

## DEMOGRAPHIC AND MORPHOLOGICAL CHANGES IN KOLKATA, INDIA DURING 1951-2014

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### Abstract

Kolkata, one of the oldest cities in India has been the destination for migrants. The influx of population over the time caused demographic and morphological vicissitudes. Hence, the present study aims to analyse the changes in demographic structure, city sprawl, and spatiotemporal changes in land use of Kolkata city during 1951 to 2014. Population data are taken from the Census of India and spatial data from the Landsat satellite image. The geographical area of the city has expanded by more than two folds during 1951-1991. Significant alteration in age-sex structure is noticeable; sex ratio improved from mere 593 to 908, the urban settlement has sprawled from mere 23% to 63% of the city area, whereas the greenery has dwindled to just 2.8%. The most substantial impact of urban sprawl is seen on agricultural/fallow land.

**Keywords:** *Spatio-temporal change; urban-sprawl; remote sensing; urbanisation; Kolkata*

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### 1. INTRODUCTION

The growth of urban centres is a multidimensional phenomenon, involving spatial morphological and population changes. Managing this growth has been a very complex phenomena and a big challenge of this century (Cohen, 2004; Sakieh et al., 2017). The cities and urban settlements have been the centres of population and focus was needed because of their pivotal functions. As the mega cities provide employment opportunities in various sectors, they attract people from various parts of the country as well as abroad (Kumar, 2015). The urbanisation is a components in the development of human societies (Dadras et al., 2015). The urban development is a complex and dynamic process. The emergence of the new world is dominated by cities and urban values (Mondal et al., 2017; Arsanjani et al., 2013). One can trace urban growth from the spatial and demographic process. The urban space is the

concentration of population within an urban economy (Castle & Crooks, 2006; Dahal et al., 2018; Al-sharif & Pradhan, 2016; Metzger et al., 2016). Urbanisation is a spatial and social process which refers to the changes of behaviour and social relationships that occur in social dimensions as a result of people living in towns and cities (Jat et al., 2008; Velmurugan & Sajjad, 2009; Abbas, 2016; Nourqolipour et al., 2016). Rapid urbanization was measured on the scale of development of suburban expansion and urban sprawl (Harris & Ventura, 1995; Sajjad, 2014). Primarily, it relates to the complex change in lifestyles which follows from the impact of cities on society (Abbas, 2016; Soja, 2013; Bhatta et al., 2010). During the past twenty decades, we have been witnessing the expansion of large cities and the growth of the space under their spatial influence (Kumar & Rai, 2014). The most of the cases were due to the changes in functional structures over time in the rural areas and the corresponding pattern change in the life of residents, resulting in the formation of new urban areas (Clark, 1982; Iqbal et al., 2012; Thapa & Murayama, 2011).

Urban growth at the global scale shows no sign of slowing and is a phenomenon even in nations where population growth has stabilised (Clarke et al., 1997). In India, the process of urbanisation began to accelerate after independence due to the partition of nation, mixed economy and rapid growth in the private sector (Sahana et al., 2018; Bhatta, 2009; Mukherjee, 2012; Kumar & Rai, 2014). The level of urbanisation rapidly increased in the recent years. According to census of India, 2011, at the state level, the urbanisation is very diverse due to the economic advantages, like southern states Tamil Nadu, Kerala and including Maharashtra, Gujarat, Punjab, Haryana and West Bengal have higher level of urbanisation than that of the national average (Census of India, 2011). In West Bengal, a large number of new towns have emerged due to the rural-urban classification in 2011 (Sahana et al., 2018; Census of India, 2011; KMDA, 2011).

The port city of West Bengal, Kolkata's urban growth and land use pattern is a sign of colonial legacy (Banerjee, 2005). The National Atlas Thematic Mapping Organisation (NATMO) has been divided the growth of Kolkata city into three-time phases as before 1793, 1793 to 1856 and after 1856 (NATMO, 2010). Later on, many changes also occurred during the independence after the division of India into two nations: India and Pakistan. After the division, the jute raw material producing regions became the part of East Pakistan while the industries remained in Kolkata region of West Bengal. Before the partition, Bengal, especially Kolkata region were very well known for the jute industries (Wright, 2011). These industries needed a specific age-sex population to work in them. As such, vast numbers of migration took place that has altered the demographic structure of the city into a different and distinct one. This demographic demand has also affected the dwelling arrangement and other daily based economic activity requirements (Bhatta, 2010; Bhatta et al., 2010). The industrial development thus shaped the morphological structure of the Kolkata city was responsible for the urban growth and much rapid urbanisation of its catchment area, especially the rural-urban fringe (UD & MAD Commissioner, 2016; Kumar & Rai, 2014; Sahana et al., 2018). As such, this study deals with the trend of urban growth and demographic change.

