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Land Use and Land Cover Analysis Using Remote Sensing and GIS Techniques: A Case Study of Nashik City, Maharashtra

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Abstract: The spatial patterns of urban land use at both the macro and the micro levels are a central issue in global change studies. The land use/land cover (LU/LC) changes are real important to have proper provision and use of natural resources and their management. Land is becoming a scarce resource due to immense agricultural and demographic pressure. Hence, information on land use /land cover and possibilities for their optimal function is essential for the selection, preparation and implementation of land use schemes meet the increasing needs for basic human needs and welfare It was done by using the data SOI Toposheets, Landsat TM, (1991), Landsat ETM+ (2001), LISS-III (2011) and LISS –IV (2016) and with the aid of using Remote Sensing and Geographical information Techniqnies. The supervised classification method is used to classify the land use and land cover of the study area. The major findings of change detection analysis revealed that the maximum change in the land use and land cover from 1981 to 2016 has been seen in the instance of the built-up area, which has varied from 2.89% to 40.36%. The major expansion of the built-up area is mainly along the highways and the outskirts.

Keywords: Landsat, Remote sensing, GIS.

INTRODUCTION

The spatial patterns of urban land use at both the macro and the micro levels are a central issue in global change studies [1]. The land use describes the use to which the land is put, whilst land-cover describes the surface cover characteristics [2]. In other words, the term land cover refers to the physical materials on the surface of a given parcel of land, while land use refers to the human activities that takes place on or make use of land, for example, residential, commercial, industrial etc [3, 4]. The land use/land cover (LU/LC) changes are real important to have proper provision and use of natural resources and their management [5]. Land is becoming a scarce resource due to immense agricultural and demographic pressure. Hence, information on land use /land cover and possibilities for their optimal function is essential for the selection, preparation and implementation of land use schemes meet the increasing needs for basic human needs and welfare [6]. The spatial dimensions of land use and land cover need to be known at all times to enable policymakers and scientists to be sufficiently equipped to take informed decisions on land resources. Therefore, a wide range of scientists and practitioners, including earth systems scientists, land and water managers as well as urban planners seek information on the location, distribution, type and magnitude of land use and land cover change [7-9]. Land use/land-cover analysis provides the baseline data required for proper understanding of how land was being used in the past, what type of changes have occurred and are expected in the future [10, 11]. Land use/ land cover is an important component in understanding the interactions of the human activities with the environment. It is necessary to monitor and detect the land use changes to balance a sustainable environment [12].

Remote sensing and Geographical Information System provides vital tools which can be applied in the analysis at the district and as well as micro level such as city level. Remote sensing provides a synoptic view and multi- temporal land uses/ land cover data [13]. Remote sensing and Geographical Information System based technologies may be applied to an area in order to generate a sustainable development plan [14]. Classification is a process of separating the information or data into a useful form [15]. The LULC classification process itself tends to be subjective and in fact, there is no logical reason to expect that one detailed inventory should be adequate for more than a short time, since land use and land

cover patterns change in keeping with demands for natural resources [16]. In practice, several land use and land cover classification (LULC) techniques/algorithms are available, viz., Supervised, unsupervised, decision tree or knowledge based, object oriented, artificial neural network and support vector machines classification techniques. However, no ideal classification technique/algorithm exists and is unlikely that one could ever be developed [16].

Study area

The city of Nashik (Fig-1) is situated in the State of Maharashtra, in the northwest of Maharashtra, on between 19° 54'40" North latitude to 20° 05'08" North latitude and between 73° 41'08" East longitude to 73° 54'22" East longitude. It is connected by road to Mumbai (185 kms.) and to Pune (220kms.). Nashik is one of the most important cities of Northern Maharashtra. The city has become the centre of attraction because of its beautiful surroundings and cool and pleasant climate. Nashik has a personality of its own due to its mythological, historical, social and cultural importance. The city, vibrant and active on the industrial, political, social and cultural fronts, has influenced the lives of many great personalities. The river Godavari flows through the city. Temples and Ghats on the banks of Godavari have made Nashik one of the holiest places for Hindus all over the World. Nashik city is one of the five places in India where the famous Kumbh Mela is held once in 12 years [17, 18].

DATA AND SOURCES

The data collection involved collection of toposheets, wards maps, satellite data. The nature of these data and there are sources shown in table-1.

