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DYNAMICS OF LAND USE AND LAND COVER CHANGE OF KAVATHE MAHANKAL TEHSIL OF SANGLI DISTRICT, 2001 TO 2021

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Abstract

Today, land use and land cover change have become crucial components of environmental monitoring and management strategies. A land cover mapping and monitoring was performed in the study area, namely the Kavathe Mahankal Tehsil of Sangli district, Understanding the causes and consequences of overexploitation of soil and water resources is necessary to maintain the current natural resources. For this study, LU/LC supervised classification was carried out using satellite images taken between March 2001 and March 2021. LULC classes were divided into five for the purpose of classification. The accuracy assessment is based on the classification error matrix and the KAPPA analysis. The land use and land cover classes were compared to detect changes between images. The largest land cover category was agricultural land, with 594.83 km2 in March, 2001 and 640.40 km2 in March, 2021.Vegetation is the second most extensive land cover category, covering 114.24 km2 in 2001 and 63.76 km2 in 2021. In the study, there were significant changes in all categories except for agriculture, vegetation cover, fallow land, and water bodies. A significant differential growth can be seen from the Built-up area, which increased from 0.128% in 2001 to 3.337% in 2021. Based on the classification methodology, the accuracy of the images of 2001 and 2021 is 81.24% and 78.96%, respectively, and Kappa statistics are 0.78 and 0.76, respectively.

Keywords: *Land Use and Land Cover Pattern, Kavathe Mahankal Tehsil, Remote Sensing and GIS*

Introduction

Land use and land cover refer to the way in which land is used or the physical characteristics of the land. Land use can include activities such as agriculture, urban development, and forestry, while land cover refers to the physical features of the land, such as vegetation, water bodies, and built-up areas. The dynamics of land use and land cover can be influenced by various factors, including population growth, economic development, technological advances, and environmental changes. For example, population

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growth may lead to an increase in urban development, while technological advances in agriculture may allow for more efficient land use for food production.

Climate change may also affect land use and land cover dynamics by altering the suitability of certain areas for certain activities or by causing natural disasters that result in land cover changes. It is important to understand the dynamics of land use and land cover because they can have significant impacts on the environment and on the people who depend on the land. Land use and land cover changes can affect the availability of natural resources, such as water and timber, and can also contribute to environmental problems such as habitat destruction and climate change. Some common land use patterns include Agricultural land, Built-up land, and other residential purposes. On the other hand, an area with a mix of agricultural, residential, and recreational land may have a more balanced and sustainable development pattern. The study of land use and land cover was the fundamental milieu of earth systems science for the understanding of the earth's surface dynamics ever since the existence of human beings (Li and Zhang, 2013). The difference between land use and land cover can be explained by looking at anthropogenic activities relating directly to land (Jansen and Gregorio, 2002). The purpose of land use and land cover is to evaluate the effects of environmental change on resources and social, economic, and cultural development (Mendiratta et al., 2008). Land use and land cover studies were conducted in different areas of interest for the purpose of analyzing land use change, monitoring urban sprawl, managing agricultural lands in watersheds, and planning urban landscapes (Hegazy and Kaloop, 2015). Various land use and land cover classification schemes have been described based on the different purposes of the studies. However, precise methods of classification are still difficult to determine. Earth observation datasets have a more fine-grained application and can handle more information regarding the classification of land use and land cover. There are two methods for classifying land use and land cover: automatic digital classification and manual vector-based visual classification; however, visual interpretation provides better results in urban areas, reducing errors associated with digital classification (Dutta, 2012). As part of the land use and land cover classification, remote sensing and reference datasets have been used, which must meet the following criteria (Review of literature and practical experience and National Remote Sensing Agency, 2008). By using remote sensing datasets in a variety of resolutions and temporal frequencies, land use and land cover can be classified over large areas. Ideally, all land use categories should be directly linked to man's activity and natural cover on the land surface in order to obtain optimal land use and land cover classification. It is important to maintain uniform classification accuracy across all categories of land use. Quality assurance and ground truthing surveys, as well as other referenced datasets, are important for assessing data accuracy. Both past and future datasets should be able to be comparable. In this study, using the guidelines of the National Urban Information Scheme (NUIS, 2006) and field-based practical experience, the land use and land covers of KTM have been mapped using visual interpretation techniques on remote sensing imageries accompanied by other ancillary datasets. As a result of urbanization and socioeconomic and environmental changes, the 21st century has been characterized by rapid urbanization. To analyze the land