## **2. NEED FOR THE STUDY**

Kolkata is one of the commercial cities of India located in West Bengal. The distinct characteristics of the population and urban morphology of Kolkata have changed over the time concerning its pull forces, and the power of population inflow for fulfilling their social, economic and dwelling needs. During the making of Bangladesh as an independent country from East Pakistan, there was influx of refugees. After the creation of Bangladesh, there has been inflow of legal as well as illegal immigration of Bangladeshi people to Kolkata, creating a lot of pressure on the city amenities. Also with the improvement in transport network, a large

number of population commute daily or on a regular basis to the city for diverse purposes (Dey, 2012). Such chunk of population also uses the urban services. As such, the Kolkata city has gone through economic crisis, unemployment, traffic congestion, the housing problem, urban heat islands, increasing air pollution, drinking water supply shortage, drainage problem, etc. overall, the Kolkata city morphology is the outcome of the influence of urban function as well as the changes of demography and socio-economic status of the city dwellers. So, the city like Kolkata has many fold challenges to sustain all the urban services for its people. Hence, there is a need to revisit an older format of any urban region to understand the current need suiting the population and economy. There is also a need to assess the changes in urban resident population and its characteristics, along with its changes in land uses. Therefore, the aim of the study is to analyse the changes in demographic characteristics, city sprawl and spatiotemporal changes in land use in Kolkata city during 1951 to 2014.

### **3. METHODS AND MATERIALS**

#### **3.1 Study Area**

The study area is located in the eastern part of India. The city comprises of 141 wards as Kolkata Municipal Corporation (KMC) and also forms Kolkata District. The city with a life of more than 300 years by now is one of the oldest cities of the country. It was the capital of India during the British India until 28th December 1911 (Wright, 2011; Bhatta et al., 2010), after that the capital was shifted to Delhi. The administrative area of Kolkata is a combination of several government agencies, and it consists of overlapping structural divisions. According to the Census of India 2011, the Kolkata city's total population is about 4.5 million, out of which 2.4 million are males and 2.1 million are females, as such the sex ratio is 908 female per 1000 male which is much lower than the national average of 940 (Census of India, 2011). Among the total population, about 1.5 million are the slum population that accounts for 32.40 percent of the total population of the city.

#### **3.2 Data Sources**

In the present study, data are taken from multiple sources to fulfil its set objectives. The population data are collected from the socio-cultural tables from Census of India 2011 (Census of India 2011). The topographical maps have been collected from the University of Texas at Austin, University of Texas Libraries: India and Pakistan Toposheet. For the study purpose the Calcutta Toposheet (Refer to this map as NF 45-7 series U502) of 1:25000 scale has been used. For the urban morphological growth analysis, Satellite Images have been used and all satellite images are downloaded from the United States Geological Survey (USGS). In this study, Landsat-MSS image (path 148, row 44) on 18 October 1972, Landsat-TM image (path 138, row 44) on 24 March 1992, Landsat OLI-8 images (path 138, row 44) on 22 April 2014 have been used for the urban expansion analysis.

#### **3.3 Methods**

Census data is used for the population density, sex ratio and age sex structure of the study area from 1951 to 2011. The analysis has been done to understand the population changes during the study period. The remote sensing and geographic information system (GIS) becomes the tools to lay modelling for urban growth analysis and its predication worldwide (Toll 1985; Gomasasca et al. 1993; Stewart & Wegener 2000; Landis & Zhang 2000; Donnay et al. 2001;

Paez & Scott 2005; Herold et al. 2005; Taubenbock et al. 2009;; Al-shalabi et al. 2013; Sahana et al. 2018). Also, GIS through maps brings us one step closer to visualizing the complex patterns and relationships that characterize real-world planning and policy problems (Tamilenth & Baskaran 2013). Therefore, the geospatial analysis has been carried out with the help of ARC GIS (10.2) and ERDAS (2014) Software to assess the Spatio-temporal changes. The satellite data has been used in the subsequent processing including layer stake, geo-referencing and supervised classification. Three satellite images are classified, and supervised classification method has been used for the land use land cover and urban growth analysis by the help of ERDAS image (2014) software.

