INDIA GEOSPATIAL FORUM

7-9 February, 2012

THEME: Geo-Budget: Enabling Sustainable Growth

Paper reference Number	**:**	**PN -83**
Title of Paper	**:**	**Remote Sensing & GIS based approach for Heritage conservation and management A CASE STUY IN BHIMBETKA AREA, DISTRICT RAISEN M.P., India: A WORLD HERITAGE SITE**
Name of Presenter	**:**	**Dr. Vivek Katare Head (LU&USD)** Remote Sensing Application Centre, M.P. Council of Science & Technology, Vigyan Bhawan, Nehru Nagar, Bhopal - 462003 Tel. no. 0755-0670787 katarevivek@yahoomail.com
Authors Affiliation	**:**	**Prof. P.K. Verma & Dr. Satish Chakravarty**
Brief Biography	**:**	**Post graduate in Geography,1983, Diploma**

in terrain evaluation & DTM from IIT, Mumbai 1987, 10 Months PG Diploma In Human Analysis form IIRS, Deptt. of Space DehraDun,1996, Ph.D in Geography from M.S University of Baroda, India. 23 years Expirience in Landuse Mapping Using RS/GIS tecniques. Integrated survey, Urban & regional Planning.15 Research paper published 2 in International Journal. Presently Head, Landuse Planning & Urban Survey Division, Deptt of S&T.

REMOTE SENSING & GIS BASED APPROACH FOR HERITAGE CONSERVATION AND MANAGEMENT
A CASE STUY IN BHIMBETKA AREA, DISTRICT RAISEN M.P., India: A WORLD HERITAGE SITE

_____

Prof. P.K. Verma
Director General
M.P.Council of Science & Technology
Vigyan Bhawan, Nehru Nagar, Bhopal - 462 003
Ph: 0755-2671800; 2671689 Fax: 0755-2671600
E-mail : dg@mpcost.nic.in; webmaster@mpcost.nic.in

Dr. Vivek Katare
Head (LU&USD)
Remote Sensing Application Centre,
M.P. Council of Science & Technology, Vigyan Bhawan, Nehru Nagar, Bhopal - 462003
Tel. no. 0755-0670787 katarevivek@yahoomail.com

Dr. Satish Chakravarty
Project Associate (LU&USD)
Remote Sensing Application Centre,
M.P. Council of Science & Technology, Vigyan Bhawan, Nehru Nagar, Bhopal - 462003
Tel. no. 0755-0670787, satish_chakravarty@rediffmail.com

ABSTRACT

Bhimbetka is known for its rock painting, rock shelters & caves where the earliest traces of human life in India were found. The shelters & paintings created by the pre-historic man are dated as early as 9000 year old. The Bhimbetka is the oldest site in world where petroglyphs were found. Additionally the Bhimbetka area is, rich in flora & fauna which makes the area site of tourism and adventure.

Bhimbetka is located in Obaidullhaganj Tehsil of Raisen District, M.P., about 47 kms from Bhopal on Jabalpur Highway NH-12. The area is surrounded by north fringe of Vindhyans Mountains and covered with magnificent rocky under capes. Recent discoveries of over 700 hundred rock shelters have brought Bhimbetka on world map making it as world heritage site by UNESCO in 2004. The site is broadly divided into Core and Buffer area in which 243 rock paintings and rock shelters belongs to Bhimbetka group in core area and 178 in Lakha Juar group.

Looking into the archeological and socio-economic importance of Bhimbetka area, a comprehensive Remote Sensing & GIS based development plan for the area has been evolved. Several important themes viz. drainage, landuse, forest, slope etc. have been mapped and superimposed in GIS environment. Based on analysis following recommendations have been made:-

- Suitable measures for conservation of rock paintings
- Slivipasture
- Gap filling with existing species
- Protection of existing Scrub forest / grasslands with cattle trenching
- Plantation in valley
- Suitable site for wild life conservation and recreation
- Tracking spot
- soil conservation

INTRODUCTION

The sprawling caves of Bhimbetka ($24^05'$ N and $76^045'$E) are located about 45 km. on NH-12, Northeast of Bhopal, and the state capital of Madhya Pradesh. Situated along the Bhopal – Hoshangabad highway, these caves bear proximity to the Miyapur village in Raisen District. The way to Bhimbetka bifurcates near Bhinyapur on the National highway, leading from Bhopal to Hoshangabad via Obaidullahaganj. The railway crossing near Bhinyapur is about 7.5 km. From Obaidullaganj and Bhimbetaka is about 4 km. from road site. The area falls within the Ratapani Sanctuary, covering an area of 124 sq km.