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use change pattern and town planning in Kavathe Mahankal Tehsil for the past twenty years (2001-2021), land use and land cover mapping have been conducted for the past twenty years. The KMT has experienced rapid urbanization and haphazard development over the past twenty years. A major contribution of this study is its use of advanced geospatial datasets, tools, and techniques to classify the land use and land cover of the rapidly growing Kavathe Mahankal Tehsil. The current study aimed to monitor land use and land cover in Kavathe Mahankal Tehsil, Maharashtra; overexploitation of soil and water must be understood and minimized to maintain current natural resources.

Review of Literature:

K.C. Ramotra at.al. (2012) studied the trends, rate and the magnitude of changes in land use /land cover of Miraj tehsil. D.G. Gatade at. al. (2012), studied crop combination region, and used Rafiulhas technique, which is known as Maximum positive deviation method for the identification of the crop combinations. Sandip Patil at.al. (2019), worked on LULC change in Navi Mumbai. They have used a combine classification method known as the hybrid classification is used for the analysis of this work ArcGIS and ERDAS software used. Images are classified in five different classes' i.e. forest land, Agricultural land, built-up area, open land and water body etc. K.C. Ramotra (2012), the land use and land cover condition are studied with the help of statistical database and five year average analysis method. The proportion of net sown area becomes very less than other periods and its main reason was the drought. N.S. Ratnaparkhi at. al. (2013), studied the land cover of the study area using the classification of images. To analyze land cover classification, digital images are pre-processed and processed. The purpose of this study is to analyze land cover in Parbhani city using remote sensing and GIS techniques. Md Masroor at. al. (2022). To maintain long-term climate sustainability in the study region, it is essential to study the influence of land use and land cover on metrological variables. Amol Kadam at. al (2021), studied land use and land cover analysis in Pune city. According to this study the water bodies and green space have marginally increased in the last two decades whereas barren land and other areas have marginally decreased. The main reason for this changes are natural pollution growth and in-migration due to the development of the IT sector.

Study Region

The Kavathe Mahankal is an important tehsil in Sangli district of Maharashtra. It lies between 16°89' to 17°20' North latitudes and 74°73' to 75°07' East longitudes. The total geographical area of the tehsil is 743.32 sq. km. (74332 hectors) and 633 meter above the MSL. The study region is a part of Deccan Plateau. The plateau is moderately to highly dissected, with weathered thickness. The major part of KMT covered with plateau moderately dissected weathering, few residual hills located in northern boundary of the KMT.