## 4. ANALYSIS

### 4.1 Trends and pattern of population change in Kolkata city

Table 1 shows the trends of population growth and spatial expansion of Kolkata city from 1951 to 2011. As such, the result exhibits the geographical expansion and demographic changes over two different time periods. It is evident that the geographical area of the city has expanded by more than two folds over a span of just four decades in the last century (during 1951-1991). However, no further expansion of city area is observed from 1991 till 2011. Since 1951, the total population has been growing till 2001, but there is a marginal decline after that. There is improvement in sex ratio throughout the study period. In 1951, it was extremely truncated in favour of male (593 females per 1000 male), but by 2011, it has come to considerably good position. Overall, there is notable change in sex ratio over the study period.

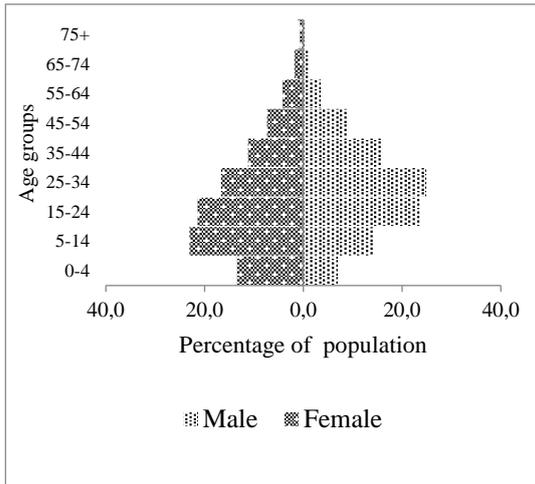
**Table 1:** Demographic profile, geographical area and statutory status of Kolkata city during 1951-2011

Year	Status of city	Area in Sq. Km	Population density	Total population	Sex ratio
1951	M	73.4	40,279	29,56,475	593
1971	MC	104.0	35,837	37,27,020	662
1991	MC	185.0	23,783	43,99,819	799
2011	MC	185.0	24,306	44,96,694	908

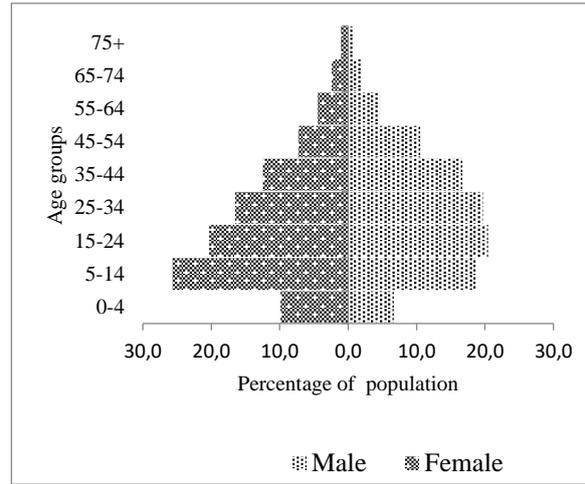
Source: Census of India  
M= Municipality; MC=Municipal Corporation