The Bhimbetka shelters exhibit the earliest traces of human life in India a number of studies suggested that at million years back some of these shelters were inhabited by man. The caves of Bhimbetka were discovered in 1957-58 by one of the great accidents of history. An intrepid archaeologist from Vickrim University, Ujjain, Dr. Vishnu Wakankar, stayed too far from the beaten path and found himself amidst this prehistoric freasure trove.In due course of time, the archaeological excavations yielded remains, serially from the upper Palaeolithic Age (300,000 to 30000 years) to the Middle Ages (5th Century to 15th Century).

Since then more than 700 such shelters have been identified, of which 243 are in the Bhimbetka group and 178 in the Lakha Juar group. Archeological studies revealed a continuous sequence of Stone Age cultures (from the late Acheulian to the late Mesolithic), as well as the world's oldest stone walls and floors. The earliest paintings on the cave walls are believed to be of the Mesolithic period.
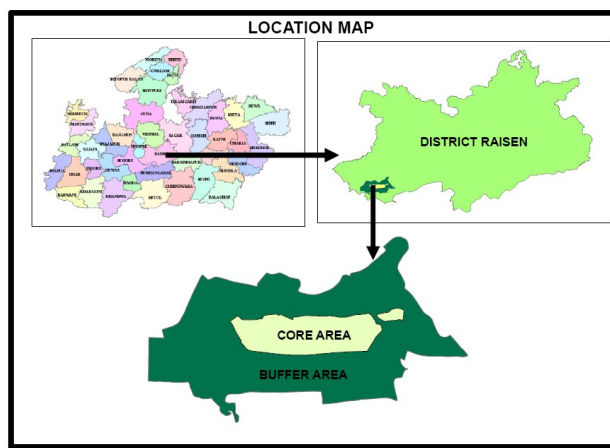
Physiographically the area is divided into three major units i.e. plain, valley and hills. The northern part of the buffer area of Bhimbetka is mostly plain, undulations were also observed around the Keselwara, Ankalpur and Kurmai villages. The elevation of the area is varies between 446-554 m. The southern part of buffer area is almost hilly and the highest elevation is 626 m observed west of the Karmai Village. The main forest type based on Champion's classification is "Southern Tropical Dry Deciduous Group 4-aC.1" with minor extent of "Dry Deciduous Scrub Forest, D/Tr-25/2." The area is protected and within Ratapani Sanctuary and mainly covered by teak forests the other associated vegetation are saj, dhaora, lendia, salai, tendu, palash, mahua, bhirra, khair, etc.

MATERIAL AND METHODS

a.   Image Interpretation

On-screen interpretation technique have been used to study digitally enhance satellite data on the basis of image interpretation characteristics i.e. tone, texture, shape, size, shadow, pattern, association and locational elements. These elements helped in identifying in delineating various types of feature and their significance for the theme. Finally, image interpretation keys have been generated for the preparation of landuse/ landcover, geology, structure, geomorphology, drainage & surface water body, transport network & settlement location, slope and soil etc., using high resolution satellite data. Satellite data of IRS LISS – III (Pan Merged) and ancillary data in the form of Survey of India toposheet (55 F/ 9) have been used.

Keeping in view the objective of the project to prepare a management plan for core and buffer zones detailed database on natural resources and terrain conditions were prepared. The data is prepared in the form of map to facilitate spatial analysis; therefore a uniform scale and standard for codification were adopted. Considering the extent of the study area special resolution of the satellite data was taken into account while preparing theme wise natural settings on 1:10,000 scales. The thematic aspects identified for the study is as follows:

- Drainage
- Landuse / landcover
- Geology
- Geomorphology
- Structure
- Settlement & Transport Network
- Soil
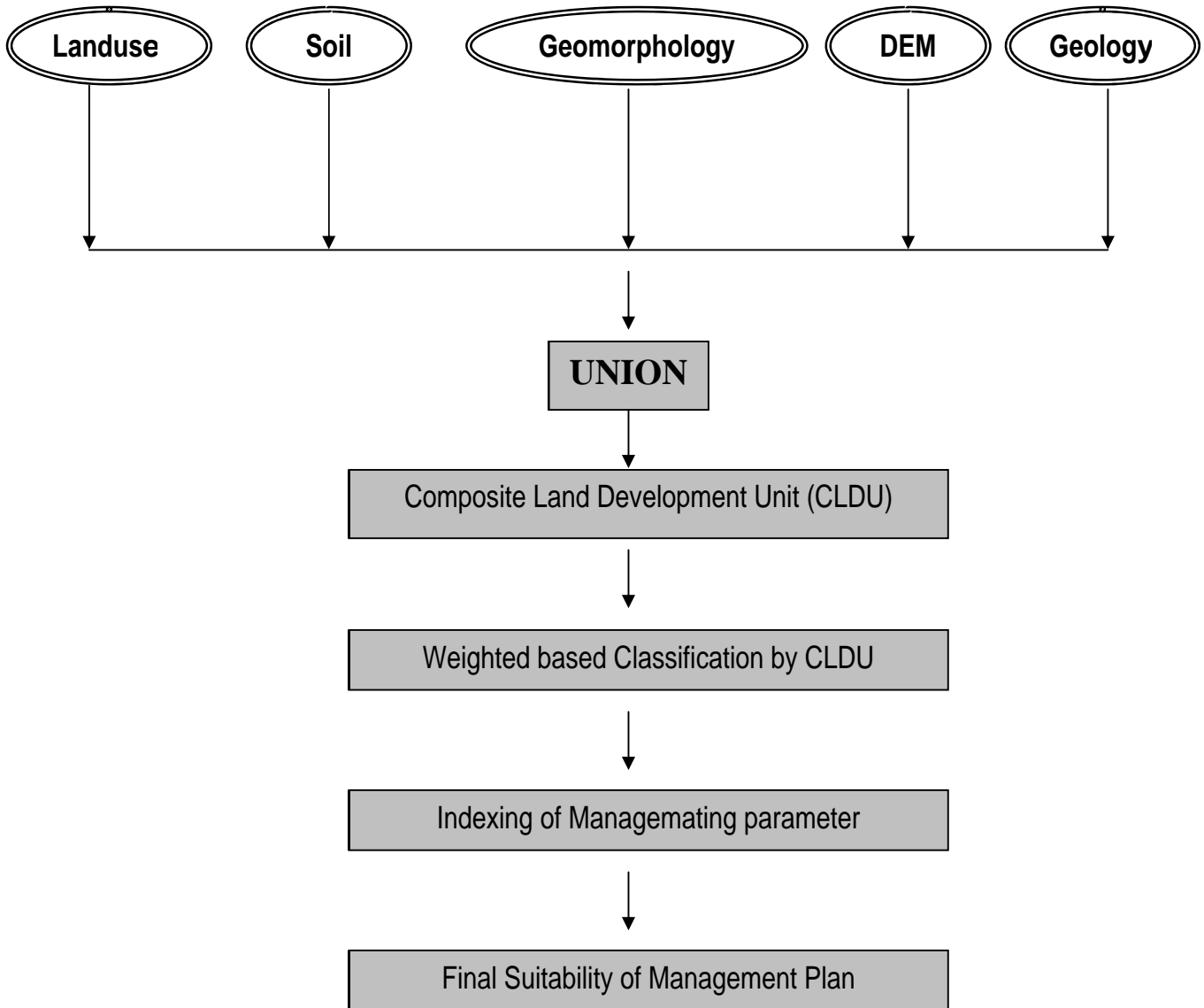- Digital Elevation Model (DEM)
- Management Plan

The database is prepared in digital environment using ArcGIS 9.2 and ERDAS 9.1 platform. Onscreen digitization was done for all the themes based on standard classification system. The data attribute tables were finalized to facilitate spatial analysis. The management plan for the world heritage site was derived using Weighted Index method in ArcGIS 9.2.

The information contains, classification systems, followed for thematic mapping is based on standard classification used by National Remote Sensing Centre & Space Applications Centre, Dept. of Space, Govt. of India. Doubtful areas were verified on the ground for each theme and appropriate corrections were incorporated after field checks.

b.   Weighted Index Method

The steps that are followed in the preparation of management plan depending upon the recommendation/ suggestion for management and conservation of the area. Identification of the suitable areas for conservation and management of study area is depends upon potentiality of the land for development, which includes land suitability, its physical capability and topographical characteristics and proximity. Therefore, the present study a multi-disciplinary approach has been taken up to carry out analysis for management, conservation and promotion for Bhimbetka area. The parameter considered for the management plan are landuse/ landcover, soil, slope, road network & DEM. Suitable weightage were assigned to generate management plan in ArcGIS 9.2 platform.

