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Evaluation of land use and land cover Change (LULC) by Geospatial Method: A case study of Surana Tons Watershed Dehradun

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ABSTRACT

The quantity, the rate and the measure of land use change are exceptionally high in India. The human effects upon the land are still incredible and expanding. This examination investigations the cycle scene change in a miniature watershed in mean rise district of Doon valley, Uttarakhand of India in 1980 and 2015. The watershed (around 440 km^2 in size) in Doon Valley. The spatial and transient change examples of land use were evaluated by deciphering far off detecting (RS) information and utilize a topographical data framework (GIS). During the most recent 35 years, the vegetal cover was changed profoundly with aggregate populace pressure (both human and creature), horticultural exercises. This article primarily accentuations on the arrangement and documentation of the progressions in LULC in the time of 1980–2015 dependent on an appraisal of India's geographical guide and consecutive pictures accumulated from the satellite.

Key words : *LULC, Accuracy, Transformation, Detection, Kappa coefficient.*

Introduction

Land use/land cover (LULC) change is having a vital part in the research of native and comprehensive ecological modification (Gupta and Munshi, 1985; Mas, 1999). Terrain covering refers how the World shell is encircled by forestry, water body, resistant surfaces, agricultural, and different types of land and water (Prakasam, 2010). Land use denotes to how human being utilized the land, either for development, conservation, or for anthropogenic purpose. Land use comprises regeneration areas, flora and fauna, agricultural land and residential area (Reis, 2008). Subsequently from the past 100 years, the anthropological populace and its impact had enlarged enormously on land. Human amendments on the Earth consequence in fluctuations on land enwrap.

Now a days multi-temporal high to moderate spatial-resolution satellite image have appear as an indispensable implements for calculate approximately characteristics such as the flora, forestry deprivation, and urban enlargement (Mustafa *et al.*, 2007). Remote sensing and GIS tool offer a stage for reviewing land changes through the land cover (Estoque and Murayama, 2015). Though, moderate resolution data, such as the Multi-Spectral Scanner (MSS), TM, and Operational Land Imager (OLI) Landsat data sets, have been used worldwide for LULC change detection analysis (Chandrashekar *et al*., 2018;)

The extent signifies a very friable ecosystem. Further than 70% of the residents living in rural areas, with population progression and inadequate land sharing forcing farmers to agriculture. Workable expansion deliberation often meets a connection be-

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tween rural backwardness and the environs. While most research recognize the loss of fauna.As a local as well as comprehensive problem, very slight is understood on a local balance about composite associations Between ecological, commercial, communal and natural reserve strategy issues that encourage variations in land use. It is common in the developing countries, huge scale assimilated development plan are introduced with the aid established from the international development agencies. Though, these nationsprivationadequate funds to follow-up the intermediations and continue with the actions once the project period comes to an end. This makes acondition of sudden extraction of development intrusions, which started to show progressive effects of difficult modification.

Study area

In the study, the terrain variations in the built-up and rural parts of Surana Tons Watershed of Doon valley were persuade using spatial technology. The focused extent covered up eastern part of Doon valley and its environs having interrelation with the Lesser Himalayas in the north, the Siwalik Hills in the south, river Ganga in the southeast and Dehradun town in the west. It covers an area about 740 square Km and is bounded between 78 05' E and 78 25' E longitude, and 30 05' and 30 30' N latitude. It falls in SOI Topo sheet Nos. 53J/3, 4, 7 and 8. Physiographical Doon valley is an irregular longitudinal synclinal valley, which lies between lesser and sub Himalayan ranges. Doon valley is an intermontane positioned valleywithin the Siwalik foreland basin in the Garhwal Himalaya (Thakur, 1995). Along the northern margins of the Doon valley, the Main Boundary Thrust (MBT) brings the Precambrian rocks of the Lesser Himalaya to override the Siwalik group (Jayangondaperumal *et al.* 2001) whereas a sudden topographic rise of the Siwalik range demarcates the Himalayan Frontal Thrust (HFT), locally called the Mohand thrust (Nakata, 1972), which separates the Siwalik group from the recent alluvium of the plains. The large part of the valley is occupied by a broad synclinal depression, called the Doon syncline (Kishore, 2005). To its south, lies a complementary fold structure, Mohand anticline, and the Santogarh anticline lie to its north.