### 4.2 Age-sex structure of Kolkata city population

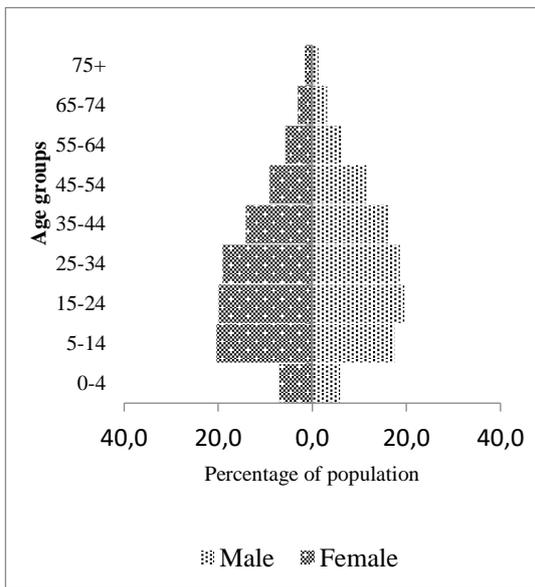
Figure 1, 2, 3 and 4 depicts the age-sex structure of Kolkata city from 1951 to 2011. The shape of graphs show that the city population has shifted from early ages to the working age population, and the age of 65+ population has also increased with time. The most significant demographic changes are recorded in the child sex-ratio over the time of six decades. In 1951, the proportion of female children were about double of their counter parts, but in 2011 the proportion has become almost same for male and female. In 1951, the working age group population was the highest compared to dependent population age groups, and the aged population was very negligible. But the recent round of census 2011 data shows a considerable proportion of aged population.



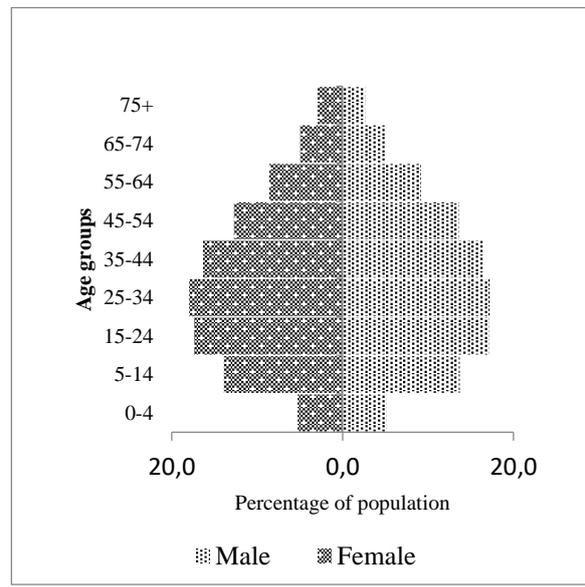
**Figure 1:** Age-sex structure of Kolkata, 1951



**Figure 2:** Age-sex structure of Kolkata city, 1971



**Figure 3:** Age-sex structure of Kolkata, 1991



**Figure 4:** Age-sex structure of Kolkata, 2011

Female population has increased over the time and in 1991 onwards the gap becomes much narrow among male and female specially in working age population. This also characterised the increasing population of women in the city either for working purposes or education or due to in-migration with husband. This city has a higher percentage of female population in the age group 0-14 years, but male population is higher compared than female population in the working age groups. The city population data showed that the older age group of 65+ populations was moving upward from 1951 to 2011. In 2011, Census data showed that working age group and old age population was increasing and child population (0-14 age) is decreasing after the 1991 census. Old age population (64+age) is rapidly increasing from mere 1.9 percent in 1951 to 7.8 percent in 2011.

**Table 2:** Percentage distribution of population in Kolkata by broad age groups

Age group	1951	1971	1991	2011
0-14	26.6	29.3	25.2	19.0
15-64	71.5	67.7	70.3	73.3
64+	1.9	2.9	4.6	7.8

