REMOTE SENSING FOR MONITORING THE CULTURAL HERITAGE: A CASE STUDY OF SACRED CITY OF KANDY

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Cultural Heritage Management (CHM) is one of the most important disciplines in archaeological studies. The ICOMOS charter for the interpretation and the presentation for Cultural Heritage Sites has been referred Cultural Heritage as *"a place, locality, natural landscape, settlement area, architectural complex, archaeological site, or standing structure that is recognized and often legally protected as a place of historical and cultural significance"* (ICOMOS, 2008). This mainly refers to that the heritage is material based (ICOMOS, 1999). Further, UNESCO-World Heritage Convention has been emphasized the importance of the documentation, managing and the monitoring of world heritage (ICOMOS, 1990; UNESCO, 2013) with several operational guidelines (UNESCO, 2008). When considering the management and the protection of cultural heritage in Sri Lanka, utilization of global situations and the global enforcements of new framework documentation, planning, managing, and monitoring of cultural heritage are very significant. With these perspectives, it is necessary to identify recent global technological adaptations and most effective methodologies, which are using for documentation, managing and monitoring of cultural heritage at present in worldwide.

Most of the countries are monitored their cultural heritage sites and visible monuments, with on-site observations, especially, including data collection, periodic observations of archaeological sites and multi-analysis based investigations. In some cases, on-site observations are time consuming and it may be a not cost-effective method (Hadjimitsis et al., 2013: 64). Within this practice, remote sensing is using along with GIS applications, as technological integrations for heritage management and monitoring process (ibid) in last few decades. Remote sensing is a way of acquisition of

information about an object or phenomenon without making any physical contact with the object (Parcak, 2009). Aerial photographs and satellite imagery technologies, which are involved an electromagnetic radiation in order to identify and detect various objects and phenomena. The Multi Spectral Remote Sensing images are very efficient for obtaining a better understanding of the earth surface (Nusrath, 2012: 58-67). It is a way acquiring information and extracting the features in form of spectral, spatial and temporal about some objects, area or phenomenon, such as vegetation, land cover classification, urban area, agriculture land and water resources. Geographic Information System (GIS) is a kind of computer based framework to gather, manage and analyze the spatial data. This can be use for analyze the spatial location and organize the layers of information into visualizations with different methods (Esri, 2018). Part of remote sensing is integrated within GIS. Hence, along with GIS, remote sensing based studies can be done by successfully.

This study is structured to identify the uses of remote sensing technology in monitoring process in the Cultural Heritage Management in Sri Lanka, with especial reference to selected monuments and areas in the Kandy, the world heritage city. Also, this research will be questioned about the utilization of the remote sensing along with GIS applications. The methodology of this study has based on field exploration, using remote sensing and satellite images, GIS application. Further, the discussion will be carried out basically, with the data gathered from remote sensing applications and their analysis.

Kandy world heritage city has been under taken several documentation procedures from the last century up to date. However, historical recordings can be identified since the very earliest period. Further, some of the remarkable evidences are provided by the Dutch and British records. Recently, government department of archaeology, central cultural fund and some individual researches have been conducted various researches on documentation, managing and monitoring the Kandyan Heritage. Apart from those studies, UNESCO and ICOMOS were also interested in research, managing and monitoring the Kandyan Heritage, based on World Heritage process (ICOMOS - Advisory Body Evaluation, 1988; Report on ICOMOS Monitoring Mission to Dambulla, Kandy and Galle, 1998 and etc.).

However, this study differs from the above process and this will be carried out by remote sensing based applications for monitoring the cultural heritage.

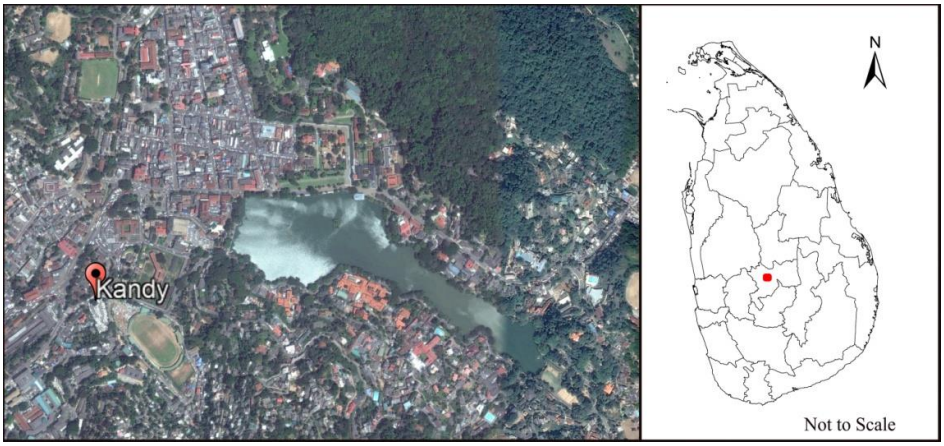

Figure 01: Kandy Sacred City Area (Google Earth Pro, 2018)