Fig.: 01. Location Map of Study Area

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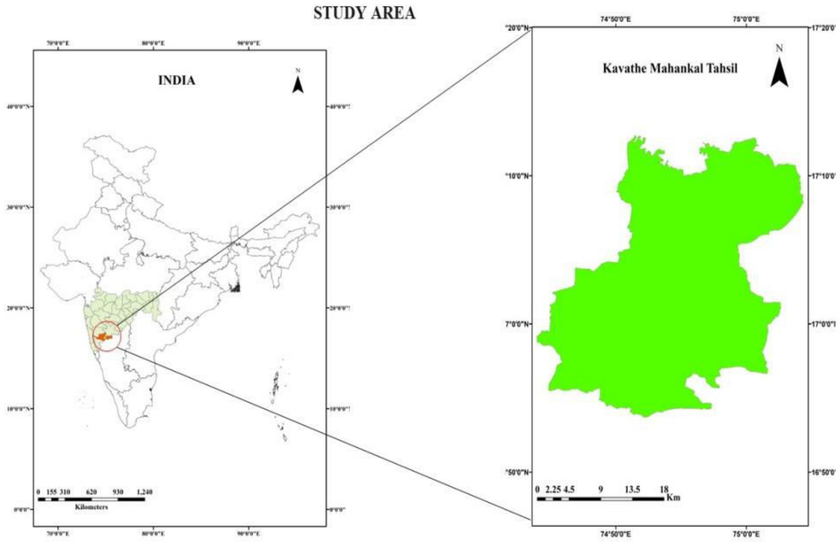
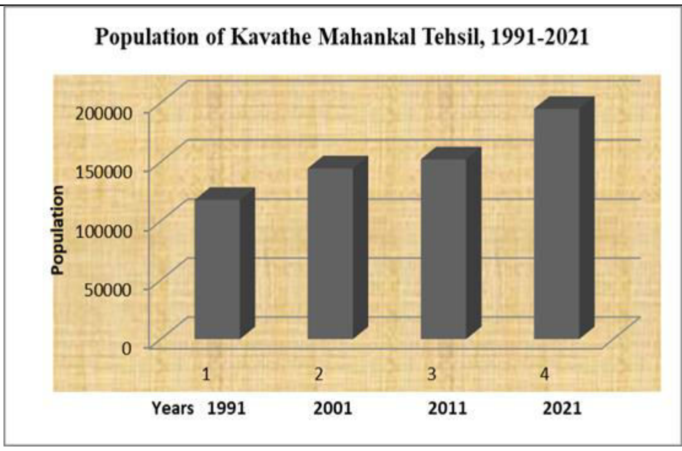


Source: Prepared by Author, 2021

Kavathe Mahankal tehsil has monsoon type climate. The winter season is of medium temperature and summer season is mostly hot and dry. The temperature decrease to 14.9 C in winter season, while the temperature increases to around 38 C in summer season. The annual temperature of the tehsil is 26°C and the annual average rainfall of the tehsil is 500 mm. The people here have made progress in agriculture. The people cultivated different agricultural crops. Viz. sugarcane, grapes, vegetables, wheat, maize, jawar, Bajara, banana, chikku, guava and different pulses. It is located about 45 k.m. away from district headquarter of Sangli. As per the Census, 2011, it has a population of 152327 with 32275 households in 60 villages of tehsil. The Census recorded the population 117901 in 1991, 144596 in 2001, 152327 in 2011, and Approximately 194,979 people with 77,615 men and 74,712 women live in Kavathe Mahankal Tehsil in 2021(Populationmeter, 2021). There are 106,129 literate people, out of which 59,114 are men and 47,015 are women.

Table: - 01. and Fig.:- 02. Population of Kavathe Mahankal Tehsil, Sangli District, Maharashtra

Sl No.	Year	Population
1	1991	1,17,901
2	2001	1,44,596
3	2011	1,52,327
4	2021	1,94,979



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Source: Census of India from 1991 to 2011 and Projected Population of KMT (Worldpopulationmeter, 2021)

Objectives

1. To Study the change dynamics of LULC of Kavathe Mahankal Tehsil of Sangli district.
2. To Map the land use and land cover pattern of the Kavathe Mahankal Tehsil for the year 2001 to 2021

Data and Methodology

This study primarily uses two types of data. These include topographic maps and remote sensing data. Toposheet and remote sensing data were georeferenced and merged in the digital mode, obtained from the USGS Earth Explorer and Survey of India.

The land use mapping of KMT was primarily based on remote sensing datasets. ArcGIS and ERDAS Imagine have been used to preprocess this satellite data set, including Georeferencing, image enhancement, mosaicking, histogram matching, atmospheric correction sub-setting, resampling, etc. In both the March 2001 image and the March 2021 pre-monsoon images chosen for identifying suitable growth of KMT. In order to identify objects during visual interpretation, these preprocessing tasks enhanced the interoperability of satellite imageries. In the land use and land cover classification up to Level-I, most of the features at the spectral and spatial levels have been correctly identified and demarcated using remote sensing datasets. Images were used to identify and classify actual vegetation lands in the study area. In order to analyze the dynamics of land use and land cover classification in urban areas, remote sensing and satellite imagery are used. According to different land uses and land cover types, there are various methods used to classify land use and land cover. Imagery derived from satellites and multispectral sensors with low resolution available for free. Landsat-7 ETM+ and Landsat-8 OLI Earth Explorer.