Source: Census of India from 1951 to 2011

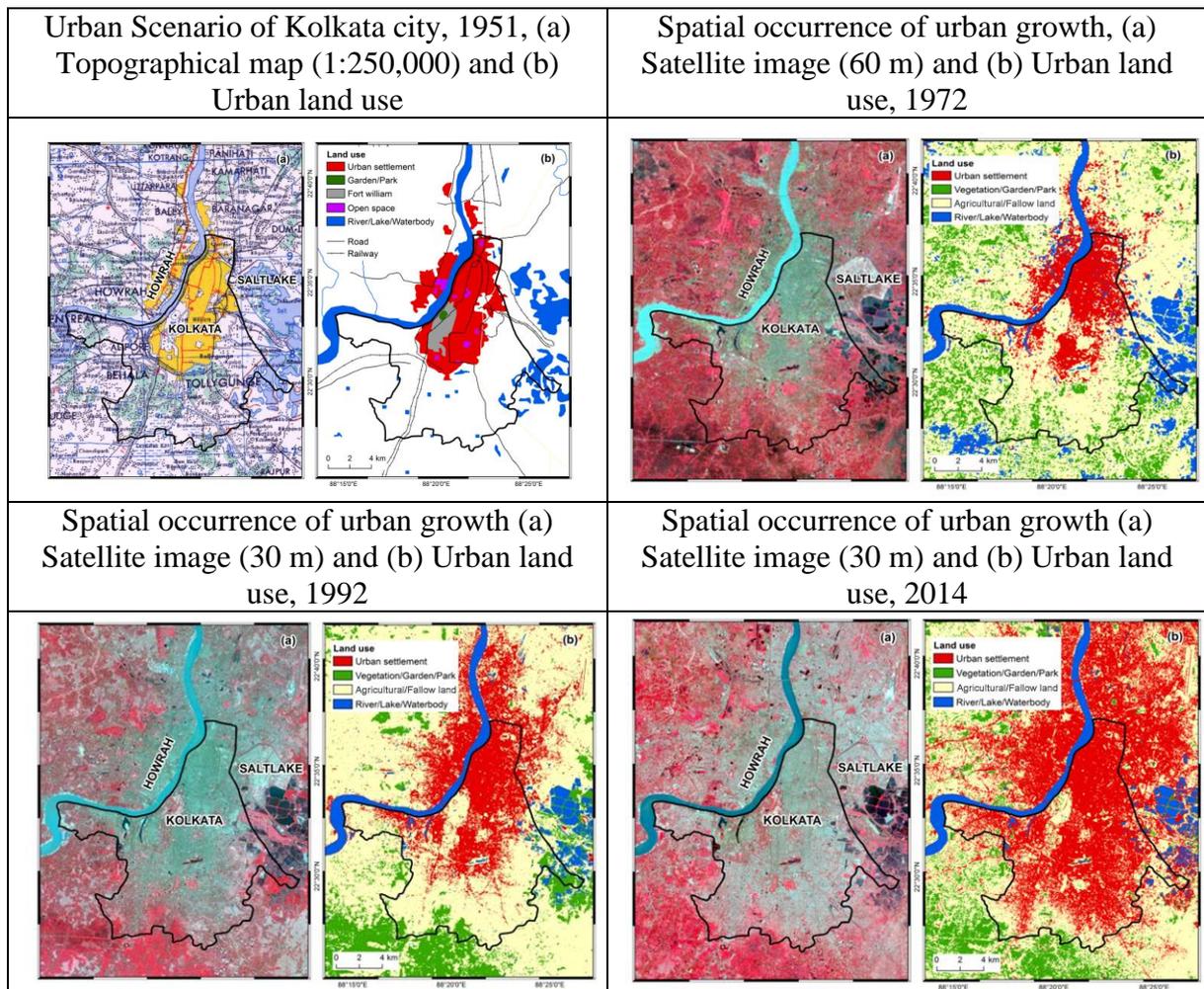
### 4.3 Spatio-Temporal Changes and Urban Growth in Kolkata City

Looking at the topographical map of 1951, the land use of Kolkata city has been classified into four major categories (table 3). First one is classified as ‘urban settlement’ which includes all the man-made structures, such as urban residential, industrial, and institutional areas, and roads, railway tracts etc. Second category includes ‘Vegetation/Garden/Park’. Third category covers ‘Agricultural/Fallow Land’. Fourth, category includes ‘River/Lake/Water Body’.

**Table 3:** Description of land use types in Kolkata

Land use type	Description
Urban Settlement	Including urban Residential, industrial and institutional areas, roads and other human-made structures.
Vegetation/Garden/Park	Including, garden, park and natural vegetation.
Agricultural/Fallow Land	Including agriculture, open space, other than built up area.
River/Lake/Water Body	Including pond, lake, reservoir and other water bodies.

Figure 5 presents topographical map of 1951, satellite image of 1972, 1992 and 2014 along with the land use classification in the corresponding years. For easy comprehension, the maps have been converted in terms of percentage of geographical area and presented in tabular form (table 4).



