PROJECT REPORT

Evaluation of impact of both small scale and large scale reservoirs on vegetation and groundwater recharge in Bundelkhand region using Remote Sensing and GIS techniques

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Acknowledgement

I cannot express enough thanks to Dr.V.C.Goyal sir and 'National Institute of Hydrology' for giving me an opportunity to work on this project. I offer my sincere appreciation for the learning opportunities provided by him.

My completion of this project could not have been accomplished without the constant guidance and support from Dr.A.K.Saraf and Dr.V.C.Goyal. I am highly indebted to them for their guidance and constant supervision as well as for providing necessary information regarding the project & also for their support in completing the project.

I have taken efforts in this project. However, it would not have been possible without the kind support and help from my friends. I would like to extend my sincere thanks to all of them.

Introduction:

In general, water resources in India are very unevenly distributed, both spatially and temporally. Idiosyncrasies of monsoon and diverse physiographic conditions give rise to an unequal distribution of water. In India, 65% of the geographical area is covered by hard rock formations

Many times hard rock terrains suffer from water scarcity because of over exploitation of groundwater resources and lack of replenishment through recharge processes. In such areas reservoirs play very vital roles, directly to provide recharge to groundwater regime and indirectly towards general growth of vegetation.

The present study evaluates impacts of reservoirs on groundwater and vegetation using LANDSAT-5 TM(Thematic Mapper) data in a typical hard rock terrain of Bundelkhand region of India. The extents of impacts of many small and large reservoirs have been assessed.

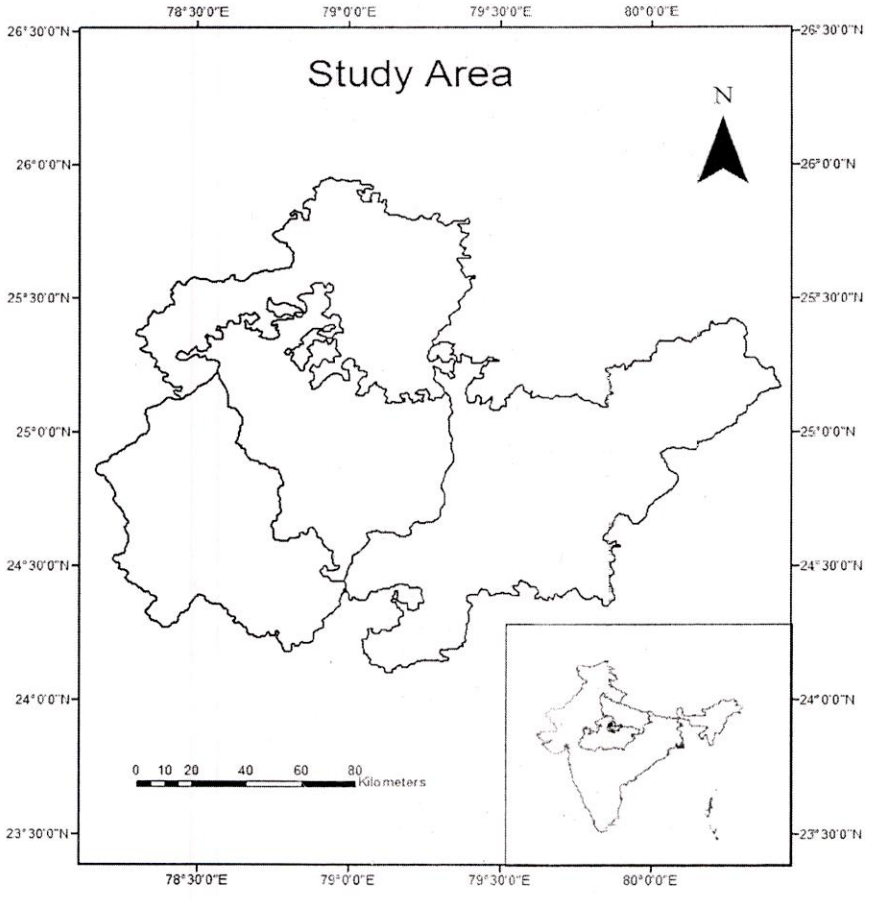
Generally, in reservoir impact studies a question arises of how much area would be benefited in terms of groundwater recharge and vegetation growth? Basically it would depend on several factors, e.g. prevailing geological conditions (including lithology and structures),soils, slopes, prior groundwater conditions, irrigation facilities/canal network and wells, area and volume of reservoir, available hydraulic gradient and transmissivity of rocks.

A concept of benefited/submerged areas ratio has been introduced in the present study as an index of assessment of impact based on vegetation growth mapped using satellite data. A comparative study in this regard has been made to assess the submerged and downstream areas of reservoir benefited in terms of growth of vegetation. It has been observed that the gains in terms of vegetation growth in downstream areas of reservoirs are much more than the loss of vegetation in submerged area due to construction of the reservoirs (Saraf et al, 2001)

Study area:

The study area is bounded by longitudes of 78°0′E and 80°30′E and latitudes of 24°0′ N and 26°0′ N which covers the four districts Jhansi and Lalitpur in Uttarpradesh, Tikamgarh and Chattarpur of Madya Pradesh.

Fig 1 Map showing the present study area



Geology of Area:

Much of the area of, Jhansi, Lalitpur, Tikamgarh and Chhatarpur, districts is granite country, marked by outcrops of great diversity in mineral composition and size, ranging from small patches to large hillocks.

A striking feature of the granite country, which has impacted settlement patterns and agriculture, is the presence of long and narrow rocky ridges, known as quarts reefs and dolerite dykes. Often, these wall-like natural features intercept the course of streams, leading to formation of water bodies and enabling the creation of large artificial lakes.

