International Journal of Multicultural and Multireligious Understanding

http://ijmmu.com
editor@ijmmu.com
ISSN 2364-5369
Volume 6, Issue 5
October, 2019
Pages: 186-194

Prediction Spatial Model of Domestic Liquid Waste Distribution in Sawojajar Village, Malang City of Indonesia

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http://dx.doi.org/10.18415/ijmmu.v6i5.1063

Abstract

The distribution of domestic liquid waste is difficult to identify and mark because it is spread. However, it is very necessary to obtain a picture of the spread of pollution and take further management steps. This research is carried out to predict spatially the level of pollution of domestic wastewater that will be used to prevent further pollution. The research was conducted in the Sawojajar Village District of Malang. The results based on the population approach show that population growth greatly influences the distribution of domestic wastewater. The relatively small population growth shows a different distribution pattern which the increasing number of populations will affect the distribution of domestic liquid waste.

Keywords: Pattern; Spread, Pollution; Distribution

Introduction

Domestic liquid waste is a source of scattered pollutants whose existence is still underestimated compared to industrial waste and domestic solid waste. According to Mitchell, the source of water pollution from domestic waste is a big problem both for the community, government and experts working in the environmental field (Mitchell, 2001). One reason is because the sources of scattered pollutants are not easily identified and marked. An analysis of sources of domestic wastewater pollutants is needed both in the form of a load calculation and a description of its spatial distribution to reveal the emergence of pollution and provide scientific information related to policy decisions by the government (Ding, 2013; Yang, 2013).

One of the causes of the high level of pollution is influenced by the quality of discharged domestic wastewater. The poor quality of wastewater is due to the suboptimal management of domestic wastewater. At present, the management of domestic wastewater is mostly done by implementing an end of pipe system. A good management system must start from the source of its emergence. If domestic

liquid waste, then waste originating from residential areas is the focus of management. This condition is neglected because the community believes that they have managed to provide a septic tank waste treatment facility to accommodate and process waste originating from toilets without regard to criteria, while domestic liquid waste from other activities is ignored. Based on this, this study was conducted to predict the distribution of domestic liquid waste in the Sawojajar Village City of Malang, especially in terms of population. To get an idea of the extent of pollution caused by domestic wastewater, an observation is needed that can inform the prediction of the spread of pollution. For this reason, spatial research was carried out to predict the pattern of distribution of domestic liquid waste. Spatial prediction, usually called spatial, is carried out to provide an overview of the spread of domestic wastewater in the future with the assumption that the current conditions are still maintained without any improvement on various elements or causes. From the results of previous studies indicate that the level of pollution of domestic liquid waste in Sawojajar Village averaged 4.09 (Prihatiningsih, Bekti; et all, 2018). This condition if left unchecked does not rule out the possibility of further aggravating the level of pollution. Observations in the study area showed that the most influential factors in the distribution of domestic liquid waste were (weight) were pollutant load (0.4509), population (0.1657), discharge (0.1307), accessibility (0.1080), land area (0.0909) and drainage system (0.0530) (Prihatiningsih, Bekti; et all, 2019).

By observing these conditions, a study was conducted to determine the distribution of domestic liquid waste. Until now, there is not much literature that discusses the distribution patterns of domestic liquid waste. The discussion is more focused on the spread of feces or feces that are part of domestic waste. Feces or feces become the most important thing in domestic waste, because in the feces contain many hazardous compounds that can pollute the environment when discharged directly into the environment, especially the content of fecal bacteria or E. coli.

Methodology

To determine how the pattern of distribution of domestic wastewater in the study area, the steps used are as follows:

a. Determine the level of pollution in the study area which is described in the form of a pollution level map using GIS (Prihatiningsih, Bekti; et all, 2018).

b. Determine the factors that influence the distribution of domestic wastewater by the AHP method (Prihatiningsih, Bekti; et all, 2019).

