road, which connects Islamabad with rest of the Punjab and North West Frontier Provinces of Pakistan. The available aerial photographs shows the situation before mining, during the mid of mining and now the latest situation. Visual and digital image interpretation of the

available images together with GIS techniques will lead us to conclude and recommend certain concrete steps to stop mining and propose certain other sites suitable for the mining.

INTRODUCTION

The study area lies at the border of Islamabad (the Capital of Pakistan) and Rawalpindi Districts. Geographically, it stretches from $33^{\circ} 42'$ to $33^{\circ} 44'$ north latitude and $72^{\circ} 46'$ to $72^{\circ} 52'$ east longitude (Figure 1). Margalla hill range starts from this point and further run north-west direction which ultimately joins the Murree mountain series. Islamabad, the Capital City; is located in the southern foothills of Margalla hill range. This area lies at a distance of about 30 km from Islamabad. From the last 30-35 years, when the Capital city came into being, after that time, the Margalla hills remained the main supplier of limestone for the construction of buildings, roads and bridges to the Islamabad and surrounding areas. Geologically, the rocks in the area range in age from Jurassic to Paleocene and are of sedimentary origin. It mainly comprises of sandstone and shale, which is very suitable for the construction of building and bridges. That is the reason that the beautiful and green Margalla hills are being eaten up by limestone mining and crushing activities (Figure 2), which in addition to the destruction of the natural landscape is causing large scale environmental degradation and air pollution. The site is exposed on the main Grand Trunk Road, which connects Islamabad with rest of the Punjab and North West Frontier Provinces of Pakistan. The available aerial photographs shows the situation before mining, during the mid of mining and now the latest situation. Figure 3a, b & c show the gradual depletion of the Margalla hill range. Aerial Photograph of 1953 (Figure 3a) shows the situation before the start of the mining activities, where the beautiful Margalla hill is standing proudly and increases the beauty of nature. While Figure 3b & 3c, which have been taken during 1986 and 1999 respectively, show that the beautiful Margalla are being eaten up by the mining activities. Plate 1 to 4 also clarifies the situation, where the crusher machines are eaten up the Margalla very hungrily.

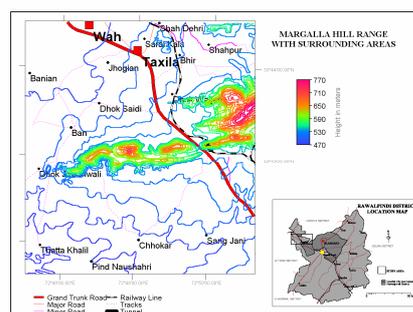


Figure 1: Location Map of Margalla Hill Range

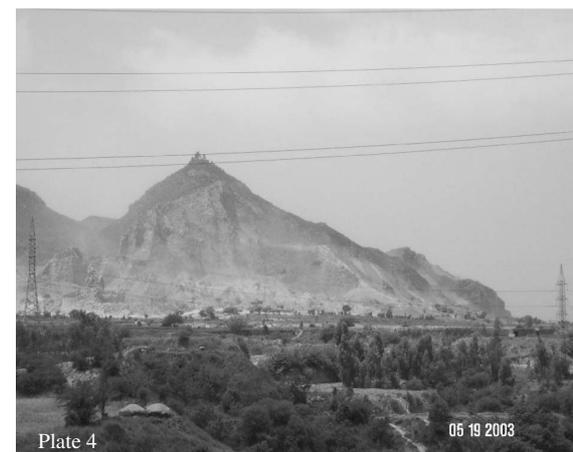
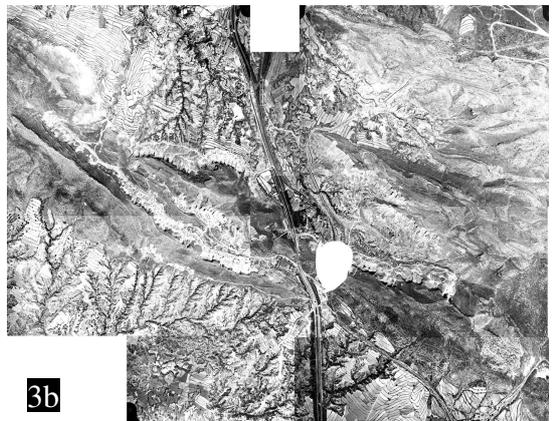
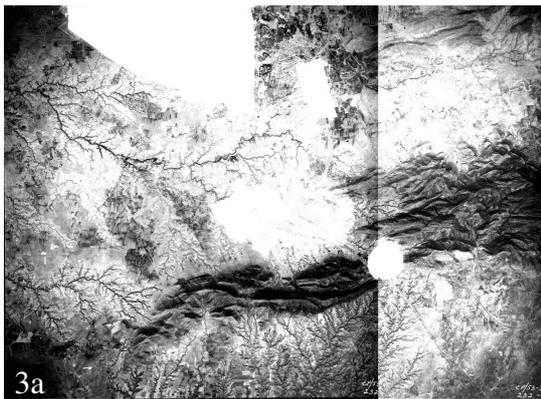
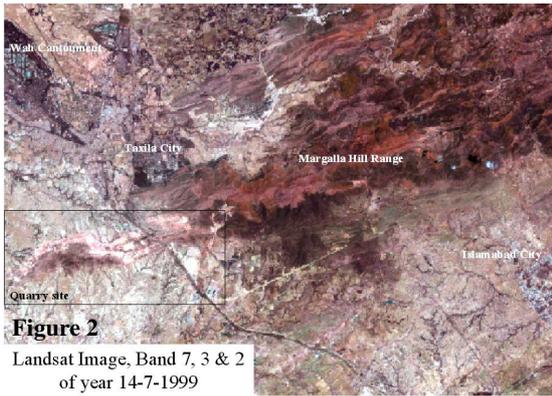