Table: 02. Landsat-7 & 8 Imagery Band properties

Sl No	Source	Imagery	Sensor	Spectral Resolution	Band combination
1	USGS, Earth Explorer	Landsat-7 2001	Enhanced Thematic MapperPlus (ETM+)	30 meter	Band 1 Blue (0.45 - 0.52 µm) 30 m Band 2 Green (0.52 - 0.60 µm) 30 m Band 3 Red (0.63 - 0.69 µm) 30 m Band 4 Near-Infrared. (0.77 - 0.90 µm) 30 m Band 5 Short-wave Infrared..(1.55 - 1.75 µm) 30 m Band 6 Thermal (10.40 - 12.50 µm) 60 m Low Gain / High Gain Band 7 Mid-Infrared (2.08 - 2.35 µm) 30 m Band 8 Panchromatic (PAN) (0.52 - 0.90 µm) 15 m
2	USGS, Earth Explorer	Landsat-8 2021	Operational Land Imager (OLI)	30 meter	Band 1 Coastal/Aerosol (0.43 - 0.45 µm) 30 m Band 2 Blue (0.45 - 0.51 µm) 30 m

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					Band 3 Green (0.53 - 0.59 µm) 30 m Band 4 Red (0.64 – 0.67 µm) 30 m Band 5 NIR (0.85 – 0.88 µm) 30 m Band 6 SWIR 1 (1.57 -1.65 µm) 30 m Band 7 SWIR 2 (2.11 – 2.29 µm) 30 m Band 8 Pan (0.50 – 0.68 µm) 15 m Band 9 Cirrus (1.36 – 1.38 µm) 30 m Band 10 TIRS 1 (10.6 – 11.19 µm) 100m Band 11 TIRS 2 (11.5 – 12.51 µm) 100m

Source: USGS, Earth Explorer

Published sources and field surveys have provided the referenced datasets. At level-I editing, this data is useful for image rectification, functional mapping, and validation of previously classified remote sensing data. Data from remote sensing were used to classify the level-I land use maps of 2001 and 2021 in this study. In addition, medium-scale and large-scale referenced datasets have been used to assess the overall accuracy of classified land use maps.

Fig.: 03. Flow chart of Methodology for land use/land covers and change detection.

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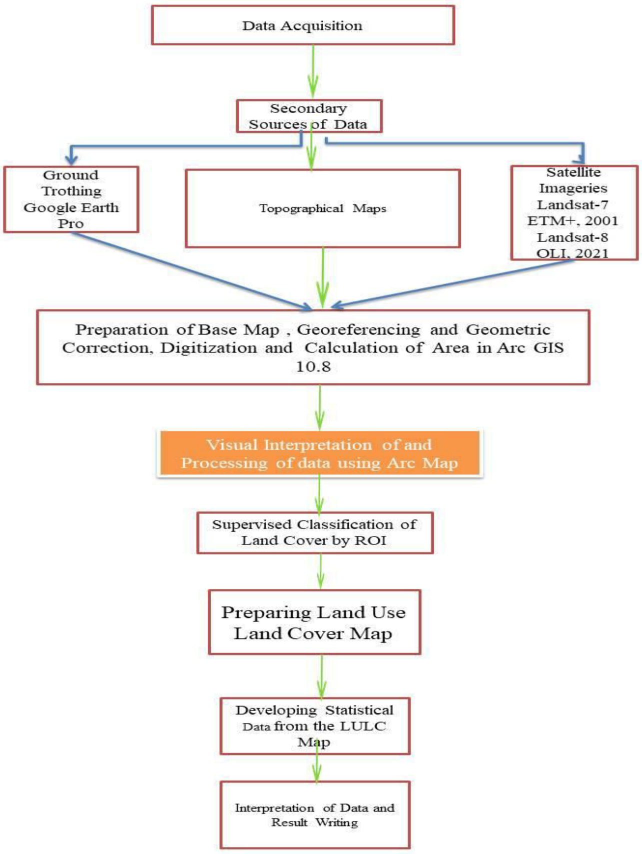
Research Methodology



Source: Prepared by Author, 2021

Result and Discussion

The extent of land cover categories in the KMT covering an area of 743.32 square kilometers divided into 60 villages. As of the 1991 census, the population was 1,17,901, which nearly doubled in 2021 to 1,94,979. Through object based supervised classification represented 80.16% and 86.09% of the District's land cover respectively. Due to the existence of a good canal system, the growth rate has differed between decades in this class.

