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IMPACT OF URBAN SPRAWL ON CULTURAL HERITAGE MONUMENTS: A CASE STUDY OF TAJMAHAL, AGRA, INDIA

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ABSTRACT

Urbanization processes as a result of population growth, migration and developing infrastructure initiatives has a direct impact on cultural heritage sites. This paper aims to monitor dynamics growth of urbanization phase that took place at Taj Mahal during the last decades and evaluate its impact to monuments and archaeological sites. Taj Mahal is in the list of UNESCO catalogue of world cultural heritage sites and monuments. GIS and remote sensing techniques have been used to prepare the temporal land use changes since the 1999. The spatial pattern of urban sprawl is studied and analyzed using archive time series medium resolution landsat ETM+ and TM satellite imagery. Unsupervised classification algorithms have been evaluated and examined for this purpose. The final outcomes revealed that a dramatic increase of the urban areas took place in the last years and as results significant pressure is expected on archaeological sites found in the peri-urban areas.

Keywords: Urbanization, Taj Mahal, Cultural heritage management, Unplanned development.

INTRODUCTION

Urbanization process has been linked with variety of resource and environmental problems worldwide, such as habitat loss and land cover change as well as degradation of natural resources (Chen et al., 2014). Extraordinary urbanization, characterized by demographic shift from rural to urbanized areas and urban expansion, deformation of resource, has taken place globally in the last several decades. Urbanization is occurrences on a recorded scale while the rapid and uncontrolled development is transforming urban areas and their environment. This transformation may cause deterioration to heritage sites throughout the world. The last few decades is evidence of modern urbanization, including investments in

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modern infrastructure in central regions, has driven to intensive changes in land use (Swensen, 2008). A large part of this urban population lives in peri-urban regions in developing countries and the issue of peri-urbanization is growing in importance because of rapid urbanization in developing countries (Zhao, 2013). Urban expansion is associated not only with changes in land cover patter, but also transform to ecological, climate and social aspect (Roychowdhury et al., 2011). Remote sensing and GIS technology have been widely used for heritage management (Pappu et al., 2010; Sarris et al., 2013). Special attention is given by some researchers to map existing urban growth and risk assessment of Cultural Heritage sites (Canuti, 2000). While some studies attempt to monitor anthropogenic as well as natural threats to archaeological sites (Hadjimitsis et al., 2011). The integration of these data sets with other multi-sources information, such as historic satellite images and GIS based analysis, can be also considered to provide public authorities for decision-making (Cuca et al., 2012). Despite the integrated use of remote sensing and GIS within archaeological research and management, an effort was made in order to apply prediction hazard models for monitoring threats in existing archaeological sites. Such prediction models may be used to map future urban areas, and therefore, to support local authorities to evaluate any potential threats for these sites. This paper seeks to highlight some of the key tools provided by remote sensing and GIS, through an extensive case study and at the same time to demonstrate how these may be employed for a more efficient cultural heritage management and urban planning (Agapiou et al., 2015). The paper uses time series multispectral satellite images to understand urban settlement patterning, with special focus to areas of archaeological sites. Indeed, multispectral freely distributed satellite images from 1999 until 2017 have been exploited. Since these images are geo-referenced, the final outcomes (i.e. urban areas for each period examined in this study) were directly overlaid and compared. In order to examine the diachronic evolution of urban sprawl in the vicinity of these sites and monuments, other cultural heritage information (i.e. archaeological sites and monuments) was used. The spatial analysis was carried out in a GIS environment.

Study Area

Agra is the city of incomparable Taj Mahal. It was the Mughals who nurtured Agra with the finest monument's architects could design (Vishal, 2016). Taj Mahal is one of the most visited buildings in the world competing with the pyramid in Egypt, the Vatican in Rome and Eiffel tower in Paris (Piyali Bandyopadhavay). Taj Mahal is most famous Mughal monument was constructed by Emperor Shah Jahan in memory of his beloved wife Mumtaz Mahal. It is symbol of love, located on the banks of river Yamuna that constructed between 1631 and 1654 by workforce of more than twenty thousand. The Mughal Emperor Shah Jahan commissioned its construction as a mausoleum for his wife, Mumtaz Mahal who died in 1630. It is marvelous example combination of Mughal, Hindu and Persian architectures, it achieved a great image all over the world due to the inspiration of true love. To build this unique monument, so many precious stones are used which came from the different parts of the world. The Taj Mahal is considered to be an iconic symbol of India. The Taj Mahal looks very beautiful under the full moonlight. Taj Mahal's importance on tourist map cannot be underestimated because this place is one of the key tourist destinations that attract tourists from all over the world. This tourist place is connected with one of the prime tourist circuit of India known as Golden Triangle that joins Agra, Delhi and