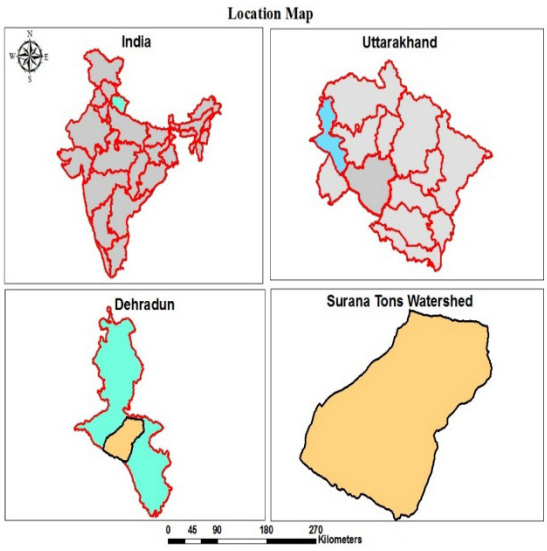

Fig 1: Location Map

Accuracy assessment

Precision valuation is crucial for specific categorizations if the arrangement of data is to be valuable in transformation finding (Owojori and Xie 2005). For the precision valuation of land cover records take out from digital imageries, idiomatic arbitrary technique was used to symbolized is similar terrain classes of the space. Post-classification alteration revealing method, accomplished in ArcGIS 10 was usedin the study. Postcategorization in built-up environs has been efficiently utilized by several academics due to its proficiency in perceiving the position, landscape and degree of alteration (Hardin *et al.,* 2007) the precision was evaluated by points, based on ground truth statistics and pictorial analysis. The assessment of catalogue outcomes and orientation facts was conceded out multivariate using in accuracy mediums. In addition, a nonparametric Kappa test was also executed to amount the degree of cataloguing accuracy as it not only accounts for diagonal elements but for all the elements in the confusion matrix (Rosenfield and Fitzpatrick-Lins, 1986). Additional procedure used to acquire the variations in land cover/use through the quantified period was overlay process. A two-way cross-matrix acquired by the utilization of this was used to pronounce the imperative change types in the study zone. Cross layout analysis was accompanied in order to control the quantifiable transfigurations from a specific classification to another land cover category and their consistent area over the calculated period on pixel to pixel origin.

Change detection Remote Sensing technique and GIS-based change recognition methodologies are generally utilized because of their cost viability