Table: 03. Land Use Land Cover Change detection report of KMT

Sl No.	LU/LC Class	2001		2021	
		Area in km^2	Area in (%)	Area in km^2	Area in (%)
1	Agriculture Land	594.83	80.016	640.409	86.090
2	Built-up Land	0.957	0.128	24.828	3.337
3	Vegetation	114.246	15.368	63.760	8.571
4	Fallow Land	17.495	2.353	8.00	1.075
5	Water Bodies	15.851	2.132	6.889	0.926

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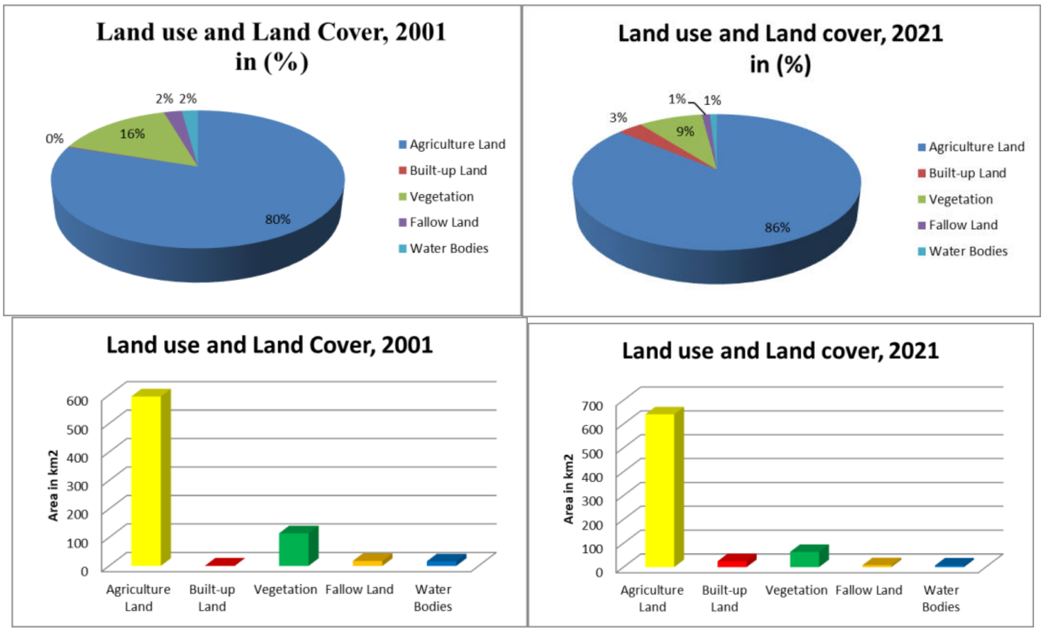
	Total	**743.382**	**100**	**743.382**	**100**

Source: Statistics generated by author

Fig.: 04. Pie Diagram no. 1 and 2, and Column no. 1 and 2 showing Land use and land cover of KMT



Source: Prepared by author in Excel

According to the Table number 03, vegetation cover in the KMT specifically exhibits greater variation than the second most extensive land cover category. Based on the March 2001 image, vegetation covered 114.246 square kilometers, i.e. (15.36%), but in the March 2021 image, forest coverage was reduced to 63.76 square km (8.57%) because of the growth in built-up land and agricultural land. The third most extensive land cover is fallow lands, which cover about 17.49 sq km (2.35%) in March 2001 and 8.0 sq. km (1.075 %) in march 2021. This figure clearly shows that there is a significant difference between the two decades. According to Table, the water bodies covered 15.851 km2 (2.13%) in 2001 and 6.89 km2 (0.93%) in 2021. Built-up Land is the most dynamic land use/land cover class classified by object-based supervised classification. A built-up land is a land covered by buildings, transportation networks, and other facilities that are used by humans. This includes human settlement and all land used by humans for their purposes. In 2001, Built-up Land covered approximately 0.957 km2, which is 0.128% of the total KMT area, whereas it accounted for 24.82 km2 (3.337%) in March, 2021.