Jaipur. Agra city is rich in its art, heritage and culture, which is also reflected in its historical monuments. This makes the city as one of the most attractive tourist places of the country. The Agra city currently has three world heritage sites such as Taj Mahal, Agra Fort and Fatehpur Sikri. This entire area is called Taj Trapezium Zone (TTZ) that covers 10,400 square kilometres area that surrounds the monuments where industrial business is limited and polluted industrial units are not allowed as per order of Supreme Court of India in December, 1996, delivered a ruling banning use of coal/coke in industries located in the Taj Trapezium Zone (TTZ) and switching over to natural gas or relocating polluting industries outside the TTZ. **Table 1** shows that important of Taj Mahal in tourism industry, According to Archaeological Survey of India, 2017, it is one of most visited places among top 10 centrally protected ticketed monuments (Archaeological Survey of India, 2017).

Table 1. 10 Most popular centrally protected ticketed monuments for visitors in 2016.

Domestic Visitors				Foreign Visitors			
Rank	**Monument**	**Domestic**	**%**	**Rank**	**Monument**	**Foreign**	**%**
1	Taj Mahal	4097897	10.2	1	Taj Mahal	395760	16.63
2	Qutub Minar	2217955	5.52	2	Agra Fort	339667	14.28
3	Red Fort	2184613	5.44	3	Qutub Minar, Delhi	334435	14.06
4	Agra Fort	1838440	4.58	4	Humayun's Tomb	147667	6.21
5	Golconda	1565886	3.9	5	Fatehpur Sikri	144070	6.05
6	Sun Temple	1552729	3.87	6	Etmad-ud-Daulah	132216	5.56
7	Charminar	1320511	3.29	7	Cornwallis Tomb Ghazipur	88282	3.71
8	Bibika Maqbara	1301278	3.24	8	Mattancherry Museum, Kochi	77634	3.26
9	Ellora Caves	1279272	3.18	9	Red Fort	75771	3.18
10	Shaniwarwada	1269530	3.16	10	Mamallapuram	64260	2.7
	Others	21539827	53.62		Others	579627	24.36
	Total	40167938	100		Total	2379389	100

Source: *Archaeological Survey of India, 2017*

METHODOLOGY & RESOURCES

Multi-temporal Landsat satellite images have been used for monitoring urban expansion sounding area of Taj Mahal, during the period 1999-2017. The overall methodology is composed by five steps. Firstly, classification analysis was applied so as to generate map the urbanization at time (Step 1). All monuments of the Agra were geo-coded in a common geodetic system (Step 2). Furthermore, GIS spatial analysis was carried out to monitor and map of land use change in the last decades in the vicinity of the archaeological sites to identify any future urban pressure to cultural heritage sites (Step 3). Status of visitor management facility through intensive primary survey of Taj Mahal (Step 4). The physical carrying capacity of Taj Mahal is calculated in set 5. In detail, 4 multispectral Landsat 5 TM and Landsat 8 OLI_TIRS were used (path/row: 146/41). A satellite image with no

or limited cloud cover – for each decade was used (1999-2017). The Landsat space program allows us to go back almost 30 years (1984). Landsat images have a spatial resolution is 30 m. Such kind of data has been successfully used for classification purposes in a variety of disciplines (Hadjimitsis et al., (2011); Cuca, Oreni & Brumana, 2012; Agapiou et al., 2015). Further characteristics of the Landsat data are shown in **Table 2.** The primary data collected during the field visits at Agra during 2017 and 2018. Primary data sources include the field observation of Taj Mahal through extensive field survey that includes focused interview and questioners. For analysis the status of tourist management of Taj Mahal, number of field survey was conducted during the various peak months of 2017 to 2018. This study also used a participant observation approach to analyses the status of tourism. These observations based on informal interviews and discussions with international and domestic tourist, government stakeholders, local people, hotel staff, skilled and unskilled workers in this industry. Secondary data like tourist statics of Taj Mahal was collected from the tourism Department of Uttar Pradesh, Ministry of Tourism, India and various reports of tourism are sited.

Table 2. Satellite data used for monitoring land use change.