c. Determine the form of a simple model of the distribution of domestic liquid waste using GIS and Landusesim. Spatial modeling can be done if dynamic data is obtained. From the six factors that have been identified and the results of weighting and scoring calculations, factors that can change dynamically are pollution load, population, and discharge. Pollution load data in the study area to state the quality of liquid waste has never been observed and studied. The liquid waste quality data used is the primary data directly observed at the time of the study, so that dynamic changes cannot be estimated. The amount of discharged wastewater generated cannot be determined according to field conditions but through a theoretical approach that the amount of wastewater produced is (60 - 70)% of the population's average need for clean water per liter per person per day (Said, 2008). So, it is only based on two data, namely the population and the discharge that can be modeled. Population and discharge are correlated variables where the more the number of residents the more discharge the waste produced. In contrast to population and discharge, wastewater quality does not

necessarily decrease with increasing population and discharge. By looking at these conditions, and based on the results of weighting and scoring, in this study spatial modeling is done by taking into account dynamic data, namely population. Furthermore, modeling is made by compiling modeling attribute data. To get the desired spatial modeling and based on the data collected, several approaches were made including:

1. Modeling is arranged based on the development of the population with an interval of 10 years because of very small population growth so that if it is modeled with a small-time interval does not show significant changes. Selected years are: 2018, 2023, 2028, 2038.

2. The quality of domestic wastewater in the year of observation (2018), the quality of land is obtained as a map in 2018. Assuming the condition remains as in 2018, without any improvement in accessibility, decreasing the burden of pollution. With the increase in population will indirectly affect the population density and the amount of wastewater discharge at the study site. The magnitude of the decline in land quality is assumed to be proportional to the decline in the quality of wastewater.

3. Land quality is determined based on the classification of Natural Break classification, where this method uses the data points determined by looking at the groupings and patterns of known population data. Data is divided by boundaries based on the largest number of residents. Because there is no standardization of the range of the original values, a value clarification approach is carried out in each pollution class as in table 2, so that pollution levels are obtained. This condition will be different for each study area because exciting conditions in each study area are different.

4. The average population growth of Malang City in one year used in this calculation is 1.25% (Malang City in Figures, 2018).

5. The parameter used to determine the index of pollution of domestic liquid waste is BOD.

Results and Discussion

The results of field observations and the calculation of Pollution Index (IP) show that the current level of pollution of domestic liquid waste in the Sawojajar Village is at mild to moderate levels. The level of pollution will change for the worse if it does not receive further attention. Therefore, a real picture is needed to provide input to the authorities in an effort to reduce the level of pollution. One way is to predict the pattern of spread in the coming years. The prediction of the distribution of domestic wastewater is made based on field observations which are strengthened by secondary data and with certain approaches, so that the attribute data obtained is used to predict the distribution pattern of domestic liquid waste in Sawojajar Village, as shown in table 1.

Table 1. Data of Spatial Modeling Attributes of Sawojajar Village

FID	Shape	Id	Block	Area	pH_dry	pH_rainy	BOD_Dry	BOD_Rainy	Load_Cont	Tot_Pop	Dens_Pop	Flow
1	Polygon	2	II	166,816	Fulfill	Fulfill	Medium	Lightly	2	1404	0.008416	168,480
7	Polygon	9	IX	154,349	Fulfill	Fulfill	Lightly	Lightly	2	1396	0.009044	167,520
3	Polygon	5	V	80,519	Fulfill	Fulfill	Lightly	Lightly	2	744	0.00924	89,280
0	Polygon	1	I	108,726	Fulfill	Fulfill	Lightly	Lightly	2	1012	0.009308	121,440
10	Polygon	4	IV	150,004	-	-	-	-	1	1796	0.011973	215,520
2	Polygon	3	III	356,901	Fulfill	Fulfill	Medium	Lightly	3	5160	0.014458	619,200
9	Polygon	11	XI	211,659	Fulfill	Fulfill	Medium	Medium	3	3252	0.015364	390,240
8	Polygon	10	X	245,033	Fulfill	Fulfill	Lightly	Lightly	2	3936	0.016063	472,320
5	Polygon	7	VII	160,454	Fulfill	Fulfill	Lightly	Lightly	2	2968	0.018498	356,160
6	Polygon	8	VIII	166,259	Fulfill	Fulfill	Lightly	Lightly	2	3328	0.020017	399,360
4	Polygon	6	VI	98,277	Fulfill	Fulfill	Lightly	Lightly	2	2012	0.020473	241,440