Climate of Area:

Bundelkhand is a hot and semi-humid region. The area is fed by southwestern monsoon rainfall from middle of June to September under the influence of monsoon depression originating

from Bay of Bengal and travelling from east to west. Over 95% of the rainfall falls between June and September, with maximum rain generally in July-August. The average annual rainfall of the area is about 1040mm. There is occasional rainfall in the period from October to March.

Generally hottest days are in May and coldest days in December or January. Maximum monthly temperature varies between 38°C and 43°C in May, which is the hottest month. January is the coldest month with a minimum temperature ranging 3°C to 10°C.

Data Used:

Remotely sensed digital data from LANDSAT-5 TM (Thematic Mapper) has been chosen for the present study. Four scenes of LANDSAT-5 TM have been extracted from USGS (United States Geological Survey)

Table 1 Details of various datasets used in present study

Type of Data	Details of data
LANDSAT-5 TM(Scene 1)	Acquisition Date: 07/03/2011 Scene ID:LT51440422011066KHC00 WRS Path/Row: 144/042
LANDSAT-5 TM(Scene 2)	Acquisition Date: 07/03/2011 Scene ID:LT51440432011066KHC00 WRS Path/Row:144/043
LANDSAT-5 TM(Scene 3)	Acquisition Date: 14/03/2011 Scene ID:LT51450422011073KHC00 WRS Path/Row:145/042
LANDSAT-5 TM(Scene 4)	Acquisition Date: 14/03/2011 Scene ID:LT51450432011073KHC00 WRS Path/Row:145/043

Methodology:

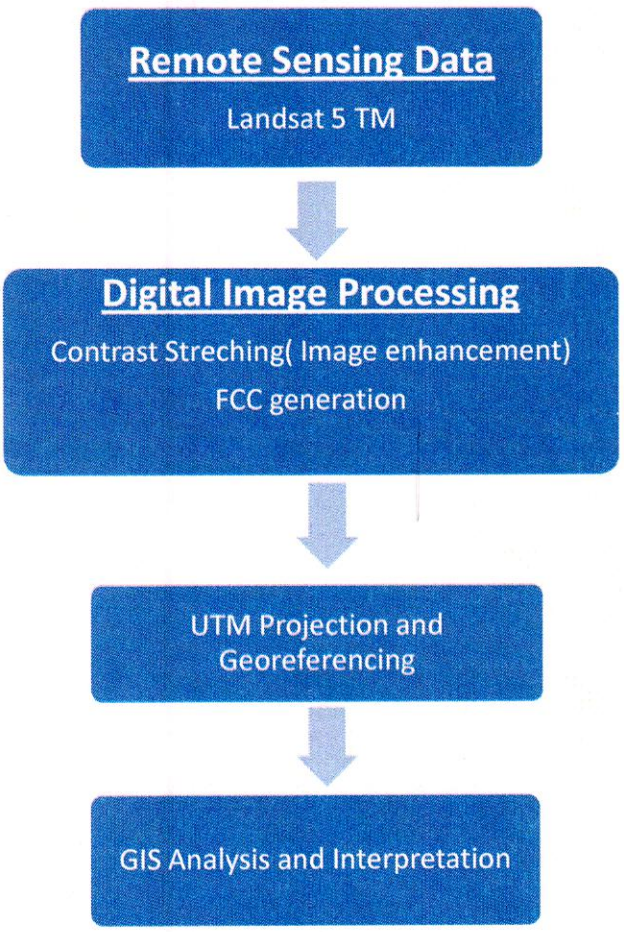
The satellite images are extracted from USGS(United States Geological Survey) source of satellite imagery. Preprocessing of satellite imagery is required before the analysis.

Image Processing:

The raw satellite images usually contain many defects like distortion, presence of noise, etc. due to variations in the altitude, attitude, and velocity of the sensor platform. So they cannot be used as map base without corrections. To use the extracted scenes for analysis image

to be carried out. In the present scenario all the four extracted scenes from LANDSAT-5 TM are processed using ILWIS software.

Image processing includes contrast stretching of individual bands for image enhancement which is effective in improving interpretability of different features. Further enhancement is done by generating false colour composite (FCC) from bands 4,3,2 coded in red, green and bluecolour scheme which highlights the vegetation cover, landuse and geomorphology



Flow chart showing the methodology adopted in the present study

Georeferencing:

Once the fcc images are generated for all the four districts,the images are georeferenced and projected to UTM Zone 44N(Universal Transverse Mercator zone 44 North) coordinate system using WGS-1984 datum.The present study area falls in North 44 zone in UTM projection system.

GIS Analysis and Interpretation:

The georeferenced images are analyzed using ArcGIS software.The lakes/reservoirs in all the four districts are manually demarcated and the area occupied by each lake/reservoir is calculated. Using vegetation as indicator (which appears red in 4,3,2 band fcc) benefited areas for all the lakes/reservoirs are also extracted manually. Once the submerged areas i.e., areas of lakes/reservoirs and the corresponding benefited areas are obtained the concept of benefited/submerged area ratio is applied for each reservoir.

At some locations, growth of vegetation is due to multiple reservoirs.Therefore we cannot delineate the effect of individual reservoir, in such cases combined benefited area is extracted for the reservoirs which are contributing.

However, some reservoirs show very little to negligible benefited area in terms of vegetation. These reservoirs are mainly used for drinking purposes. Few reservoirs are difficult to analyze because the vegetation indicator is not clear, and exact factors contributing to vegetation growth are unknown and thus benefited area cannot be marked for such reservoirs.

All the analysis done in the four districts of the present study area is represented by generated maps and tabulated results which are created using ArcGIS software.