FLOW CHART – PREPARATION OF MANAGEMENT PLAN

```
   Landuse      Soil      Geomorphology      DEM      Geology
      │          │              │             │          │
      ▼          ▼              ▼             ▼          ▼
```

                        ┌──────────────┐
                        │   UNION   │
                        └──────────────┘
                                │
                                ▼
        ┌───┐
        │   Composite Land Development Unit (CLDU)   │
        └───┘
                                │
                                ▼
        ┌───┐
        │   Weighted based Classification by CLDU   │
        └───┘
                                │
                                ▼
        ┌───┐
        │   Indexing of Managemating parameter   │
        └───┘
                                │
                                ▼
        ┌───┐
        │   Final Suitability of Management Plan   │
        └───┘

RESULT & DICUSSION

a. Integrated Analysis for Generation of Management Plan

The objective of the study is generating management plan for the Bhimbetka area, which is optimally suitable to the terrain and to the productive potential of the local resources. The main issues related to management plan are:

- Conservation of Rock Paintings
- Degradation of Forest Land
- Wildlife Conservation and Recreation
- Low Soil Fertility (Root zone limitation - shallow soil depth)
- Promotion of Tourism
- Protection of Existing Natural Resources.

b. Importance Matrix of Seven Parameters

The individual theme maps describe in the proceeding chapter has been studied in order to make a spatial assessment of the relative variation of resource potential and range of terrain conditions. In order to facilitate analysis weightage has been assigned to each parameter to generate Suitability Index (SI). Table – 1.

Table: 1 Weightages Derived for the Seven Parameters

S.No.	Parameter	Weightage
1	Landuse / landcover	9
2	Soil	5
3	DEM	1
4	Geology / structure	7
5	Geomorphology	5
6	Waterbody	2,4
7	Transportation network	6,8

The importance of seven parameters was generated considering the natural setting. The importance number as per the Saalty's guideline shown in Table-2.

Table:2 Criteria for Generating Comparison Matrix for Bhimbetka

Parameter	1.Landuse/landcover 2. Soil 3. DEM 4. Geology/ Structure 5. Geomorphology 6.Waterbody 7. Transportation Network						
1.	1	1/ 5	5	7	5	1/ 2	1/ 8
2.	9	7	1	7	5	4	7
3.	1	1/ 5	1/ 7	1/ 5	1	1/ 4	1/ 8
4.	1	1/ 5	1	7	5	1/ 2	7
5.	1	1/ 5	1	1	5	1/ 2	1/ 8
6.	1	1	1	6	8	4	1

The importance levels have been assigned bases on the objective of the study. The importance list and the importance scale is as follows:-

a. Landuse/landcover is:

More importance than soil (5)
Less importance than DEM (5)
Less importance than geology/ structure (7)
Less importance than geomorphology (5)
More than --- importance than transport network (1/ 8)

b. Soil is:

less importance than landcover/landuse (9)
Equal importance with DEM (1)
Less importance than geology/ structure (7)
Less importance than geomorphology (5)
Less importance than transport network (8)

c. DEM is:

Equal importance with landcover/landuse
More than ------- importance than soil (1/ 5)
More than -- importance than geology/ structure (1/ 5)
Equal importance with geomorphology
More than --- importance than transport network (1/ 8)

d. Geology / Structure:

Equal importance with landcover/landuse
More than --- importance than soil (1/ 5)
Equal importance with DEM
Less importance than geomorphology (5)
More than --- importance than transport network (1/ 8)

e. Geomorphology is:

Equal importance with landcover/landuse
More than ------- importance than soil (1/ 5)
Equal importance with DEM
Equal importance with geology/ structure (5)
More than --- importance than transport network (1/ 8)

f. Transport Network is:

> Equal importance with landcover/landuse
> Less importance than soil (8)
> Equal importance with DEM
> Less importance than geology/ structure (6)
> Less importance than geomorphology (8)

c. Applicability of the Weighted Indexing Method

The weighted indexing method is more appropriate than other method as its takes into account, the importance factor of the parameter. The technique can be applied for many other applications in GIS, i.e.