Fig. 3a, b & c: Aerial Photographs taken in 1953, 1986 and in 1999 show the Margalla hill are being eaten up on the western side of the main Grand Trunk Road

Plate 1-4: Photograph shows the mining activities and the old traditional quarrying practices in Margalla Hill Range

The use of Remote Sensing techniques are very useful tools for quick assessment and monitor such kind of changes, especially the use of these techniques in Geographical Information System (GIS) enable us to interpret and visualize the changes taken place from time to time. Visual and digital image interpretation of the available images together in GIS environment will lead us to conclude and recommend certain concrete steps to stop mining activities and propose certain other sites suitable for the mining.

Therefore an attempt has been made to monitor these changes in putting the aerial photos in GIS environment and to derive some concrete conclusion.

GEOLOGY OF THE MARGALLA HILL RANGE

The rocks in the area range in age from Jurassic to Paleocene and are of sedimentary origin. The limestone deposits of the Samana Suk and lockhart limestone formation from the main source of aggregate material around Islamabad and are being quarried extensively (Figure 4).

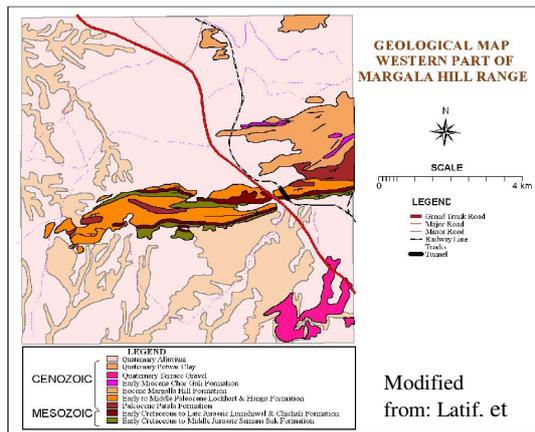


Figure 4: Geological Map of Margalla Hill Range & Surrounding Areas

The various lithological units are described as under:

- a) **Hangu Formation:** It consists of laterite, lateritic claystone and sandstone with minor siltstone. Sandstone is reddish brown, weathers dark rusty brown, fine to coarse grained, pisolitic and ferruginous.
- b) **Lockhart Formation:** It is well-developed formation in the area. It consists of predominantly marine limestone and subordinate marl and shale. Limestone is pale gray to dark gray, medium grained, thick bedded, in part nodular, hard, bituminous, and fossiliferous. Marl is grayish black amid fossiliferous. The shale is olive, gray to greenish gray and has weakly developed cleavage. Thickness ranges from 70 to 280 m. Limestone has an average Los Angeles Abrasion Test Value of 22.79 percent loss for 500 revolutions. The average apparent specific

gravity of the crushed rock is 2.69 and average absorption is 0.625.