Table-1: Primary and secondary data details for the study area.

Type of Data	Source(s)
Toposheets No. 46H/12, 46 H/16, 47 E/09,47 E/13	Survey of India, Scale 1:50000
Satellite Imagery – Landsat TM Land Sat ETM+ LISS-IV	www.glcf.co.in (Global Land Cover Facility)
LISS-3; IRS-P6 Path: 95 Row:59	National Remote Sensing Centre (NRAC), Hyderabad
Demographic Details From Primary Census Abstracts For 1981,1991,2001 and 2011	Census of India
Ward map and administrative boundary	Nashik municipal corporation

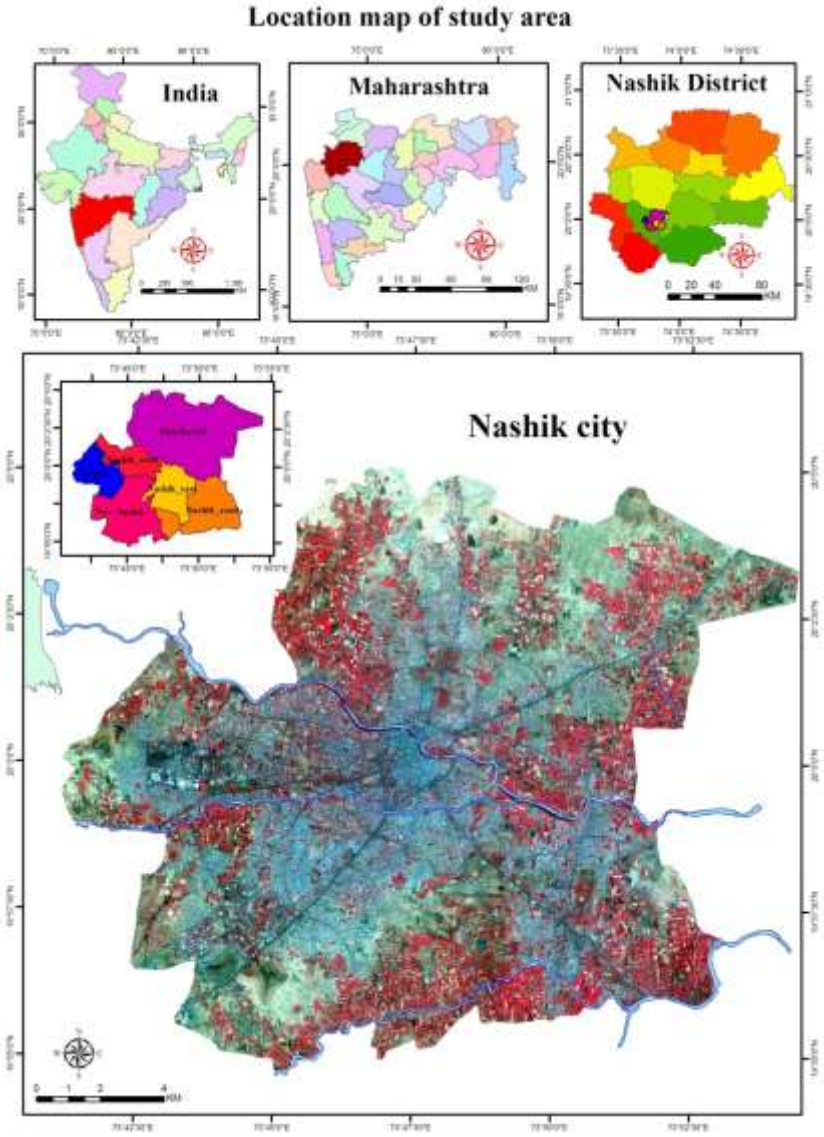

Fig-1: Location map of the study area

METHODOLOGY

Application of Remote sensing and GIS technology have been identified (Figure-2) and used as a vital tool to land use / land cover changes using ERDAS and ARC GIS software.