Satellite	Sensor	Date of acquisition
Landsat 8	OLI_TIRS	2017-04-22
Landsat 5	TM	1999-04-21

Source: *USGS Earth Explorer*

Step 1: Classification of satellite images

In this study k-mean clustering technique are used to unsupervised image classification, in this process by which each image in a dataset is identified to the member of one of the inherent categories present in the image collection without the use of labelled training samples. Unsupervised categorization of images relies on unsupervised machine learning algorithms for its implementation (Abassolaode et al., 2014). Due to its most widely expected technique make its more suggested for this study (Daata et al., 2008) k-mean clustering in a given dataset with center obtained after repeated optimization of an overall measure of cluster quality known as the objective function. Its result is sensitive to the initial centers used in the clustering process (Abassolaode et al., 2014). In this study unsupervised classification is be formed to prepare the land use land cover map of Agra **(Figure 1)**.

Step 2: Geo-referenced on cultural heritage sites

All monuments and tourist place were mapped in a common geodetic system (WGC 984, UTM) **(Figure 2)** and recent master plan boundary of Agra was used to map these monuments and sites.

Step 3: GIS SPATIAL ANALYSIS

The final results (i.e. classification analysis and monuments) were imported into the GIS environment for further analysis. A buffer zone of 300 of Taj Mahal was created in order to examine the land use changes within this area around the monuments.

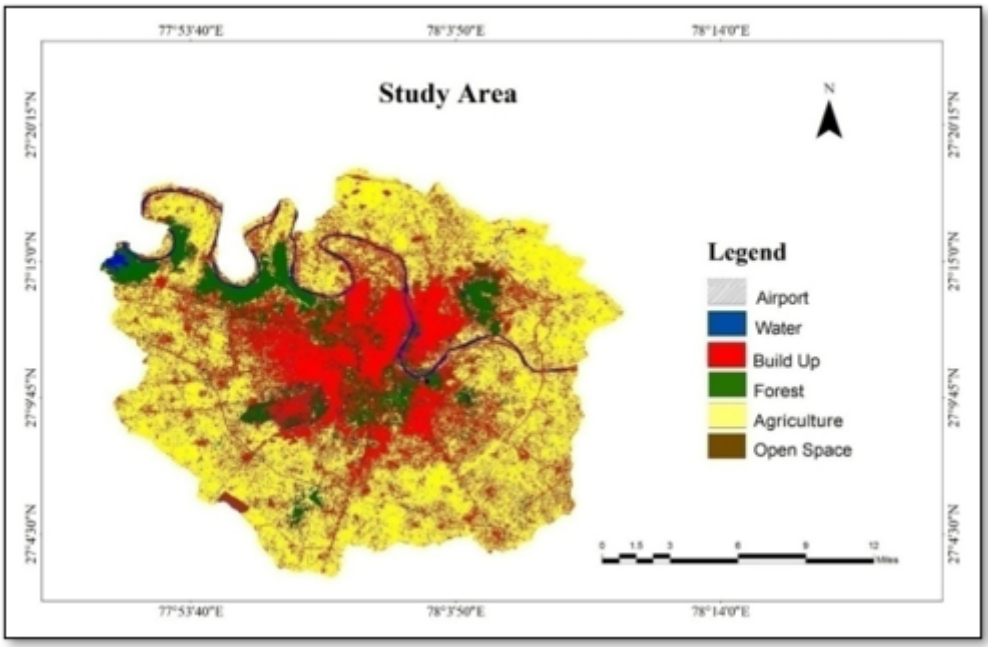

Figure 1. Land Use and Land Cover of Agra, 2017.

Source: Compiled by author

RESULTS & ANALYSIS

GIS (Geographical Information System) and remote sensing techniques are used to investigate the land use change detection of regulatory and prohibited area of the city. The land use and land cover change analysis help us to understand the changing pattern of the region **Table 3** and map of the change in build-up from 1999 to 2018 shows in **Figure 2**. It is obvious through geospatial analysis that the build-up area in the regulated boundary is rapidly increasing. The value of the build-up area is enhanced from 149.16 to 191.88 h from 1999 to 2017 nearby Taj Mahal which indicates rapid transformation in the cultural landscape of the city.