Drain	Access	TotPop_23	TotPop_28	TotPop_33	TotPop_38	Dens_23	Dens_28	Dens_33	Dens_38	Flow_23	Flow_28	Flow_33	Flow_38
5	5	1442	1480	1520	1561	0.008642	0.008873	0.009111	0.009355	172992	177625	182383	187267
5	5	1433	1472	1511	1552	0.009287	0.009535	0.009791	0.010053	172007	176613	181343	186200
5	5	764	784	805	827	0.009488	0.009742	0.010003	0.01027	91671	94126	96647	99236
5	5	1039	1067	1096	1125	0.009557	0.009813	0.010076	0.010346	124692	128032	131461	134982
5	5	1844	1893	1944	1996	0.012294	0.012623	0.012961	0.013308	221292	227219	233304	239553
5	5	5298	5440	5586	5735	0.014845	0.015243	0.015651	0.01607	635784	652811	670295	688247
5	5	3339	3429	3520	3615	0.015776	0.016198	0.016632	0.017078	400692	411423	422442	433756
5	5	4041	4150	4261	4375	0.016493	0.016935	0.017389	0.017854	484970	497959	511295	524989
5	5	3047	3129	3213	3299	0.018993	0.019502	0.020024	0.02056	365699	375493	385550	395876
5	5	3417	3509	3603	3699	0.020553	0.021104	0.021669	0.022249	410056	421038	432314	443893
5	5	2066	2121	2178	2236	0.021021	0.021584	0.022162	0.022756	247906	254546	261363	268363

Table 2. Classification of pollution levels based on population in Sawojajar Village.

Color	Total Population	classification	Pollution Indeks (IP)
	13.110 – 17.690	1	Meet Quality standards
	17.700 – 35.380	2	Contaminated lightly
	35.390 – 69.250	3	Medium polluted
	69.260 – 90.910	4	Heavily polluted

From attribute data based on exciting conditions then processed, and then carried out modeling based on existing approaches, in order to obtain an overview of the distribution model of the quality of domestic liquid waste in Sawojajar Village as shown in figures 1 to 5.