Data collection and preprocessing

In the present study, remote sensing data like Land TM [19], Land sat ETM+ (2001) and IRSP6 LISS-III (2011) false color composites are collected from Global Land Cover Facility web site. Preprocessing has involved scanning, geo-referencing, and digitization of survey of India toposheets at 1:50000 scale to serve as the base map. Firstly, survey of India WGS 1984, Universal Traverse Mercator (UTM) projection system. After geo-referenced the SOI toposheets and other maps were digitized in different features like point ,line and polygon such as administrative boundaries, roads, and railway network, contour, drainage network and built-up land, scrub land, fallow land, agricultural land etc.

Image Classification

The image obtained from Global Land Cover Facility was geo registered with respect to the survey of India toposheets, initially; apply standard image processing techniques for the analysis of satellite data such as rectification, enhancement, band extraction, restoration and classification were completed. The supervised classification technique was employed for the image classification using ERDAS Imaging Software. The classification of land use was categorized into 06 major classes such as Built-up area, Agriculture Land, Vegetation cover, Fallow Land, Scrub Land, Water Bodies etc [20].

Field work

Field work is important step ground truth of the results to understand the land use / land cover change of the study area. This step indicates the visit to the study area in different time or seasons using global poisoning system (GPS) surveys and digital photographs. That helped to understand the existing land use and land cover and the actual that took place in the study area from 1981 to 2011.

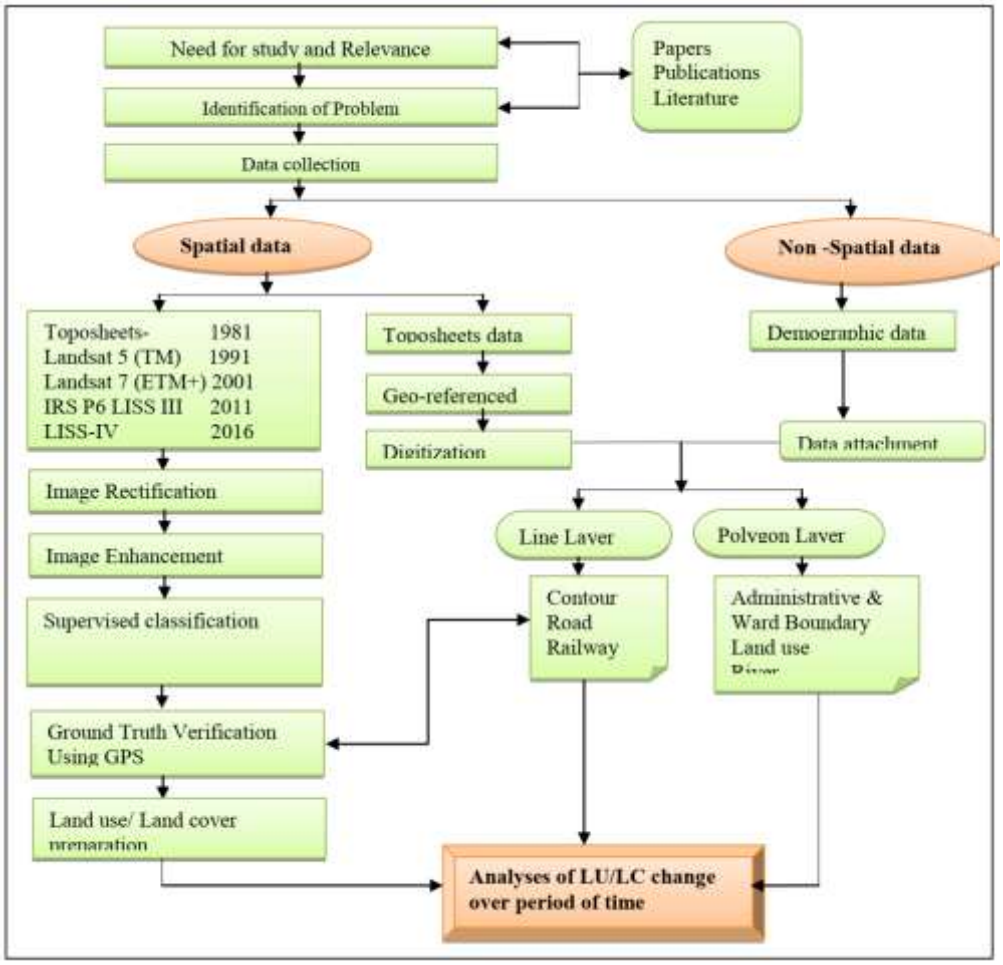

Fig-2:

Land use and land cover analysis of Nashik city:

The above discussion is mainly related to city as whole; the sum is supported by identification of direction of growth on the basis of map and images. It is also necessary to understand change in spatial pattern at micro level. This has been based on ward level analysis. The changed analysis carried out by computer techniques given in image each pixel may give us idea regarding future estimate trends.