Results & Conclusion

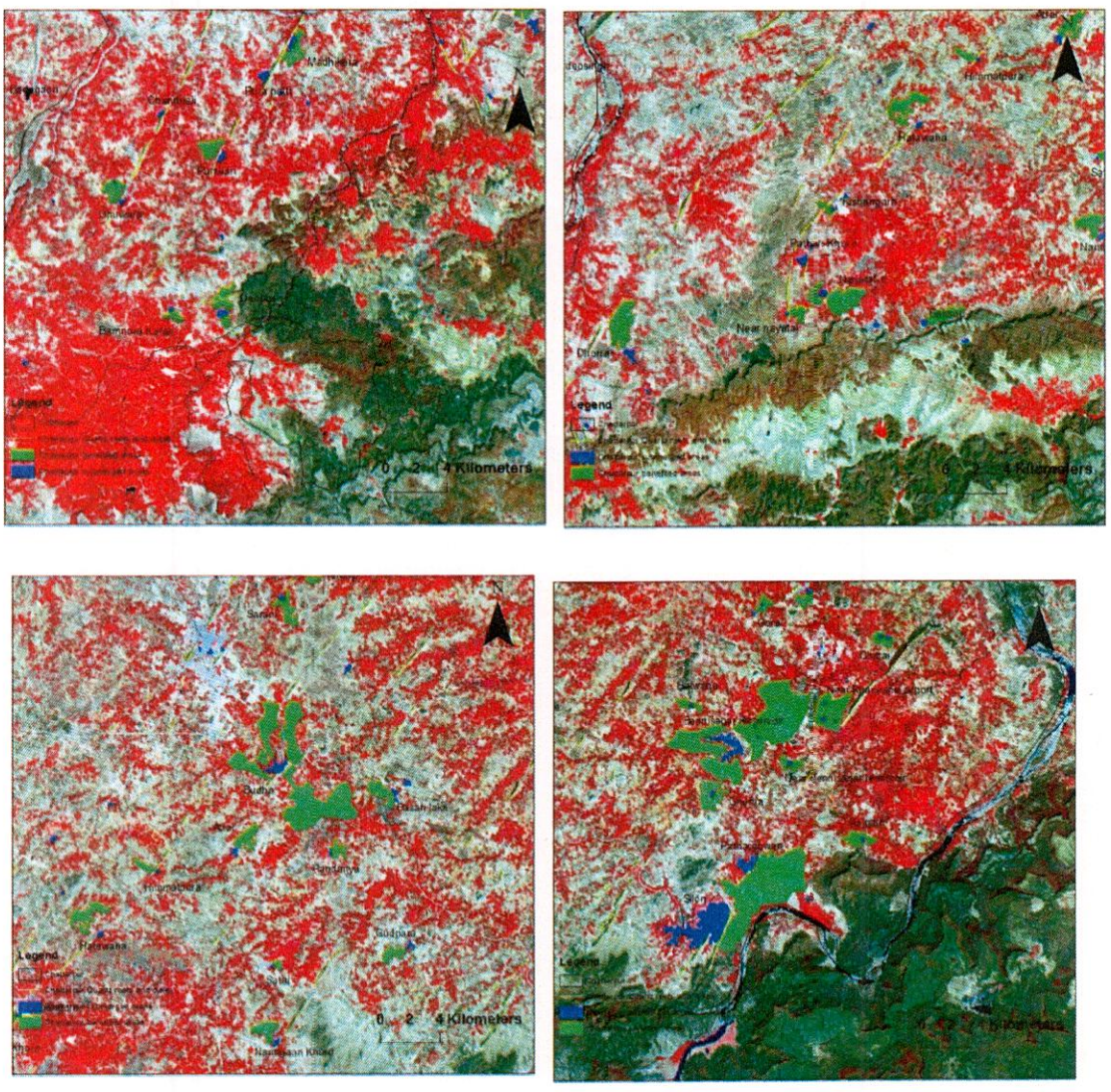
It has been observed that the gains in terms of vegetation growth in downstream areas of reservoirs are much more than the loss of vegetation in submerged area due to construction of the reservoirs

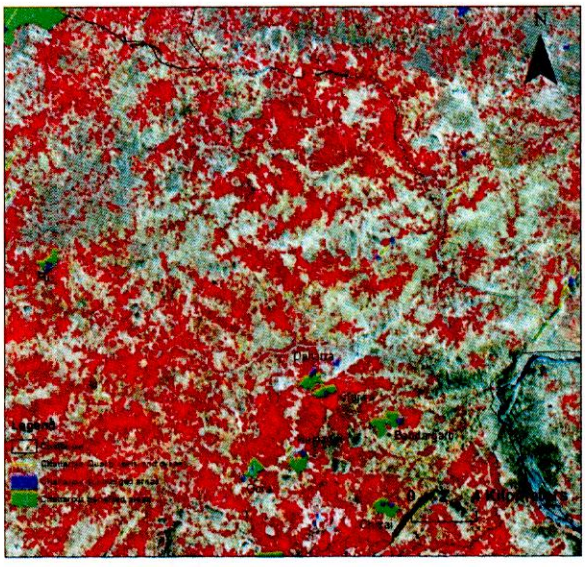
Total identified reservoirs in all the four districts are mapped and tabulated with their submerged area, benefited area and their ratios. Some lakes/reservoirs have no or very little(almost negligible) benefited area and benefited area in case of few reservoirs is difficult to demarcate. All such reservoir benefited areas are indicated in the table as NA.

Maps of four districts:

The maps generated using LANDSAT 5 TM FCC (bands 432 in RGB scheme) images, depict reservoir submerged area and benefited area, which is evident due to growth of vegetation in downstream of the reservoirs.