- c) **Chichali Formation:** It comprises sandstone and shale. Sandstone is grayish green to dark yellowish green, glauconitic, massive hard. Shale is greenish black, thin bedded and fissile.
- d) **Lumshiwal Formation:** Small lenticular bodies of this formation are exposed in the range. The formation comprising greenish gray, medium grained, glauconitic sandstone and yellowish gray limestone is exposed in the range. The limestone is thin to medium bedded, argillaceous and at certain places it becomes shelly.
- e) **Samana Suk Formation:** It is exposed on the southern side in the form of lenticular body. It is composed of thin to medium bedded limestone with subordinate calcareous sandstone. The limestone and dolomite belong to marine environment and deposited on a continental shelf. Limestone of Samana Suk Formation indicates different amounts of energy in the various carbonate depositional environments. The limestone is brownish gray to yellowish gray. It is oolitic biomicritic, and intraspartic. Exposed thickness ranges from 200 to 250 m. Its contact with overlying Lumshiwal Formation is unconformable. The base is not exposed.

AVAILABLE DATA

- The following data was available for the study.
 - ☞ Landsat image showing the recent most picture of the Margalla Hill Range.
 - ☞ Aerial Photographs of 1953, 1983 and 1999.
 - ☞ General Toposheet (43C/14) on a scale of 1:50,000 prepared by the Survey of Pakistan.
 - ☞ Geological map prepared by the Geological Survey of Pakistan.

OBJECTIVES OF THE STUDY

- ☞ The main objective of the study is to study the effects of mining on Geomorphology.
- ☞ To propose certain alternate sites to reduce the environmental impact in the area.
- ☞ To monitor these changes by using GIS and Remote Sensing techniques.
- ☞ To prepare the Digital Elevation Model, Landuse map as by product.

METHODOLOGY ADOPTED FOR PREPARING MAPS

Creation of Digital Elevation Model (DEM)

For this study, ILWIS 3.2 version was used. Infact ILWIS is a powerful tool not only for the analysis of GIS data but it is also a useful tool for the image processing and enhancement.

A detail contours with interval of 15m were drawn from the toposheet number 43C/14 in GIS and for this purpose,

on screen digitization were used. When the contour were finalized after checking the redundancy and segment mode of the map, then these contour were interpolated by using the “Contour Interpolation” command in ILWIS. As a result DEM was produced which was further enhanced to get more attractive picture of the DEM (Figure 5a, and 5b).

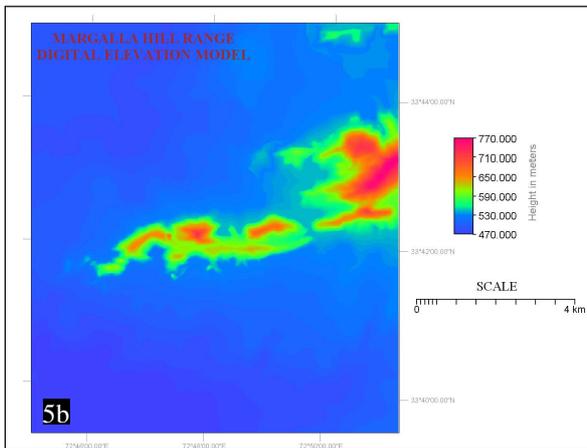
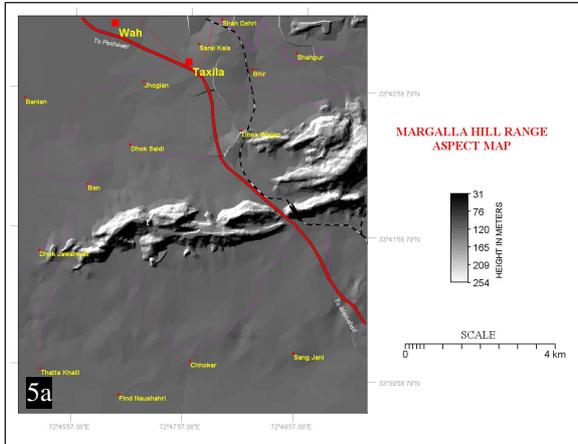


Figure 5a: Aspect map derived from the enhancement of DEM
Figure 5b: Digital Elevation Model derived after interpolating the contour on interval of 15m

The aerial photos will be georeferenced first by taking tie point on selected places with the help of Global Positioning System (GPS), which will be used to collect the said data in the field. After getting data, the aerial photos will be georeferenced with the study area. Then the contour map will be superimposed one by one on these aerial photos to get the GIS statistical data. As a result a separate maps will be prepared in which the rate of encroachment will be shown in the form of DEM for three different years. Side by side statistical data will be generated which will lead us to conclude that if a specified rate is continue, in how much year the Margalla hill range will be completely diminished.