- Land Capability Analysis

- Suitability Analysis

- Environmental Sensitivity Analysis

In the present study suitability analysis has been done. Using the resource database, which is presented in Table: 3

Table: 3 Datasets used for Analysis

Sr. No.	Theme	Spatial data type
1.	Landuse / landcover	Polygon
2.	Soil	Polygon
3.	DEM	Raster
4.	Geology / Structure	Polygon / Line
5.	Geomorphology	Polygon
6.	Transport Network	Line

The suitability is expressed as a Cumulative Index (CSI) for six parameters. The CSI is the measure of relative suitability of the land for the purpose of management plan. The thematic maps of all the themes were brought to single coverage by set of UNION operation in ArcGIS 9.2 version. The composite coverage had all the attribute of the original seven layers. The sliver polygons based on the mapping unit were eliminated. Categorisation of the CSI is a achieved by ranging the CSI into different classes, where each range indicates the amount of limitation acceptable for each class.

All six parameters were selected and suitability has been calculated by multiplying weightages with rank of each parameter and summing of the value of the all six parameters. Suitability Index where each range indicates the limitation for each class, minimum, maximum mean and standard deviations have been used for categorizations. Higher the suitability value, higher is the priority for the recommendations, lower the suitability values indicate lower priority for recommendations.

CONCLUSION

Based on these criteria following it is concluded that to manage & conserve the area environmentally and ecologically also considering objective the study following recommendations were suggested for the Bhimbetka.

- Suitable measures for conservation of rock paintings
- Slivipasture
- Gap filling with existing species
- Protection of existing Scrub forest / grasslands with cattle trenching
- Plantation in valley
- Suitable site for wild life conservation and recreation
- Tracking spot
- soil conservation
    - Stop dam
    - Boulder bunds
    - Tracking routes
    - Dense forest
- No action area

1. Suitable measures for conservation of rock paintings: The rock painting belonging to Bhimbetka group and the Lakha Juar group is continuously deteriorating due to natural weathering process. The chemical weathering increase

Fig : 11

particularly during rainy season, the rainwater leaches down from the cores of rocks and the chemical weathering takes place to overcome this problem. It is therefore prop osed that an area of 0.19 sq. km may be treated with suitable measures to save the rock paintings of upper Palaeolithic Age.

2. Slivipasture: Silvipasture is the activity of growing trees along with grasses. The buffer area of the Bhimbetka is dominated by agricultural activities and the large population lives here. Due to agricultural activities and population pressure the fringe area of revenue forest and reserve forests were in pressure. As a result densely vegetated areas (open jungle) were converted into scrubland. To avoid further degradation, it is proposed that an area of 1.93 sq. km may be put under silvipasture activity, initially the land will be protected by grasses of
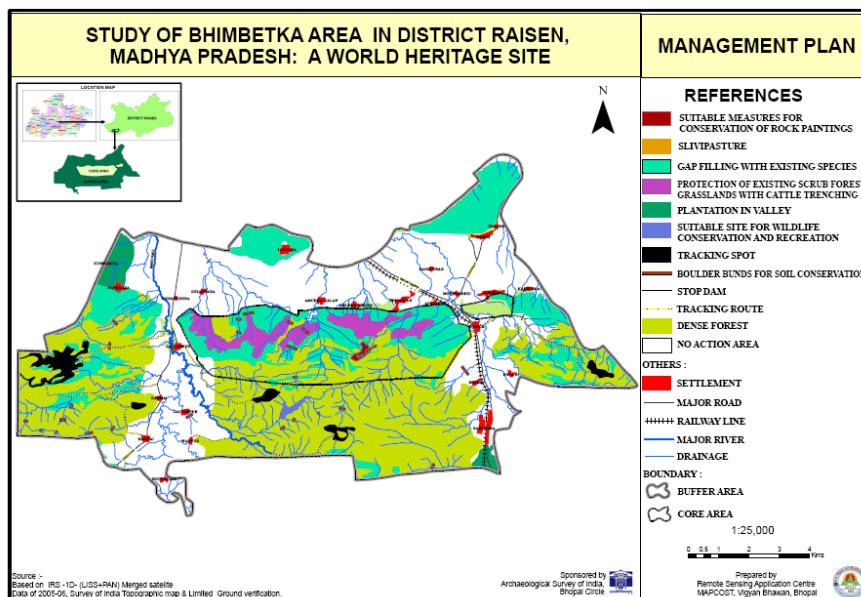
local importance and afterwards suitable species which have fuel importance may be planted in these areas.