Chattarpur District:

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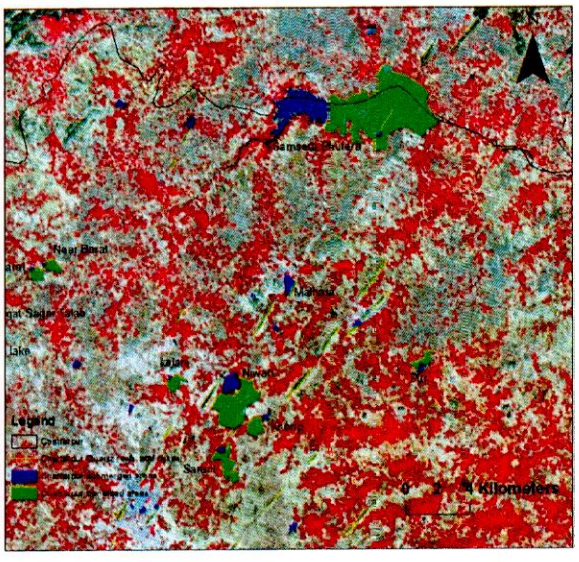
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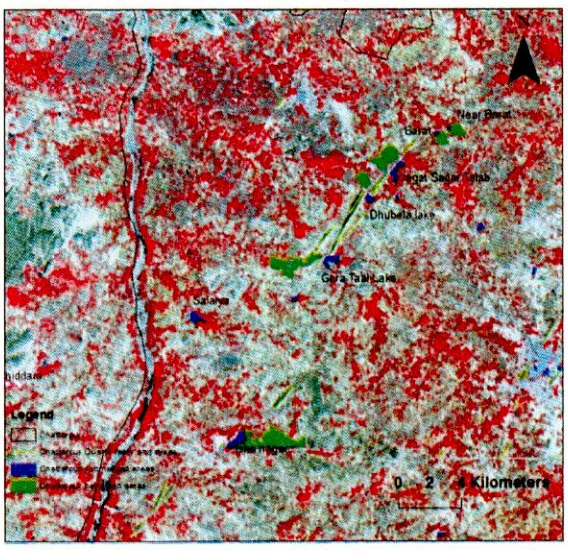
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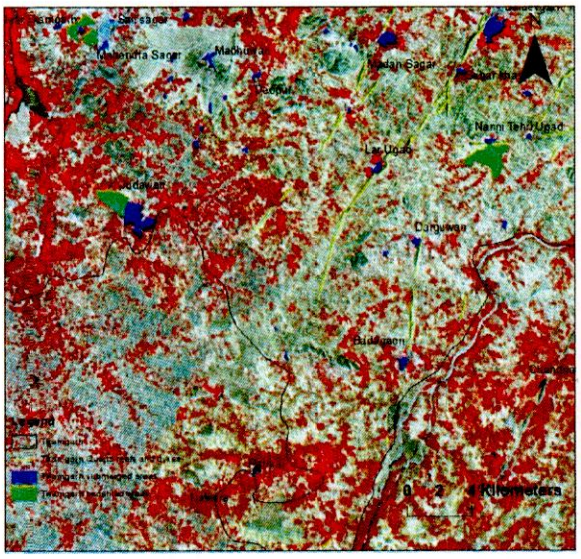
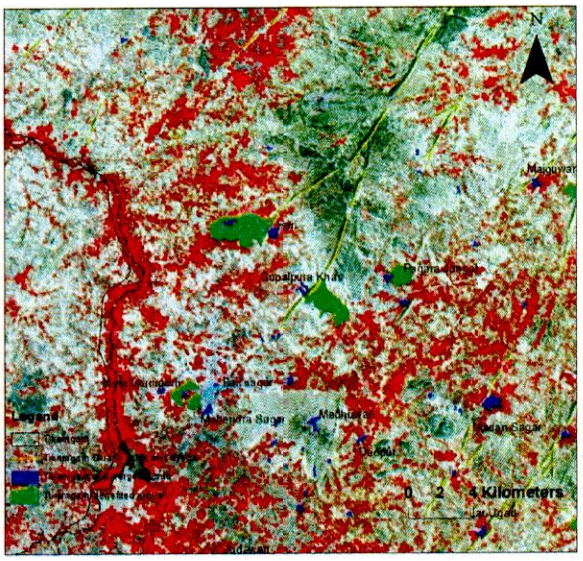
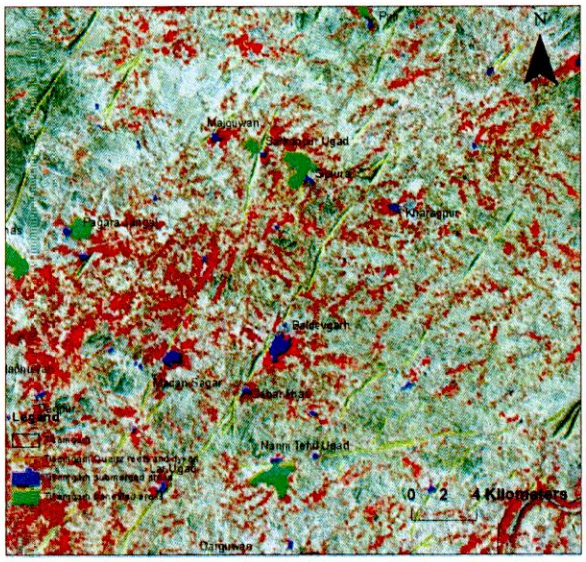
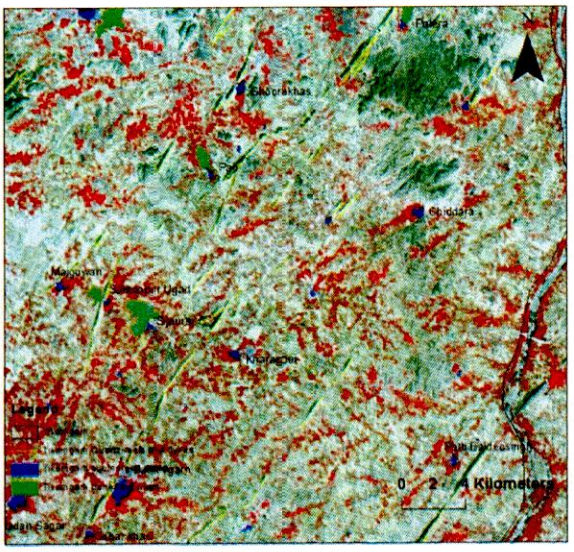
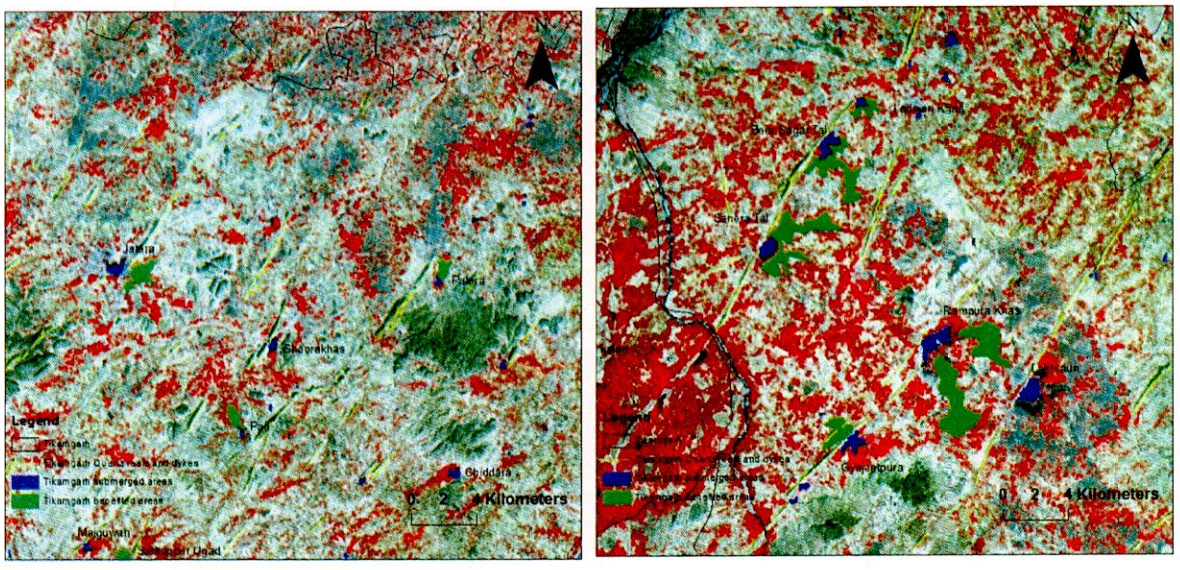
Tikamgarh District:



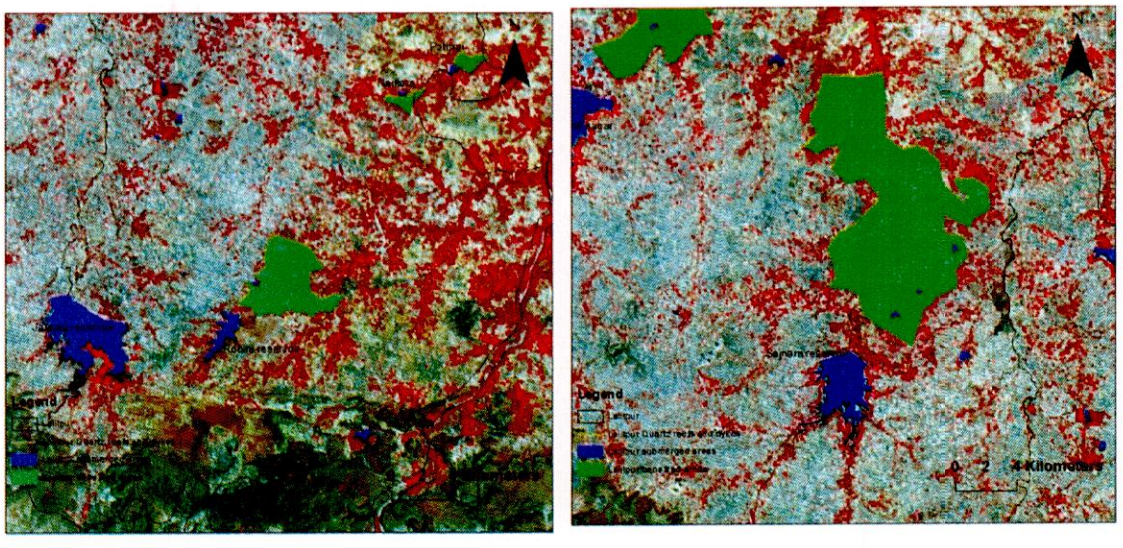


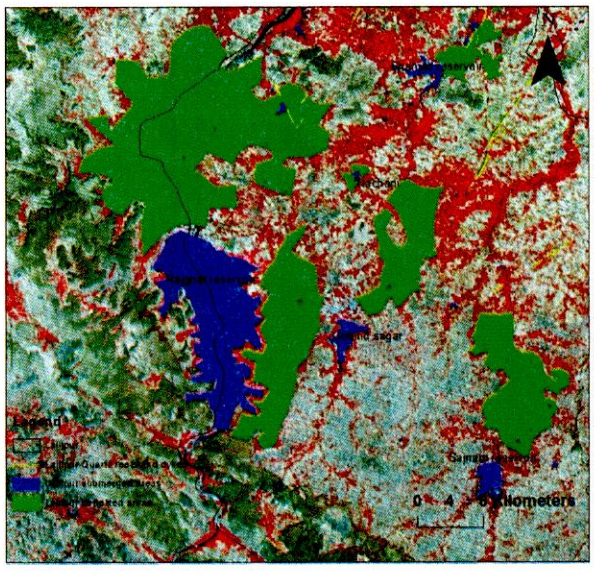






Lalitpur District:

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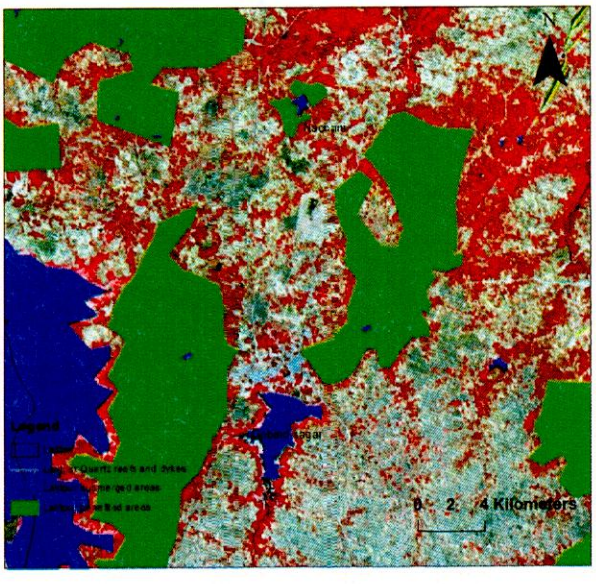
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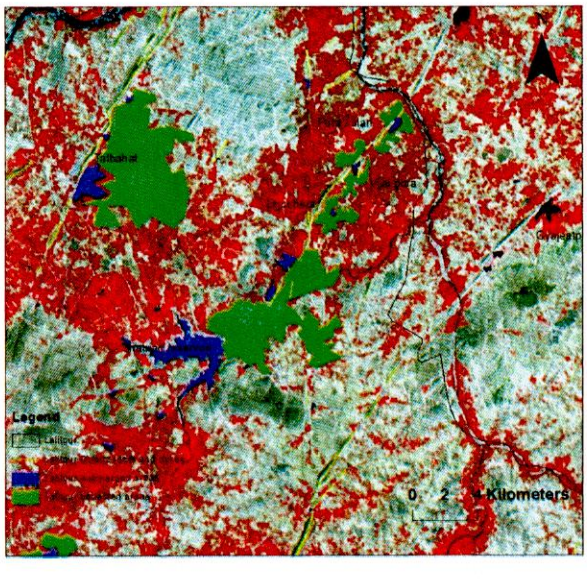
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