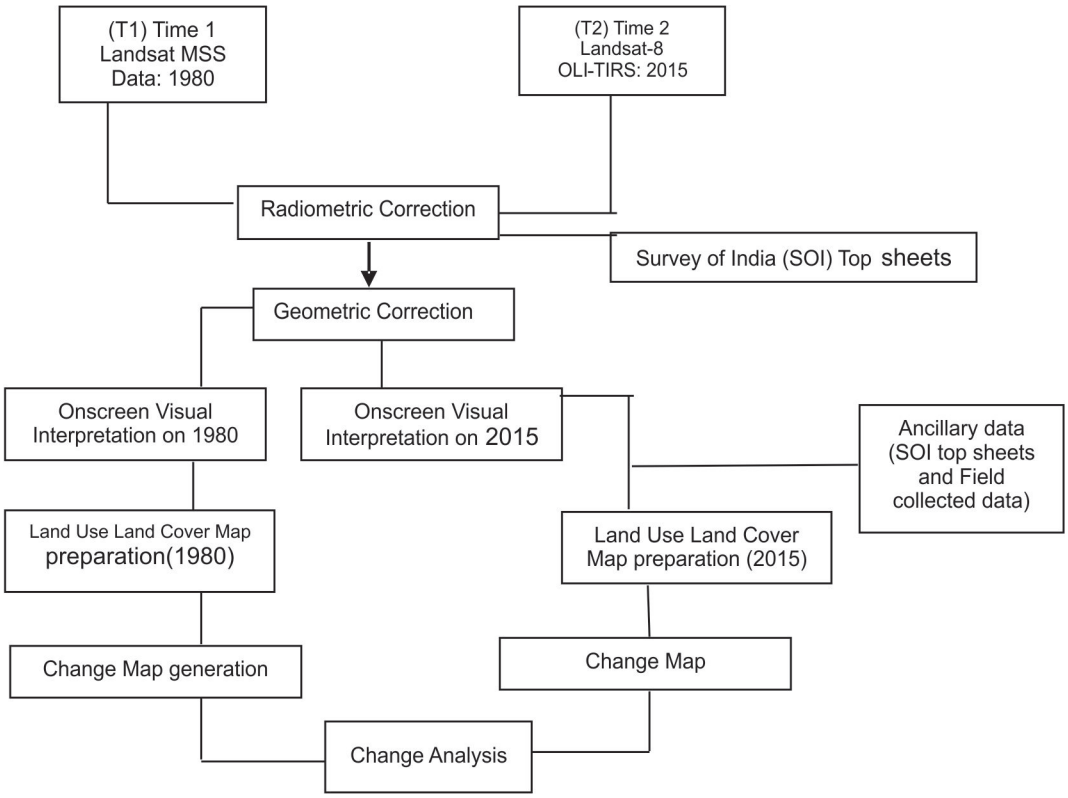

Fig. 2. Showing Methodology for Change detection

what's more, high worldly goal. Along these lines characterization change discovery procedure, acted in ArcGIS 10 was utilized by the examination. Post grouping in metropolitan climate has been viably utilized by different specialists because of its productivity in distinguishing the area, ecology and pace of progress (Hardin *et al.,* 2007). Additional method utilized to acquire the adjustments in land cover/use throughout the predefined time-frame was encrustation methodology. A two-way cross-grid acquired by the use of this was utilized to depict the key change types in the examination region. Cross arrangement investigation was led to decide the quantifiable changes from a specific classifica-

Table 1. Satellite data specifications

Data	Year of acquisition	Bands/color	Resolution (m)	Spectral resolution/bands	Source
Landsat "MSS	1980	Multispectral	60	Band 4 – Green Band 5- Red Band 6 -Blue Band 7 -Near Infrared	WWW. USGS.gov.in
Landsat "8	2015	Multispectral	30	Band 1 – Ultra Blue Band 2 – Blue Band 3 – Green Band 4 – Red Band 5 – Near Infrared Band 6 – Shortwave Infrared1 Band 7 – Shortwave Infrared2 Band 8 – Panchromatic Band 9 – Cirrus	OLI-TIRS

tion to alternative land cover classification and their relating zone over the assessed period on pixel to pixel premise. The level of exactness of the outcomes relies upon the precision of the topical guides arranged through picture grouping. The extent of progress (C) in each class was resolved utilizing the accompanying condition:

$$Ci = Li - Bi$$

The fraction change (C %) in all land-use class was considered by allocating the change in a category by the study area in the baseline year and multiplying by 100, by the simple equation.

$$Pi = Li - Bi \backslash Bi * 100$$

Where: *i* = Figure of classes in an image
Ci= Degree of alteration in class *"i."*
Pi = Fraction of variation in class *"i"*
Li = Baseline image (1978)
Bi = Most recent image (2015)

Results and Discussion

The informational collections of the Surana Tons Watershed locale (Landsat MSS for 1980 and Landsat 8 OLI for 2015) were enlisted utilizing the AutoSync workstation module in ERDAS IMAGINE 14. The informational collections were enrolled by rectification the pictures with scope and longitude esteems from the as of now rectification of SOI topo sheet of the examination region. After enlistment, both the informational collections were prepared through visual understanding. The distinguished Category were digitalis by attracting polygons to create signature documents. In the following stage, regulated characterization was performed by the mark document in ERDAS Imagine 14 for creating the LULC maps. The exactness appraisal effects for the two informational collections are introduced in Tables 3 and 4. The zone involved by various classes in the two years was acquired from the property Table. After-picture order, the post-characterization examination strategy was achieved, where a LULC map from one informational collection (1980) was contrasted and a LULC map from another informational index (2015). As per the correlation, the progressions happening between the two investigation years are introduced significantly. After-picture order, maps were set up on a 1:50,000 scale by utilizing Arc Map 10.1.