**Figure 5:** Urban growth scenario of Kolkata from 1951 to 2014

**Table 4:** Land use classification scheme, percentage changes of land use pattern in Kolkata

Land Use Pattern	1951	1972	1992	2014
Urban Settlement	23.06	25.1	34.7	63.0
Vegetation/Garden/Park	NA	10.1	6.0	2.8
Agricultural/Fallow Land	NA	59.6	57.4	33.4
River/lake/Water Body	7.6	5.2	1.9	0.9

In the study, the spatial expansion has been assessed by using the remote sensing data and geo-information system. It is observed that the spatial growth of Kolkata city has not followed any planning model. In the year 1951, within Kolkata city, only 23.06 % of area were covered under the urban settlement. It has increased to as high as 63.0% by the year 2014. The changes in land use pattern in Kolkata city during 1951 to 2014 is presented in table 4. It clearly indicates that there are drastic changes in the land use pattern within the study area. The percentage of urban settlement kept on increasing, causing decrease in the other land use. In 1972, the urban settlement covered about one fourth of the space, whereas by 2014 it has sprawled to about 63% of the area. In 1972, about one-tenth of the space was covered with the greenery; it has dwindled to only 2.8 percent in 2014. During the same period, the water body has decreased from 5.2 percent of the area to less than one percent. The strongest impact of urban sprawl is seen on agricultural/fallow land. The agricultural/fallow land has diminished from about 59.6 percent to 33.4 percent.

## 5. DISCUSSION

The present study captured the spatial expansion and population changes of Kolkata city during 1951 to 2014. The spatio-temporal change in the city has influenced the land use changes and the development of urban settlement (Bhatta et al. 2010). Historically, the function of the city was much better than the other cities. In the time of independence, a vast number of refugees had settled in the city, wherever the land was easily available. The people from neighbouring states and districts continue to migrate and contribute to the growth of the settlement. The external and internal factor plays a significantly important role in the growth of the city (Bhatta et al. 2010; Bhatta 2010). The city functions were a major factor, and that contributed to the growth of Kolkata city. Kolkata's urban structure has changed over the period of time. A large number of public and private organizations have occupied the urban periphery (Sahana et al. 2018). This space occupation directly and indirectly affects the land uses in the city. In 1912 Kolkata Improvement Trust (KIT) initiated programme of development in urban infrastructure of the city based on the Kolkata Improvement Act, 1911 (K. I. Act) (UD & MAD Commissioner 2016). This administrative board was a kind of integration and used for quick implementation of the various urban development projects within the city. In 1961, the Kolkata metropolitan planning organisation, the first of its kind of developmental authority was set up through a resolution of the development and planning department to develop comprehensive development plan for the metropolis of Kolkata (UD & MAD Commissioner 2016). In the late sixties, Hooghly River bridge commissioners were set up under the Hooghly River Bridge Commission Act.1969 for construction of the third bridge across the river Hooghly (UD & MAD Commissioner 2016). In 1966, Kolkata Metropolitan Water and Sanitation Authority, and again in 1970, Kolkata Metropolitan Development Authority (KMDA) was set up to carry-out the large-scale urban infrastructure development (KMDA 2011; UD & MAD Commissioner 2016). All these contributed to the morphological changes of the city, and in giving shape to the current status of the city.

## 6. CONCLUSION

The study showed that, with changes in demographic characteristics of any urban population, the land use changes come spontaneously. Over the period of time, the first urban region of India (that is Kolkata) has changed dramatically, in terms of boundary, population growth, density and sex ratio. Due to the emergence of new urban centre like Mumbai and Delhi (NCR), regarding employment and livelihood opportunities, the flow and magnitude of migration have diminished and this is reflected in the population growth. Most of these changes have occurred after the 1970s. This study not only explores the spatio-temporal changes in the Kolkata city but also showed the demographic changes. The spatial analyses show that the Kolkata urban area grew very rapidly, and spatial expansion was quite pronounced towards North, East, South-East and South of the city. A significant growth in the built-up area from 1951 to 2014 is quite apparent. This city is the leading business hub as well as the state capital of the West Bengal. Being a popular tourist destination, (because of Victoria Memorials, Kalighat Kali temple, Indian Museum, Dakshinashwar Kali temple, Eden garden Maidan, Howrah Bridge, Marble Places, etc.) it also plays a very strategic role of the tourism industry. In general, the study finds out by the help of remote sensing data that the city built-up area has very rapidly increased and there is rapid decline in the open space, green space and water bodies. It changed the landscape of the city.

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