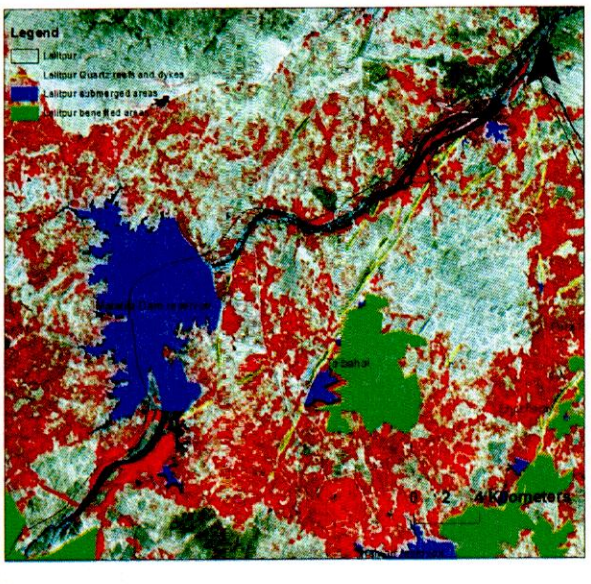
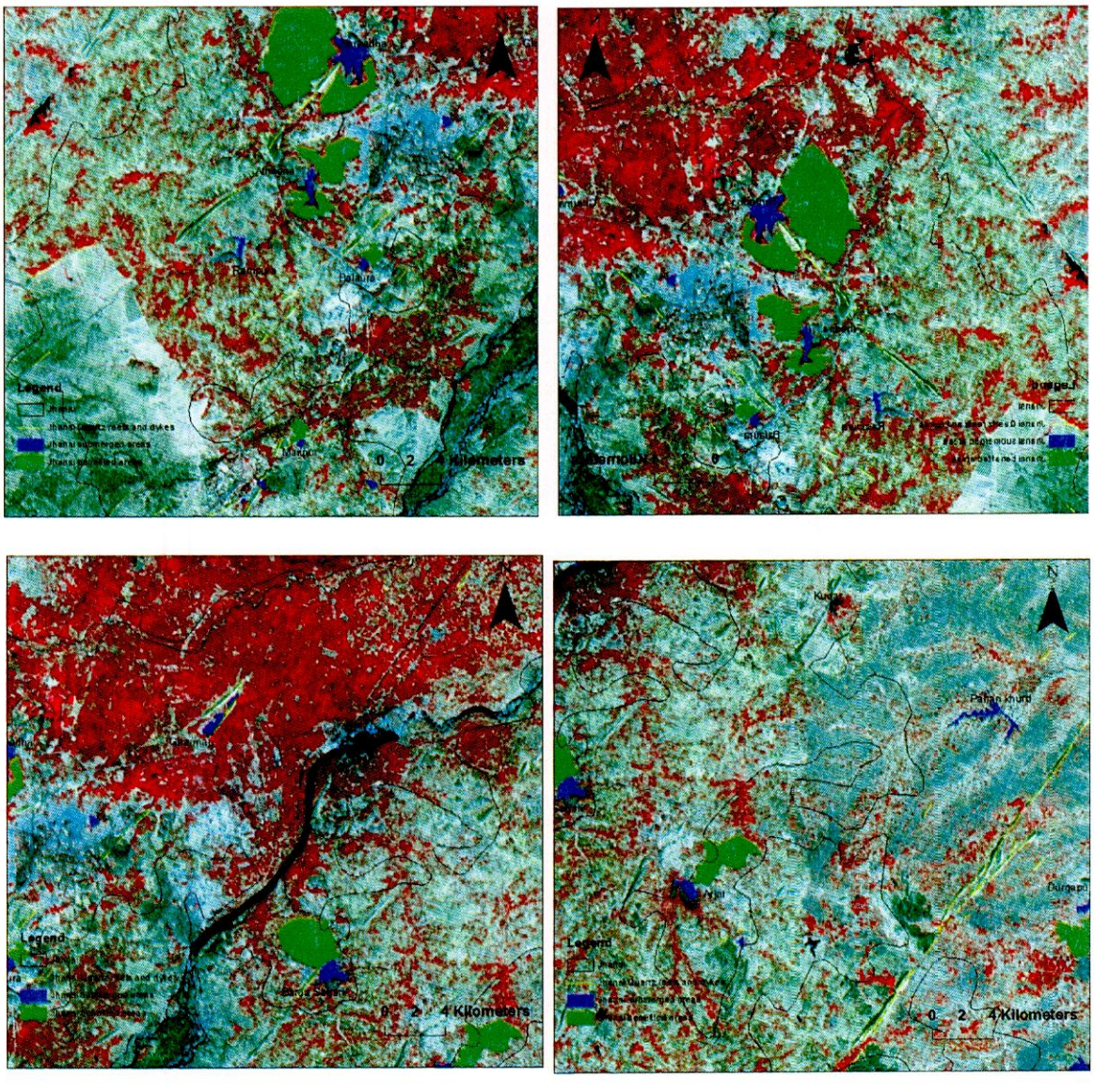
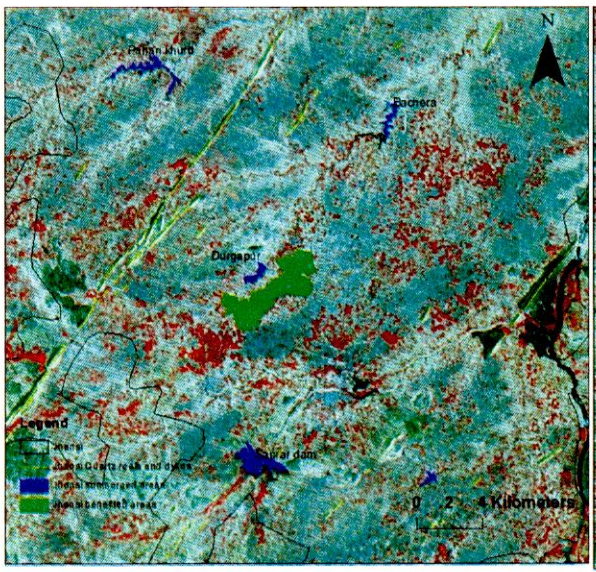
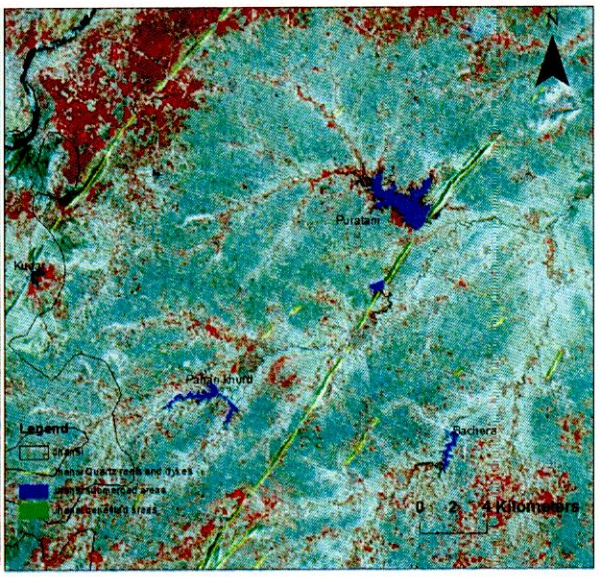
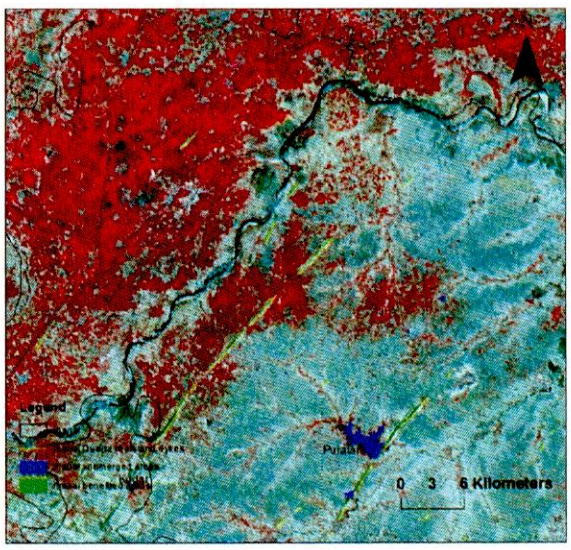