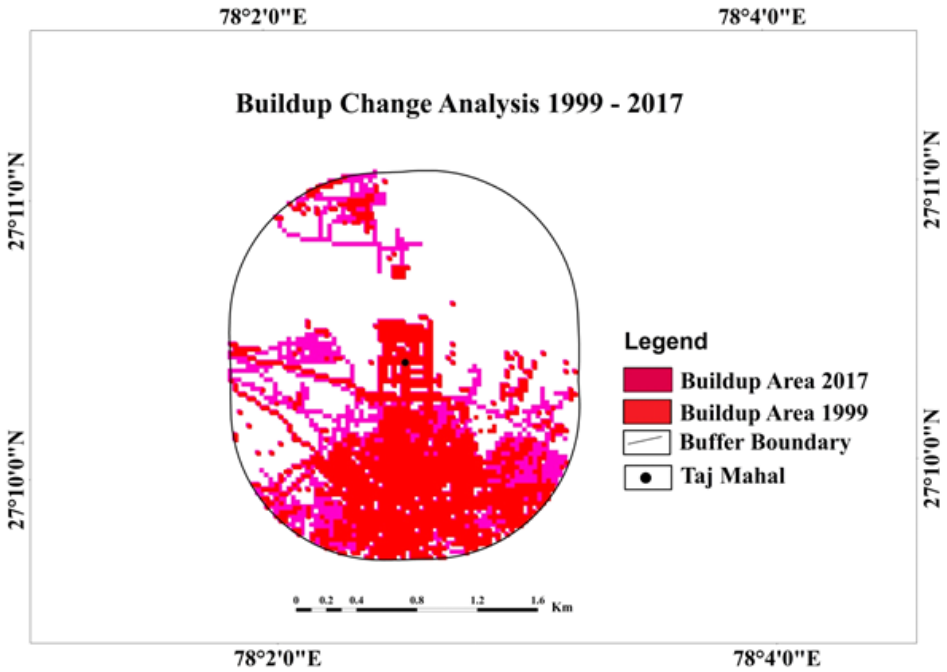

Figure 2. Build up Change Analysis near Taj Mahal.

Source: compiled by author

Table 3. Land use and Land cover change in 1 km buffer zone at Taj Mahal.

Class Name (Hectare)	1999	2017
Water	25.11	33.66
Green	159.61	166.05
Open Space	124.58	70.65
Build up	149.16	191.88
Agriculture	49.77	45.99

Source: Compiled by author

The value of Settlement Class is enhance 149.16 to 191.88 hectare from 1999 to 2017 under 1 km buffer of Taj Mahal, that indicate build-up phenomena, due to urbanization, rapid urbanization in Agra distort landscape and develop various problems such as congestion in the city and at the time of Taj Festival it's become more miserable, Some of the tourist area such as Taj Mahal and Agra fort become more congested (Piyali Bandyopadhvay).

The carrying capacity of Taj Mahal should be increased to accommodate more tourists as it is evident that number of tourists is increasing over the years. The tourist places like Taj Mahal and Agra Fort have sufficient open spaces to have more tourists. It has huge potential because of open and green belt available. There is tremendous pressure on environmental resources of the city, so it is required to develop a green belt which will further increase the environmental carrying capacity of the Taj Mahal and its surrounding area. Accommodation carrying capacity of city is required to be enhanced to attract more visitors. Economic carrying capacity of the city is improving because revenue generation from tourist activities is increasing.

As evident as primary as well as secondary data Taj Mahal is overcrowded during holidays and peak season. There is a need of proper and appropriative visitor management system to control overcrowding at Taj Mahal. A large number of people at a particular time may lead to desertion of physical and ecological aspect of the Taj Mahal compound. There physical and ecological sustainability is of paramount significance. The Taj Mahal should support optimum number of tourists which can be very well accommodated in available carrying capacity. The threshold level of Taj Mahal should not be surpassed. The government should take various steps regarding visitor management.

STATUS OF VISITOR MANAGEMENT

Visitor management plan for any tourist destination cannot work without mutual understanding of local host and visitors, our literature review suggest Taj Mahal is facing huge pressure of visitors in every year. At Taj Mahal, there no shelter at tickets counters for tourists which also highlight the negligence of tourist's satisfaction. For development of improved Visitor management plan for Taj Mahal, there is need to concern more about physical infrastructure, control overcrowd at ticked counter (window), water and sanitation facilities for tourist area.

CONCLUSION

Landsat 5 and 8 satellite data were successfully used for estimating the urban expansion surrounding the Taj Mahal that indicate the rapid unplanned

development. The huge tourist's pressure on Taj Mahal has already overtaken its present physical carrying capacity and also influenced the visitor management services.

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