LULC pattern of Surana Tons Watershed in 1980

The LULC map design produced from the Landsat MSS data set. The terrain categorizations for the time 1980, and their data are listed in Table 1. Conferring to the outcomes, the prevalent category was forest (258.215 km^2, 58.65% of the total area), trailed

Table 2. Classes delineated on the basis of supervised classification

S.No	Class	Description
1	Built-up	Built-up, marketable, industrial, diversified urban
2	Forest	Mixed forest lands
3	Agriculture land	Crop fields, harvest land and fallow lands
4	Wasteland	Exposed Land areas of soil and barren area inclined by human impact
5	Water	River bodies, lagoons, pools and tanks

Table 3. Confusion matrix indicating the overall accuracy and Kappa statistics of the 1980 LULC map of the study area.

Classified Data	Reference Data						
	Water	Agriculture	Build Up	Forest	Wasteland	Total Raw Data	Accuracy (User) %
Water Bodies	23	0	0	0	0	23	100
Agriculture Land	0	31	0	3	2	36	86.11
Build Up	1	2	27	0	3	33	81.18
Forest	0	3	2	37	3	45	82.2
Wasteland	0	1	2	0	14	17	82.35
Column Total	24	37	31	40	22	154	
Producer Accuracy %	95.83	83.78	87.10	92.50	63.64		
Overall Classification Accuracy %	85.71%						
Overall Kappa	82.76						

by agriculture (139.685 km^2, 31.73% of the total area). The remaining terrain class's classes are settlements (10.780 km^2, 2.44 % of the entirearea), wasteland/other lands (2.530 km^2, 0.574% of the entireextent), and water (29.07 km^2, 6.6.% ofthe entireextent).

LULC pattern of Surana Tons in 2015

The categorized figure for 2015 was generated by the Landsat 8 OLI data set. Conferring to the 2015 outcomes, of terrain area mainly comprised forest land (251.439 km^2, 57.10% of the total land), surveyed by agriculture land (123.541 km^2,

Kappa coefficient and overall accuracy for the 1980 and 2015 images

Exactness evaluation was done for the 1980 and 2015 LULC maps. For the 1980 LULC Map, 154 pixels were chosen haphazardly. The 1980 LULC map had a general kappa measurement of 0.827 and a general precision of 85.71% (Table 3). The maker's precision for every class was greater than or equivalent to 80%. The client's exactness for three (water bodies, developed land, and woodland) classes was over 80%. Squander land classifications have a client's precision of 63.64%. For the 2015 LULC map, 216 pixels were chosen haphazardly. The general kappa measurements and by and large precision of the 2018 LULC map were 0.891 and 87.12 %, individually (Table 4). The maker's precision of each class was higher than 90%. The client's exactness of the multitude of classes aside from develop and no man's land was 85.41 and 82.14 % separately. The exactness of everycategory was seen to be palatable in the two characterizations. The general grouping exactness results and kappa measurements for the 1980 and 2018 LULC maps are introduced in Tables 3 and 4, separately. Post-classification evaluation of the identified transformation was done to generate conversion maps by using GIS, to understand the three-dimensional configurations of alteration amongst years.

Change detection from 1980 to 2015

The expanse in the LULC category and its deviations since 1980 to 2015 are represented in Table 5. Figure 3 shows the three-dimensional extension of the urbanized area. In 1980, the area enclosed by urbanized land was marginal and generally sited in the middle of the research area. Uplifted and down lifted deviations were analyzed over 35 years in the area under the LULC classifications. The aquatic part, forestry, and farming land sets revealed a decline in their zone, whereas the built-up land and