Administrative ward wise Land Use / Land Cover of Nashik city, 1981

The land use and land cover analysis has been superimposed on SOI Toposheets of ward level. It has surveyed of collecting land use data for six different uses of land. The quantitative data has generated have been in the table-2 and graphical represent in figure-4.

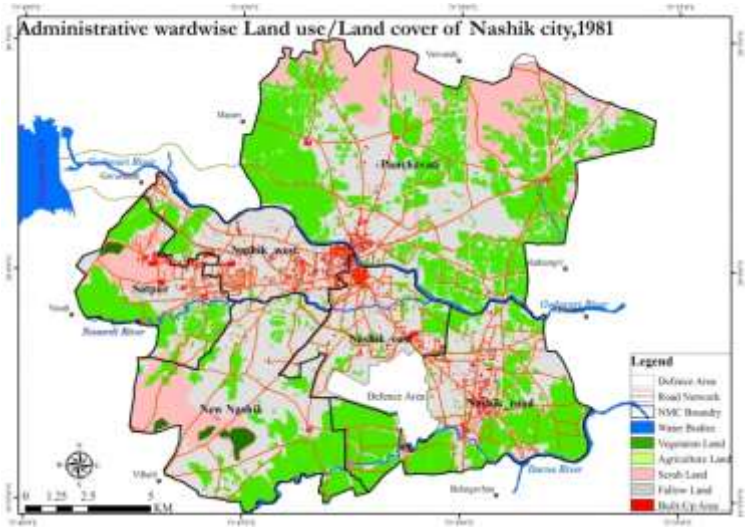

Fig-4: Administrative ward wise Land Use / Land Cover map, 1981

During 1981 the Nashik city administrative ward wise land use for various types of land use like as Built-up area, agricultural land, vegetation, Fallow land, Scrub land and water bodies etc. have been given here on the basis of micro level analysis most of fallow land in Nashik road 14.14 sq. km, Panchavati (33.89 sq. km) and new Nashik have same (20.48 sq. km). Vegetation has acquired in Panchavati (3.6 sqkm), Nashik road and New Nashik (3.3sq. km). Most of the built-up area mainly observed Nashik East and Nashik West and Nashik Road ward. Less built up area was observed in New Nashik and Satpur area. High proportion of scrub land has observed in Panchavati and Nashik road area. Less proportion of scrub land availability was in Satpur and Nashik-west area. In all the ward, water bodies proportion was less than 1% but comparatively higher in Panchavati (0.98%) and Nashik Road (0.99%) ward. The major river Godavari and its tributaries are flowing areas the ward respectively.

Administrative ward Wise Land Use / Land Cover of Nashik city, 1991

The LU/LC has been derived from Landsat TM satellite data. In 1991 total built-up area has been increased but all class constantly decreased.

The above data (Figure-5) represented administrative ward wise status of land use and land cover of Nashik city. Agricultural land was more available in the Nashik Road area and less availability in the Nashik east area. Fallow land was more in new Nashik area and less in Nashik West wards. Lastly Scrub land had less availability in the Nashik west area and more Scrub land is Panchavati area.

Built-up area was more in new Nashik (3.80 sq. km) followed by Nashik west, Nashik east mainly 3.38 sq. km, 3.28 sq. km. Less of built up area in Satpur area (2.11sq. km). Agricultural land is another type of land use. It was covered mainly most of the Nashik road (11.93sq. km) followed by Panchavati (24.1sq km), Nashik-east (8.01sq. km) lowest in the area in Satpur area it is 5.22 sq. km due these areas in an industry.