3. Gap filling with existing species: The dense forest within the core and buffer area having scattered patches of open forest, where the density of plant is less than 10%. These gap areas should be filled with existing species. An area of 23.64 sq. km within the dense forest need to be taken up for gaps fillings.

4. Protection of existing Scrub forest / Grasslands with cattle trenching: The fringe area of reserve forest as well as revenue forest is in abiotic pressure. It was observed that some of the sites could be converted into good grassland / scrub lands. This will take care of fodder and fuel wood requirement of the area. These areas can be protected by cattle trenching to avoid further degradation. Areas of 4.07 sq.km need to be protected.

5. Plantation in valley: The valleys in the northwest and the southwest of the buffer area are under constant pressure of soil erosion due to slope factor. The top fertile soil has been washed out as a result of rainfall runoff characteristics. To avoid further soil erosion, it is suggested that proper soil conservation measures should be taken up in area of 2.12 sq. km, within the buffer area by planning suitable trees, which have higher growths and large Leaf Area Index (LAI).

6. Suitable site for wild life conservation and recreation: An area of 0.23 sq. km west of Goutampur village was suggested for wildlife conservation and recreation considering topographic location of the sites. The site is covered from three sides by hills and it is the ideal location for wildlife conservation. The location is having all parameters necessary for establishment of recreational sites with protected wildlife. The major requirement of water and fodder is available within the area.

7. Tracking spot: In view to promote tourism five tracking spots were identified within the buffer area. An area of 1.96 sq.km in five different locations was marked considering Digital Elevation Model (DEM) and spot heights. The tracking routs were identified on the basis of standard parameters required for tracking route identifications. This type of activities not only promotes tourism but also generate revenue for the management of the core area.

8. Soil conservation: The southern part of the buffer area is highly elevated and therefore the slope gradient is more that resulted soil erosion is the major problem in this area. The rivers are flowing towards the north carrying the topsoil during the rainy season. To avoid erosion twenty-four boulder bunds were suggested in core and buffer area. To recharge the ground water and to conserve surface water three stop dams were suggested near the Kesalwara, Goutampura and south of Karracalai villages.

<u>REFERENCE:</u>

1. Javid, Ali and Javeed, Tabassum. *World Heritage Monuments and Related Edifices in India*. 2008, page 19
2. http://originsnet.org/bimb1gallery/index.htm
3. Klaus K. Klostermaier A survey of Hinduism, SUNY Press, ISBN 0887068073, http://books.google.com/books?id=ltn3OuF_i4sC"... prehistoric cave paintings at Bhimbetka (ca. 30000 BCE) (1989),."
4. Mathpal, Yashodhar. Prehistoric Painting Of Bhimbetka. 1984, page 25
5. Sajnani, Manohar. Encyclopaedia of Tourism Resources in India. 2001, p. 195
6. "Rock Shelters of Bhimbetka". World Heritage Site. http://whc.unesco.org/pg.cfm?cid=31&id_site=925 Retrieved 2007-02-15.
7. The Lonely Planet. India. 2007, page 689.
8. Madhya Pradesh A to Z, Madhya Pradesh State Tourism Development Corporation, Cross Section Publications Pvt. Ltd., New Delhi 1994.
9. Manual of Remote Sensing.
10. Arora and Mohan (1986), Quoted by Bhatia K.S. (1993). Agroforestry - A sustainable land Management system for Degraded Ecosystem. In Nat. Work on Farm Forestry Management, 31P
11. Bhatia K.S. (1993) Agro forestry - A Sustainable Land Management System for degraded Eco-system National Workshop Management, IIFM Edited by Prof. (Dr.) T.H. Babu, M.Sc. (IAR) Ph.d (Australia) P.G. Biol.: Pg. 30-35.
12. Land use/Land cover Classification System (1990) by NRSA, Hyderabad in Technical guideline for integrated study to combat Drought for sustainable Development Oct. (1991), PP. 30-31.
13. Akhouri Pramod Krishna: (1996): Land Cover Change Dynamics of a Himalayan Watershed Utilizing Indian Remote Sensing Satellite (IRS) Data: 0-7803-3068-4/96 IEEE, pp 221- 223.
14. Remote sensing and Geographical Information System Database Integration tool for water resources management(Journal : National workshop on Emerging Challenges in Water Resources Before Chhattsigarh State C.G.W.B Ministry of Water Resources Govt. of India N.C.Cg.R Raipur (12 Dec 2003)

_____