Legend
Lalitpur
Lalitpur Quartz reefs and dykes
Lalitpur submerged areas
Lalitpur benefited areas
0 2 4 Kilometers

Jhansi District:




N
Pahsin Jhurri
Bachera
Durgapur
Legend
Jharsi
Jhansi Quartzreefs and dykes
Jhansi shear zone
Jhansi basement area
0 2 4 Kilometers


N
Puratam
Kurai
Pahsin Jhurri
Bachera
Legend
Jharsi
Jhansi Quartzreefs and dykes
Jhansi shear zone
Jhansi basement area
0 2 4 Kilometers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Puratam
0 3 6 Kilometers

Results for Chattarpur District:

Lake/Reservoir	Submerged Area(Sq.km)	Benefited Area(Sq.km)	Benefited/Submerged Area Ratio
Gora lakes	0.05	0.76	15.321
Kalani lake	0.03	0.6	17.942
Deopur lake	0.25	1.56	6.3034
Bamnora kalan lake	0.1	0.48	5.042
Ghuwara lake	0.13	1.26	9.4951
Panwari lake	0.23	1.33	5.9016
Madhikera lake	0.27	1.28	4.7566
Dhorra lake	0.34	3.11	9.0361
Baksoi lake	0.12	1.43	11.784
Near Nayatal lake	0.03	0.67	20.639
Nayatal lake	0.19	3.7	19.389
Nandgaon Khurd lake	0.11	1.47	13.428
Kishangarh lake	0.06	0.33	5.6571
Silon-Patharguwan lakes	6.57	17.4	2.6546
Satai lake	0.02	0.27	11.986
Gudpara lake	0.11	0.95	8.788
Rajgarh lake	0.05	1.3	24.995
Hatawaha lake	0.1	2.14	22.29
Ghurra lake	0.06	2.11	37.054
Himmatpura lake	0.04	0.49	13.826
Near Bennisagar reservoir	0.06	0.74	11.566
Pandariya lake	0.05	0.67	14.387
Atrar lake	0.14	1.3	9.2234
Bennisagar reservoir	1.07	20.8	19.438
Hatwaha lake	0.03	0.61	17.629
Near Khajuraho airport	0.16	4.03	24.936
Basari lake	0.14	1.42	10.286
Budha lake	0.61	18.8	9.5109
Chitrai lake	0.1	0.78	7.9731
Ishanagar lake	0.61	2.97	4.8599
Rajnagar lake	0.06	0.65	10.663
Bandargarh lake	0.06	1.03	18.171
Khajwa lake	0.03	0.58	20.557
Daharra lake	0.09	0.67	7.437
Sarani lake	0.1	1.37	13.612
Khonp lake	0.06	0.8	13.98

Gora Taal lake	0.31	1.82	5.8961
Niwari lake	0.71	4.57	6.4565
Pur lake	0.07	0.53	7.1089
Dhubela lake	0.19	0.57	2.988
Jagat Sagar Talab	0.32	1.3	4.1293
Barat lake	0.04	0.43	10.284
Near Barat lake	0.03	0.49	17.452
Samsera Phutera lake	3.49	18.4	5.2799
Chanduali lake	0.12	NA	NA
Purapathi lake	0.29	NA	NA
Pathari Khurd lake	0.3	NA	NA
Salaiya lake	0.33	NA	NA
Malhara lake	0.38	NA	NA

Results for Tikamgarh District

Lake/Reservoir	Submerged Area(Sq.km)	Benefited Area(Sq.km)	Benefited/Submerged Area Ratio
Judawan lake	1.73	1.72	0.995
Nanni Tehri Ugad lake	0.13	2.51	19.77
Gopalpura khas lake	0.15	2.94	19.4
Pagara jangal lake	0.13	1.26	9.4
Kari lake	0.23	4.97	21.76
Sijaura lake	0.09	1.87	20.55
Sarkanpur Ugad lake	0.07	0.48	6.765
Pali lake	0.06	0.72	12.06
Palera lake	0.1	0.67	6.485
Jatara lake	0.41	1.77	4.364
Gyajeetpura lake	0.82	1.67	2.035
Rampura Khas lake	1.28	9.88	7.709
Sanera Tal lake	0.77	5.57	7.263
Beer Sagar Tal	0.81	3.68	4.56
Ladwari Khas lake	0.22	0.95	4.286
Badagaon lake	0.24	NA	NA
Darguwan lake	0.15	NA	NA
Lar Ugad lake	0.19	NA	NA
Sebar Khas lake	0.11	NA	NA
Madan Sagar lake	0.6	NA	NA
Baldevgarh lake	1.11	NA	NA

Patti Baldeosingh lake	0.11	NA	NA
Deopur lake	0.1	NA	NA
Madhuwan lake	0.2	NA	NA
Mahendra Sagar	0.14	0.54	3.799
Near Tikamgarh lake	0.07	0.87	12.7
Sail Sagar	0.05	NA	NA
Kharagpur lake	0.17	NA	NA
Chiddara lake	0.27	NA	NA
Majguwan lake	0.18	NA	NA
Ghorakhas lake	0.19	NA	NA
Lakhraun lake	1.15	NA	NA

Results for Lalitpur District

Lake/Reservoir	Submerged Area(Sq.km)	Benefited Area(Sq.km)	Benefited/Submerged Area Ratio
Naikora lake	0.14	1.52	10.828
Rohini reservoir	2.29	18.3	7.9927
Pathari lake	0.24	1.69	7.1363
Sajnam reservoir	10.1	98.7	9.7623
Gobind sagar	8.92	77.8	8.7236
Rajghat reservoir	161	517	3.2089
Nacahni lake	0.56	4.24	7.6117
Shahjad reservoir	6.93	24.8	3.5878
Talbahat lake	2.52	30.1	11.937
Bhuchera lake	0.08	2.54	31.701
Vijaipura lake	0.12	2.78	22.648
Pura Kalan lake	0.32	2.29	7.2716
Jamani reservoir	13.8	NA	NA
Matatila Dam reservoir	59.7	NA	NA

Results for Jhansi District

Lake/Reservoir	Submerged Area(Sq.km)	Benefited Area(Sq.km)	Benefited/Submerged area ratio
Durgapur lake	0.56	9.76	17.344
Barua Sagar	1.29	8.99	6.9708
Manpur lake	0.13	1.06	8.2952
Balaura lake	0.26	0.96	3.7292
Athodna lake	0.74	8.51	11.503
Simradha lake	2.8	30.2	10.778
Arjar lake	0.88	6.46	7.3768
Saprar Dam	2.27	NA	NA
Pahari Khurd lake	0.92	NA	NA
Puratani lake	4.23	NA	NA
Gharmau lake	0.77	NA	NA
Rampura lake	0.34	NA	NA
Bachera lake	0.45	NA	NA