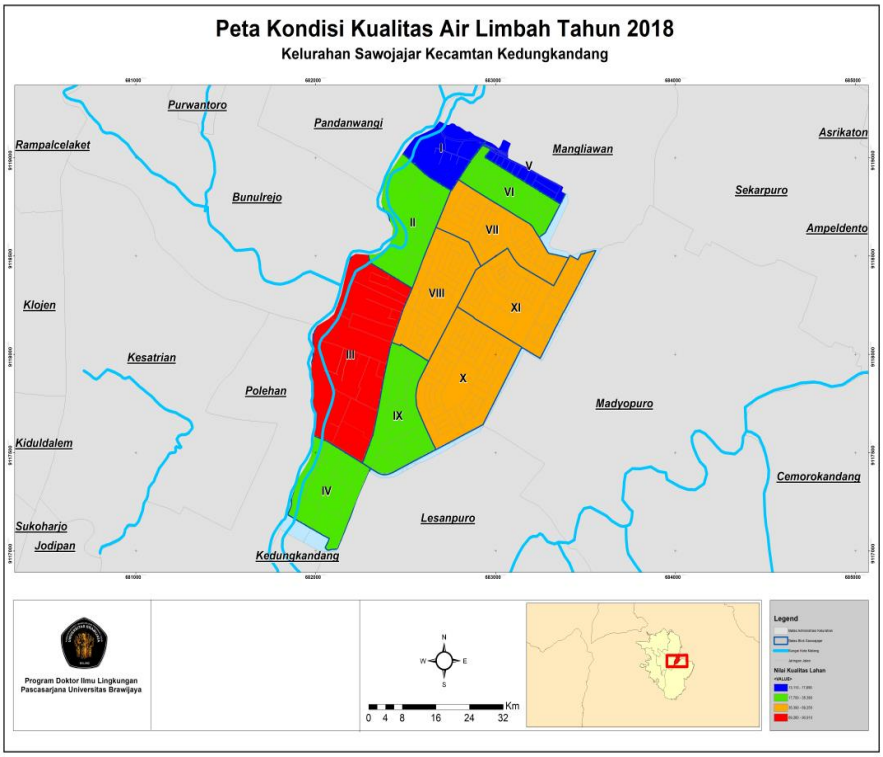

Figure 1. Predicted Map of Domestic Wastewater Quality in 2018

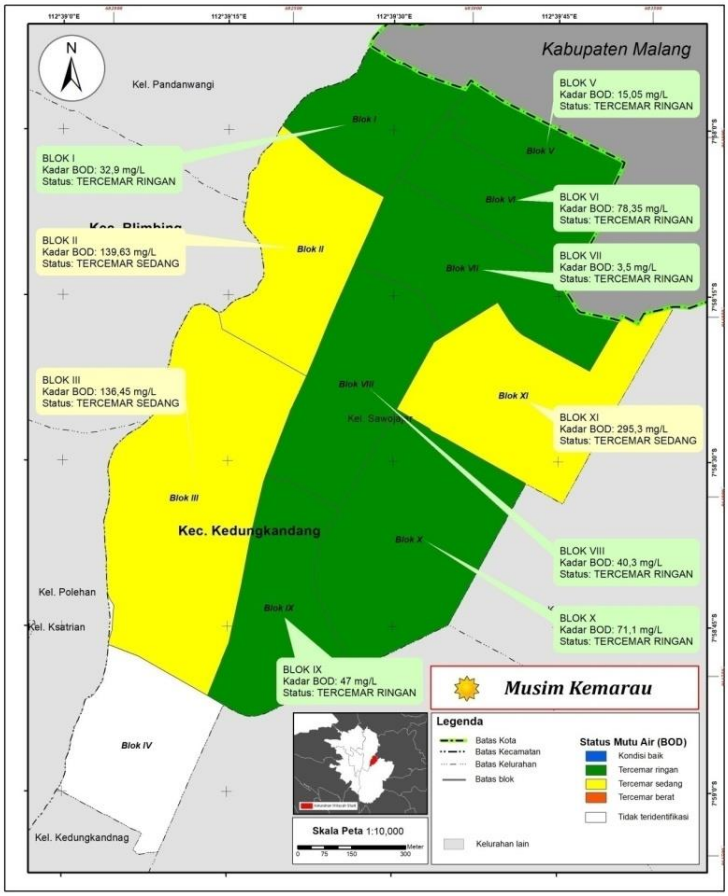

Figure 2. Map of distribution of domestic liquid waste (BOD) exiting conditions in the dry season (Prihatiningsih *et al.*, 2018)

Figure 1 illustrates the condition of domestic wastewater quality in 2018. Based on figures 1 and 2 there is a significant difference, where the actual field conditions are better than the results of the calculation approach. In exciting conditions, block II, III and XI, showed a moderate level of pollution, while the results of calculations, block II was in a mildly polluted condition, block XI was moderately polluted while block III was in a heavily polluted condition. Meanwhile Block I and V in the status of exiting status are slightly polluted but based on calculations they still meet the quality standards of domestic wastewater. This shows that waste management through the provision of accessibility, drainage system management is able to improve the quality of wastewater even though in blocks I and V illustrate the occurrence of wastewater quality decline. Even so, it should be reconsidered that the management system is not optimal, it will not rule out the possibility of a decrease in the quality of liquid waste. As it is known that Sawojajar Village is one of the villages that has an ODF predicate (Anonim, 2018), but in reality there are still areas with moderate levels of pollution as indicated by IP values of 4.09 and *E.coli* content in the observed liquid waste samples of 85 and 143.50 MPN / 100 ml (dry season) and block 11 it was 295.30 MPN / 100 ml (dry season) and 30 MPN / 100 ml (rainy season) (Prihatiningsih, Bekti; et all, 2018). Many things cause pollution conditions in the study area, including the treatment system that is used as fulfilling the accessibility of domestic waste treatment that comes from toilets does not meet the standards, decreases the efficiency of the waste treatment building because it is aged without maintenance, and the proper functioning of the drainage system in drain domestic liquid waste.

If the existing conditions are not sought to improve its management, it does not rule out the possibility that the quality of wastewater in the Sawojajar Village will decrease over time and increase in

population. Not merely due to population growth, but factors to improve accessibility including facilities and infrastructure for domestic wastewater treatment including the application of appropriate domestic wastewater treatment equipment or increasing the efficiency of existing domestic waste processors and supported by a good drainage system. The improvement, improvement and development of facilities and infrastructure is important to maintain environmental quality, although from the results of modeling based on population until 2038 (Figures 3 to 5), the quality of domestic wastewater does not show significant changes. This is due to the relatively small amount of population growth. Improved accessibility is needed because the facilities and infrastructure for liquid waste management have an important role. Changes were seen in 2038, where in block I the status of fulfilling the quality standard was changed to mild contaminated and block XI, from being polluted to being heavily polluted. If a conclusion is drawn, the most important factor that determines the quality of domestic wastewater is the availability of accessibility that can function properly, so as to produce effluent wastewater with quality that meets the specified requirements.