RESULTS

The study shows that that if the present quarrying rate remain continue, within few years the western side of the Margalla hill range will be completely diminishes furthermore due to continuous quarrying, the

environmental problem will become more serious issue as already there is a lot of dust and people are suffering many diseases.

DISCUSSION

To reduce quarrying from the Margalla hill range, some alternate quarrying sites has been proposed for future mining and to preserve the beautiful Margalla hills from further quarrying. These sites are easily approachable through main road and situated at a reasonable distance from Islamabad and Rawalpindi districts (Figure. 6).

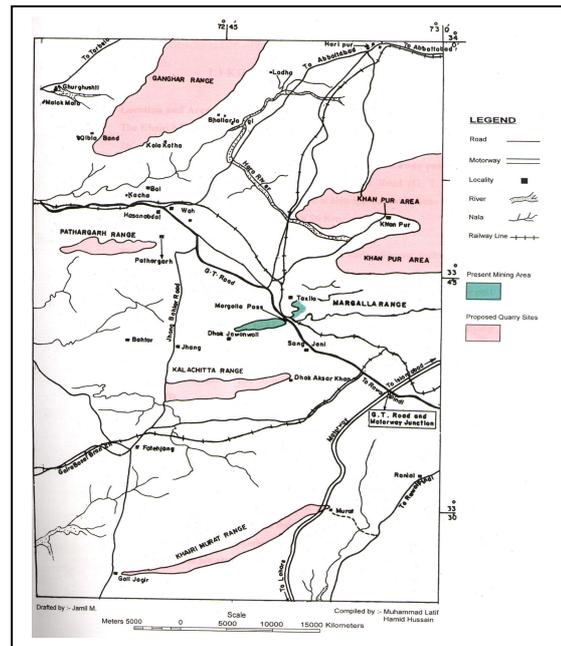


Figure 6: Alternate Limestone quarry sites around Islamabad

CONCLUSION

Based on the interpretation of the aerial photographs and studying other relevant data, it can be concluded that if the present quarrying remain continue, very soon the western side of the Margalla hills will be diminishes. Therefore five new proposed sites have been recommended. These sites are Khairi Murat, Kala Chitta, Pathargarh, Khanpur and Ganghar Ranges, which can be used for future exploitation for limestone aggregate in place of present Margalla hill range mining site. The reserves of limestone of all the five localities are enough to meet the present and future needs of construction material as compared to the present mining site, which will soon be depleted. The quality of limestone is more or less same in all these new localities as that of the Margalla Hills quarries.

All the above localities are easily approachable especially the Khairi Murat Range where the Islamabad — Lahore Motorway passes through its North Eastern side. Main power supply line is also passing through all the recommended localities.

REFERENCES.

Akhtar, M., Bajwa, M.S., & Kausar, A.B., 1983. Geology of Fatehjang area, Attock and Rawalpindi Districts, Punjab, Pakistan. GSP I. R. No. 171.

Gauhar, S.H., 1966. Cement Resources of Pakistan, GSP Pre-Publication. Issue No.39.

Hussain, A., and Lawrance, R.D., 1987. Landslide near Nicholson Monument, Margalla Range, Islamabad, Pakistan, GSP I.R., No. 282.

Latif, M., and Hussain, H., 2002. Limestone Quarry Sites Around Islamabad and Kohat. GSP I. R. No. 721.

Sheikh, I.M., Pasha, M.K., Williams, V.S., and Khan, K.S.A., 1993. Environmental Geology of the Islamabad-Rawalpindi Area, Pakistan. Project Report (I R), PK. 109, 3A.

ACKNOWLEDGMENT

The authors are highly appreciated the efforts of Mr. Shafique ex student, who contributed in preparing contour and geological maps on our request. We highly acknowledge his contribution.