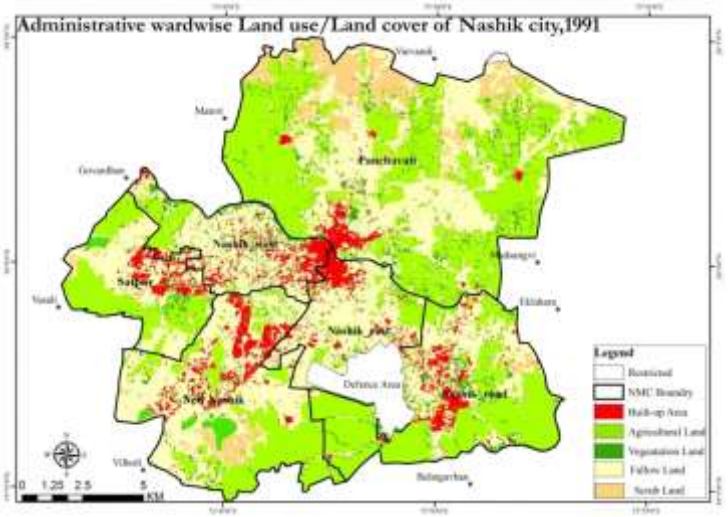

Fig-5: Administrative ward wise Land Use / Land Cover map, 1991

Administrative ward wise Land Use / Land Cover of Nashik city, 2001

The LU/LC has been derived from Landsat ETM+ satellite data. In 2001 total built-up area has been increased but all class constantly decreased.

For year 2001, administrative ward based land use and land cover analysis (Figure-6) of Nashik city. Administrative wise was classified by the six classes likes as Built-up area, vegetation, Fallow land, Scrub land, water bodies etc. In built-up area occupied more in the new Nashik area followed by Nashik east, Nashik road. The comparatively less built-up area was covered in Satpur and Panchavati area. The more availability of agricultural land was in the Nashik road area (10.93sq. km) and less in Satpur area (5.1sq. km) and fallow land was more in Panchavati (27.15 sq. km) and less in Nashik west (2.11sq. km) and Scrub land was more the Panchavati area and was less in Satpur area was (6.21 sq. km).

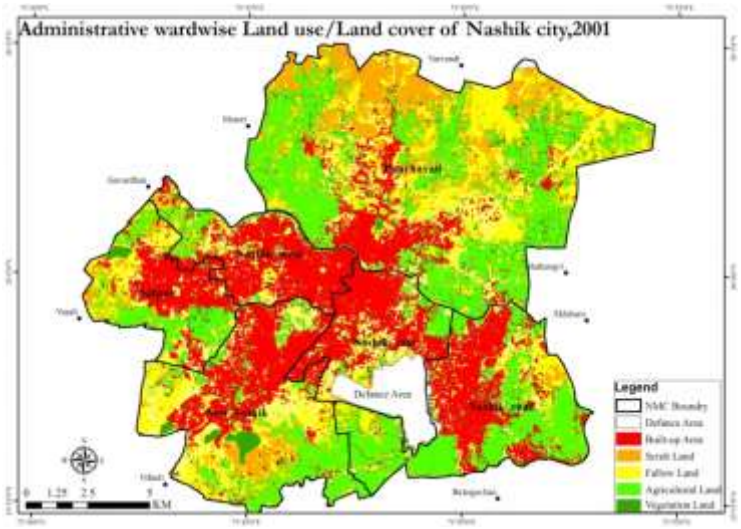

Fig-6: Administrative ward wise Land Use / Land Cover map, 2001

The administrative ward wise land use/land cover analysis of the Nashik city was carried out for (Figure-7) year 2011. To understand the decadal changes in the six categories. The LU/LC status of the cautions covered Built-up (98.63sq. km), agricultural land (47.29sq. km), vegetation (12.27sq. km), Fallow land (30.56 sq. km), Scrubland (67.25sq. km) and water bodies (3.10sq. km). The built up area was more in Panchavati administrative ward and area was 23.71sq.km. The less built-up area was in Satpur area (10.23 sq. km) and vegetation was more in the Nashik road area being 3.01 sq. km and less was 1.07sq.km in Satpur area.