This researcher applied Landsat, Sentinel 2 and Google satellite imageries for analysis purpose from the year 2002 to 2018. GPS locations have been taken from using mobile GPS and the use of CTDroid Sri Lanka application. Further, the some of the data, which has been gathered from field studies, have been analyzed by using Arc. GIS 10.5. The study has been followed by several satellite images to identify the differences and the issues of the Kandy sacred city area in recent years. Further, *Normalized Difference Vegetation Index (NDVI) and* algorithms were applied for the study. NDVI is one of powerful analysis tools in GIS, which is employing the Multi-Spectral Remote Sensing data technique to find vegetation index, land cover classification, vegetation, water bodies, open area, scrub area, hilly areas, agricultural area, thick forest, thin forest with few band combinations of the remote sensed data.

Following maps are representing the land cover classification of Kandy sacred city in last sixteen years.

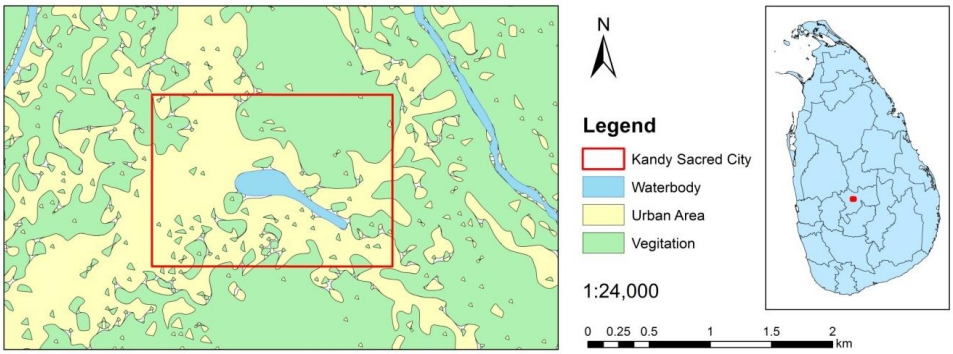

Figure 2: Kandy City area in 2002

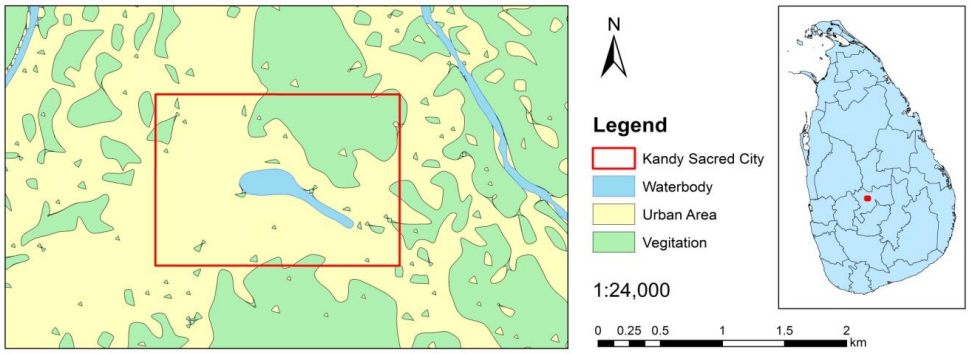

Figure 3: Kandy City area in 2018

In order to remote sensing based monitoring assignment of the Kandy sacred city area, several facts can be recognized. Specially, when considering completely the sacred city area, changes of the natural vegetation can be identified. This effect is nearly showing the percentage of 19.5% for last sixteen years and percentage of 1.65% per year. The urban activities are showing more than 18.5% percent of development, and for one year, this can be a percentage of 1.16%. Moreover, along with field investigations, the study is showing renewals and the conservations of the protected monuments are increased in percentage of 1.70% per year. Moreover, traffic based issues can be seen. Air pollution is also increased in last decades. In addition, highly protected monument premises were

also effaced by new construction, some are called temporary buildings. However, some monuments and the areas were not affected by illegal constructions or activities, due to ongoing management process.

The study is showing considerable issues in the sacred city of Kandy, which can be affected cultural heritage, as the instant of, changes of the natural vegetation, urban activities, renewals and the conservations, traffic and air pollution, illegal and new construction. As a living heritage, some of the activities can be expected. However, it must be in miner level, but here it is high. According to these results it is necessary to overtake a risk assessment analysis of cultural heritage in Kandy. Further, monitoring of the surroundings areas is also necessary.

The use of remote sensing along with GIS applications in heritage monitoring process is very effective. This is kind of a low and cost-effective method and it does not need much of human resources. Use of on-site observations and data collection can be lead in to multi-analysis based investigations via remote sensing and GIS applications. Further, this can be recommended in heritage management and the monitoring purpose in Sri Lankan context.

Keywords: Cultural Heritage Management, Sacred city of Kandy

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