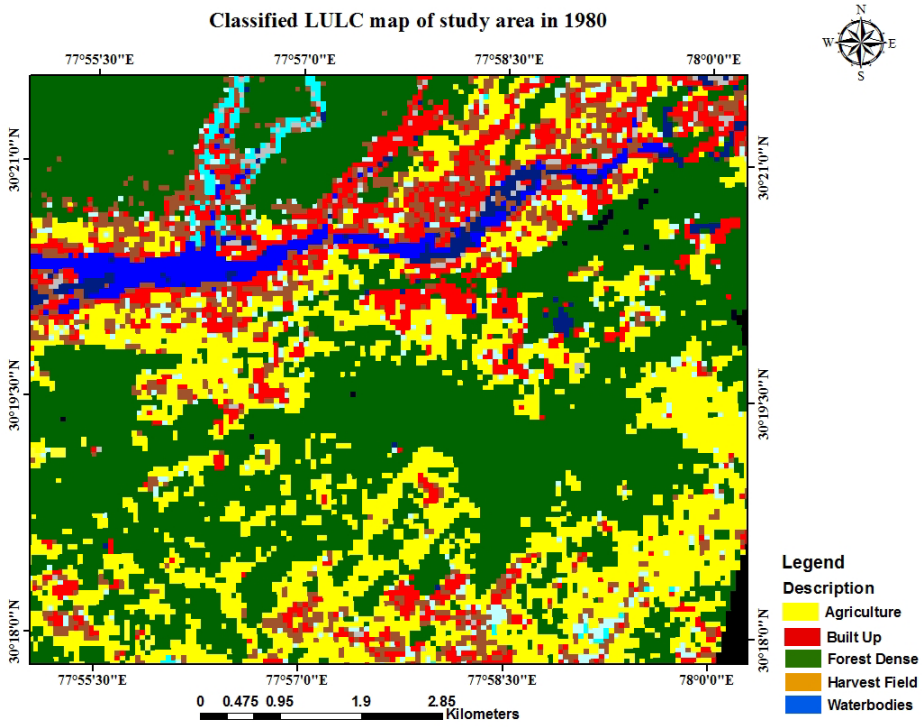

Fig. 3. Classified Map Surana Tons Watershed in 1980

waste land classes shown an upsurge in extent. As presented in Table 5, the ut most considerable variations in extent were perceived for the urban /other land classes, subsequent by the water bodies, agronomy land, and forestryclasses.

Fig. 5. Change Statistics of terrain category 1980 (1-5 represent the class in Table 5)

The research emphases on the alteration in the land cover over a long period (1980–2015) of the research area. So, the general technical study adjudicate the state, dynamics, and tendency of shifting landscape of Surana Tons Watershed. Moreover the transformation association and interface among numerous category of land was also considered. The general image of varying land cover was assessed with acceptable accuracy.

Water bodies

The extent of water bodies dropped from 29.07 km^2 in 1980 to 23.01 km^2 in 2015, which signifies a net reduction of 6.06 km^2. The expanse under water bodies diminished due to the transfiguration of water bodies into other land the drop in the extent from past scenario and rainfall intensity by the study area over the past 35 years.

Table 4. Confusion matrix indicating the overall accuracy and Kappa statistics of the 2015 LULC map of the study area.

Classified Data	Reference Data						
	Water	Agriculture	Build Up	Forest	Wasteland	Total Raw Data	Accuracy (User) %
Water Bodies	36	0		1		37	97.29
Agriculture Land	1	46	1	1	1	51	90.19
Build Up	0	1	41	2	4	45	91.11
Forest	0		2	48		54	88.88
Wasteland	0	3	4	2	23	29	79.31
Column Total	37	50	48	53	28	216	
Producer Accuracy %	97.29	92.00	85.41	90.56	82.14		
Overall Classification Accuracy %	89.18%						
Overall Kappa Statistics	87.12						