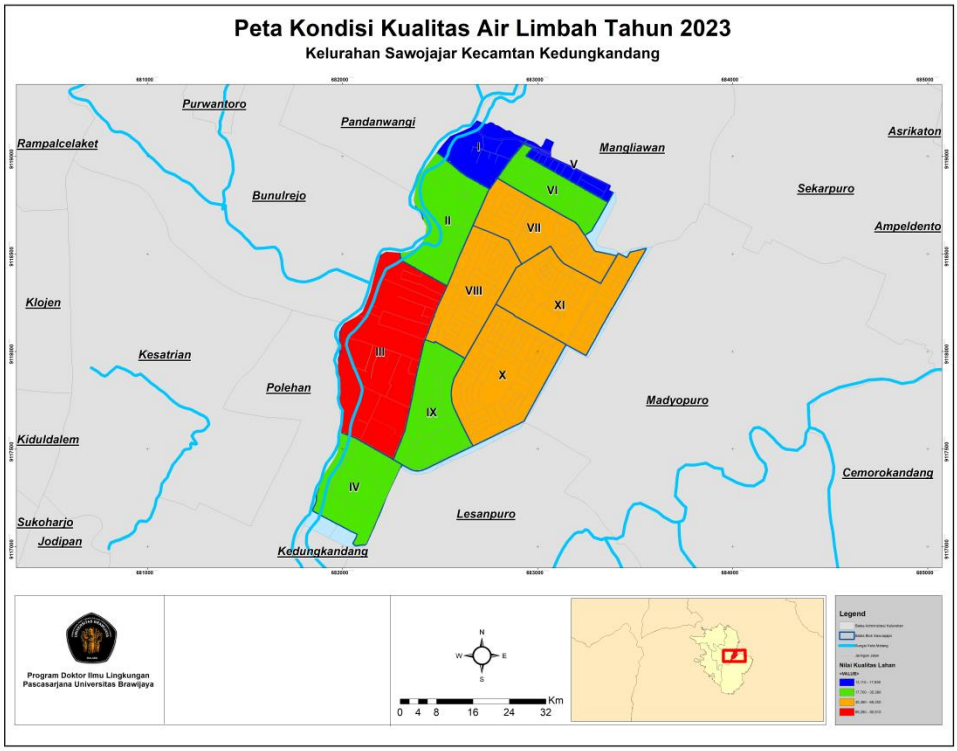

Figure 3. Map of Domestic Wastewater Quality in 2023

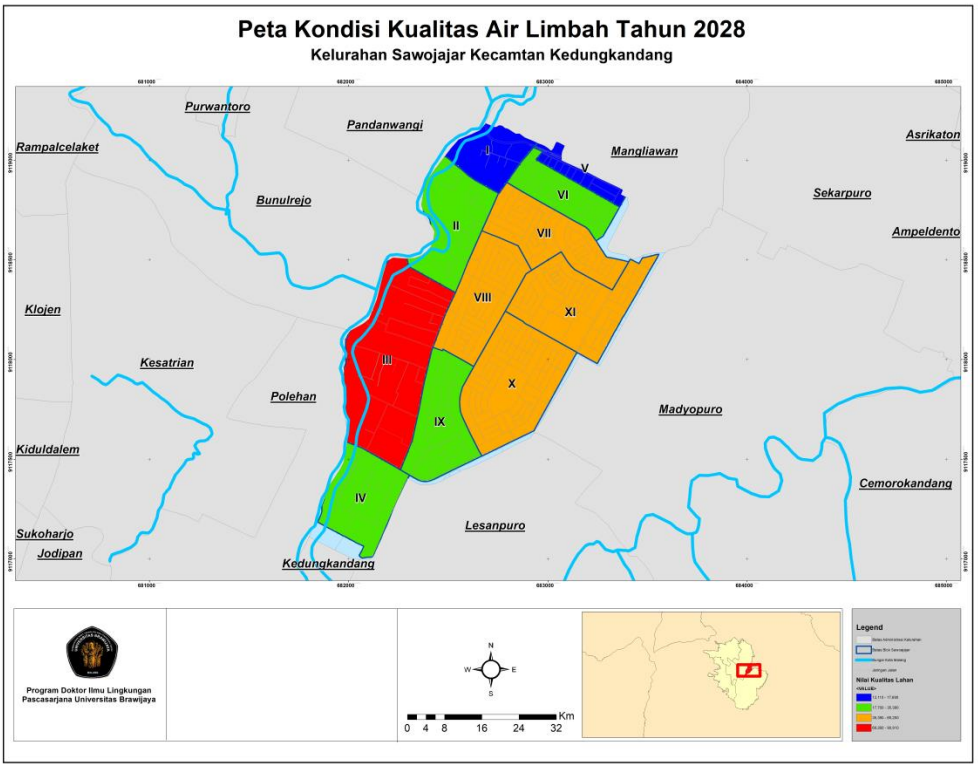

Figure 4. Map of domestic wastewater quality in 2028

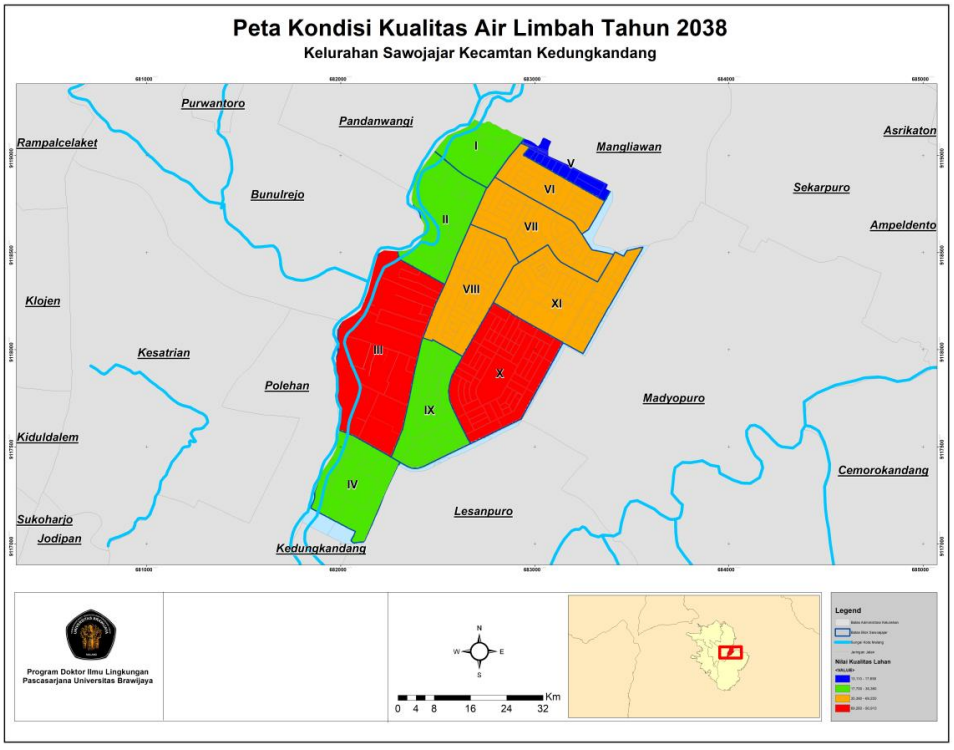

Figure 5. Map of domestic wastewater quality in 2028

Sanitation system or household waste disposal system is an important thing in maintaining environmental quality because the sewage system that is not good will cause contamination of the quality of the surrounding environment both water and soil. The poor condition of the sewage system can cause high contamination and influence on soil and water quality and can cause a high number of E. coli bacteria (Aji, 2007).

Conclusion

Based on the results of observations and approaches taken to estimate the distribution pattern of domestic liquid waste in the Sawojajar Village, overall it can be concluded that, the level of pollution in the Sawojajar Village will increase if there is no improvement in the domestic liquid waste management system. The distribution of domestic wastewater quality is mainly influenced by the number and habits of the population, accessibility that does not meet the requirements, and the drainage system.

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