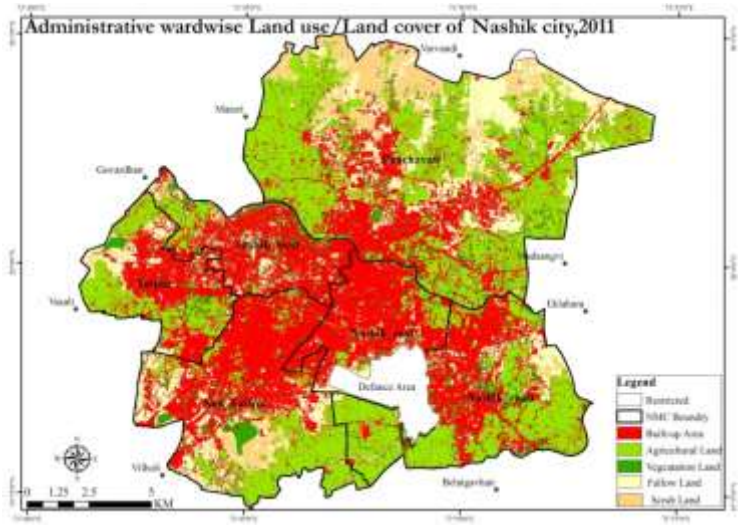

Fig-7: Administrative ward wise Land Use / Land Cover map, 2011

Administrative ward wise Land Use / Land Cover of Nashik city, 2016

The administrative ward wise land use/land cover analysis of the Nashik city was carried out for (Figure-7) year 2016. To understand the decadal changes in the six categories. The LU/LC status of the cautions covered Built-up (104.84sq. km), agricultural land (46.29sq. km), vegetation (11.27sq. km), Fallow land (27.01 sq. km), Scrubland (67.25sq. km) and water bodies (3.10sq. km). The built up area was more in Panchavati administrative ward and area was 25.77sq.km. The less built-up area was in Satpur area (11.27 sq. km) and vegetation was more in the Nashik road area being 2.25 sq. km and less was 1.05sq.km in Satpur area.

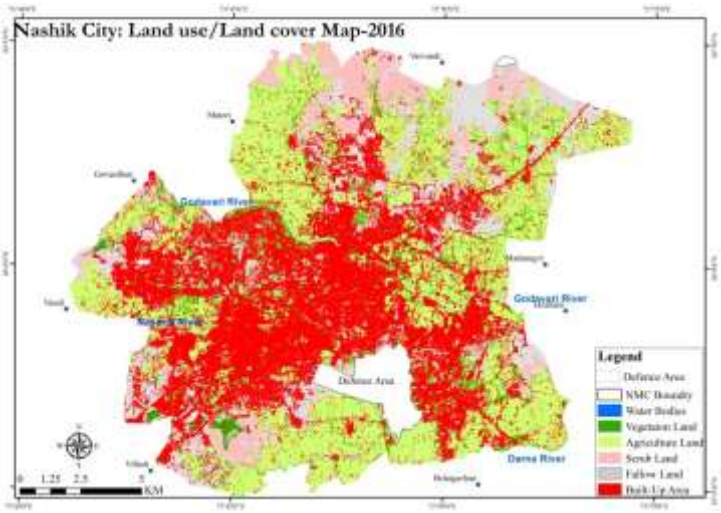

Fig-7: Administrative ward wise Land Use / Land Cover map, 2016

CONCLUSION

The change in land use land cover patterns over the period from 1981-2017(Figure-3). The land use and land cover classification has been worked out using satellite imagery with the help of supervised and unsupervised classification algorithm for the Nashik city. The imagery has shown that the six thematic classes have built-up area about 40.36%, agricultural land, 17.82%, vegetation cover, 4.34%, fallow land, 10.40%, scrub land, 25.89%, water bodies 1.20%. These land use land cover classes are similar to the standard urban land (built-up) in 2017. There is a decrease in the agricultural land, vegetation land, fallow land, and scrub land and water bodies over the periods more in Panchavati area and less Scrub land was a Nashik west area. The major findings of change detection analysis revealed that maximum change in the land use and land cover from 1981 to 2011 has been seen in case of the built-up area, which has changed from 2.89% to 40.36%. The major expansion of the built-up area is mainly along the highways and outskirts. Agricultural land has been decreased from 24.86% in 1981 and 17.82% in the last 35 years. This is due to converting of agricultural land into built-up area. The negative impact was observed on area under water bodies, vegetation cover, scrub land and fallow land. Vegetation cover has been decreased from 6.55% to 4.34%, scrub land from 29.37% to 25.89% and fallow land from 34.77% to 10.40% over the period of 1981 to 2016.

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