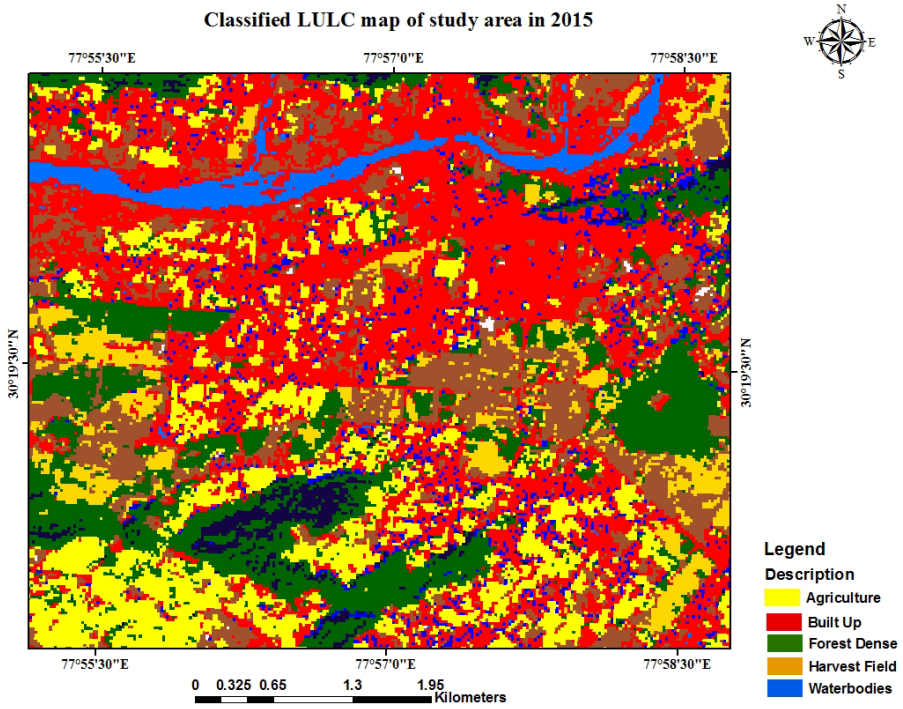

Fig. 4. Classified Map Surana Tons Watershed in 2015

Agriculture land

The agriculture land extent diminished from 139.685 km^2 in 1980 to 123.541 km^2 in 2015, which signifies a net drop of 16.14 km^2. The accessible agriculture land within the research range moderately diminished during the study time. Agricultural terrain shrunk due to the necessity for urban expansion and economical and social progression actions inside the study area.

Built-up land

Urbanzoneaugmented from 10.780 km^2 in 1980 to 37.736 km^2 in 2015, which characterizes a net Intensification of 26.95 km^2. Built-up land amplified due to the growth in populace, tourism activities, and the inflated demand for housing by residents.

Forest cover

The extent of forest land reduced slightly toomoderately from 258.215 km^2 in 1980 to 251.439 km^2 in 2015, which symbolizes a net drop of 6.776 km^2. The reduction in forest land is accredited to the transformation of forest cover intourban area.

Wasteland

The area under wasteland augmented from 2.530 km^2 in 1980 to 4.562 km^2 in 2015, which signifies a net increase of 2.032 km^2. The advance in wasteland is accredited to the statistic that farmers in the area have abandoned agriculture deeds. Whilesome wasteland were adapted into the urban and agri purpose land.

Conclusion

In the current learning, valuation of LULC and their variety uncovering were completed utilizing advanced picture Handling strategies. Assessment uncovered that metropolitan territories, and no man's land expanded during 1980-2015 bringing about considerable decrease of woodland zone and horticulture land. The transformation of timberland and fruitless land to metropolitan land has caused shifted and broad ecological corruption in the investigation territory and the significant negative results related with the fast metropolitan advancement are the developments of ghettos. Significant main impetuses of metropolitan land development are populace development and financial extension. In this examination, far off detecting and GIS were incorporated for measuring and understanding the LULC changes in Surana Tons Watershed more than a long time from 1978 to 2018. The method utilized in this investigation is straight forward and reasonable. The degree of terrain changes in Surana Tons Watershed was resolved utilizing multitemporal satellite symbolism. In this examination, characterization exactness was estimated utilizing the disarray lattice. The general grouping exactness of this investigation was worthy. Huge changes in the LULC were seen in the examination zone somewhere in the range of 1980 and 2015. In 35 years, the zone under developed land and other land expanded significantly, while the zone under farming area and water bodies diminished. The reasons for the LULC deviations in the examination region contain the decrease in cultivating exercises and the upsurge in developed exercises.

Scope

Further study was used to conduct the research in Geospatial technology for the susceptible area especially in case of hilly topography.

Table 5. LULC categories in the 1980 and 2015 data sets and variation in the extent of each class over 35 years (In km^2 and %)

S. No.	Class Name	1980	LULC Area (Km^2) 2015	Area Changed (Km)^2 (2018-1980)	Percent Change%
1	Build up Area	10.780	37.736	-26.95	+71.420
2	Water bodies	29.07	23.01	-6.06	-20.84
3	Forest	258.215	251.439	-6.776	-2.62
4	Agriculture land	139.685	123.541	-16.14	-11.55
5	Wasteland	2.530	4.33333562	+2.032	+44.41
	Total	440.280			

(+) Specifies a growth and (") specifies a decline in the extent in a LULC class over 35 years (1980–2015).

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