Fig.: 05. Land Use Land Cover Map of KMT, 2001

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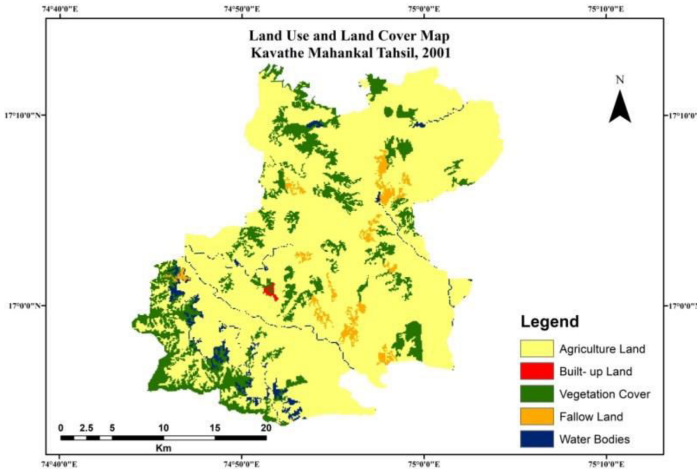
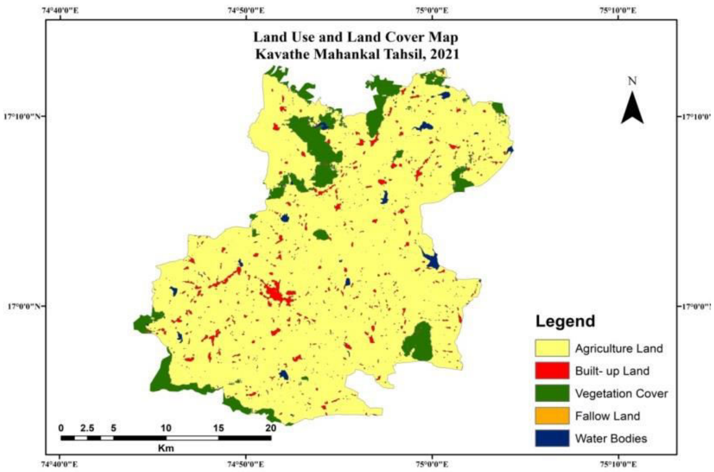


Source: Prepared by author in Arc Map

Fig.: 06. Land Use Land Cover Map of KMT, 2021



Source: Prepared by author in Arc Map

Land Use/ Land Cover Changes and Accuracy Assessment of KMT

According to Table - 4, the classification methodology performs quite well, with an overall accuracy of 78.96 % and 81.24 %, as well as a Kappa statistic of 0.78 and 0.76 one-to-one, for the March 2001 and March 2021 images. In table, both accuracy assessments indicate average Kappa near to value 1. This means the true (i.e. observed value) agreement approaches 1 and the chance of agreement approaches 0. As per the processed result of producer and user accuracy, the class in March has the best classification accuracy.

Table: 04. Accuracy assessment results of the LULC classification, 2011 and 2021

	Year	Overall Accuracy	Kappa Coefficient
1	2001	81.24	0.78
2	2021	78.96%	0.76

Source: Generated by author

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Conclusion

This paper uses remote sensing data and GIS technology to analyze LU/LC changes in KMT, Maharashtra, India. According to our findings, LU/LC changed significantly between 2001 and 2021. Built-up areas are expanding significantly. However, agricultural, water bodies spread, and vegetation cover areas are decreasing. From this study, it is evident that population growth and development activities have a significant impact on LU/LC change. Accurately identifying agricultural land, vegetation cover, fallow lands, and water bodies. Using these land use cover maps and ground information will help to develop plans for the study region. Urbanization and socioeconomic development need to be planned and managed. It can be useful for environmental management groups, policymakers, and local people.

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