Correlation Analysis of Biodiversity with Local Wisdom in Indigenous Villages and Non-Indigenous Villages in Bogor Regency

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Abstract. Biodiversity is an abundance of various types of landscape resources on the face of the earth. The sustainability of biodiversity in a landscape is inseparable from the role of humans living. Various cultures have knowledge, practices, wisdom, and other cultural representations in utilizing and preserving the landscape resources. Urug Village is one of the traditional Sundanese villages that still maintain its local wisdom. Preservation of biodiversity and environmental management in traditional villages are based on local wisdom. It can be used as a reference for landscape management to preserve biodiversity in their environment. Therefore, this study aimed to compare the level of biodiversity in indigenous villages and non-indigenous villages and to find out the correlation between biodiversity and local wisdom, and to formulate local wisdom-based biodiversity management plans. The results of the biodiversity index calculation indicate that the level of biodiversity in Urug Indigenous Village is higher with index value 1.96. Cipatat village has a lower index of 1.34. Both of these biodiversity indexes are in the medium category. But the results of the T-test show that these two indexes are significantly different. It can be validly concluded that the biodiversity index in Urug Indigenous Village is higher than in Cipatat Village. Logistic regression was carried out to determine the correlation of biodiversity index with local wisdom. The results of the logistic regression analysis showed that there was a positive relationship between the biodiversity index and local wisdom. The recommendations for biodiversity management were formulated through SWOT analysis. This analysis resulted in three main recommendations for biodiversity management strategies based on local wisdom.

Keywords: biodiversity, biodiversity management, indigenous village, local wisdom

1. Introduction

Biodiversity is an abundance of various types of natural resources that exist on earth. Biodiversity needs to be maintained because it is an important component in ecosystems and biochemical cycles. Role of human life in general determines biodiversity, for example in the provision of food, medicines, raw materials, and so on [1].

The preservation of biodiversity in the area cannot be separated from the role of humans living inside. Various cultures have knowledge, practices, and other cultural representations in utilizing and protecting environmental sustainability and natural resources. These things are reflected in daily life and local traditions which are often referred to as local wisdom [2]. In Indonesia Constitution No. 32 of 2009 [3] it is said that environmental management must be implemented based on the principle of local wisdom.

Urug Village is one of the Sundanese traditional villages that still retains its local wisdom. According to Dewantara [4] there are principles of simple and independent life held by the...
community of Urug Indigenous Village. One form of independence is a community that can meet its own settlement needs.

The level of biodiversity decrease as the environmental problem increase, issues such as deforestation, land clearing, and ecosystem damage. Indigenous peoples live side by side with the surrounding natural environment in harmony. The practices of local wisdom carried on for generations that the environment can be used sustainably and maintained its existence for the next generation. Conservation of biodiversity and landscape management in traditional villages based on local wisdom are important to be studied. It can be used as a reference for landscape management to preserve biodiversity in their environment.

The objectives of this study were as follows:

- Assessing the biodiversity index of Urug Indigenous Village and Cipatat Non-Indigenous Village.
- Comparing the level of biodiversity in Urug Indigenous Village and Cipatat Non-Indigenous Village.
- Analyzing the correlation between local wisdom and biodiversity
- Formulate recommendations on biodiversity management plans based on local wisdom

2. Methods

2.1. Study sites and time

The study was conducted in Urug Indigenous Village and Cipatat Non-Indigenous Village, Sukajaya District, Bogor Regency (Figure 1). The two villages were chosen as study site because they are in the same district and has the same social and physical traits. It can be considered that the only difference was the existence of indigenous customs. Time of the study is from January 2019 until April 2019.

![Study sites](image)

Figure 1 Study sites

2.2. Study Methods

The method used in this study were survey, direct measurements in the sites, and interviews. The stages of the research included preparation, inventory, analysis, and the output. (Figure 2).
Comparing H’ in indigenous and non-indigenous village 

Recommendations on biodiversity management plans based on local wisdom

Social and cultural related to local wisdom on biodiversity management

Biodiversity index (H’) in indigenous and non-indigenous village

Correlation between local wisdom and biodiversity

2.2.1. Analysis

2.2.1.1. Local Wisdom

Cultural landscape is assessed using 11 criteria [5] which given a score between 1-4. The total score is categorized into three category, which are: Score >7 : very high cultural landscape diversity; Score 4-6 : high cultural landscape diversity; Score ≤ 3 : moderate cultural landscape diversity.

### Table 1 Cultural landscape assessment criteria

| Criteria                                      | Score 1                                                                 | Score 2                                                                 | Score 3                                                                 | Score 4                                                                 |
|-----------------------------------------------|-------------------------------------------------------------------------|-------------------------------------------------------------------------|-------------------------------------------------------------------------|-------------------------------------------------------------------------|
| Presence of historical and archaeological sites | Presence of historical and archaeological sites but their authenticity has changed or modified so as to eliminate cultural values | Presence of historical and archaeological sites but their authenticity has changed or modified so as to reduce cultural values | Presence of historical and archaeological sites and their authenticity has changed or modified but does not affect cultural values | Presence of historical and archaeological sites and their authenticity is well preserved |
| Presence of historical architecture           | Traditional architecture only used in important building and modern architecture is dominant | The use of traditional and modern architecture is balanced | The use of traditional architecture is more dominant than modern architecture | Traditional architecture is used in every building |
| Important historical monuments                | Presence of important historical monuments but their authenticity has changed or modified so as to eliminate cultural values | Presence of important historical monuments and their authenticity has changed or modified so as to reduce cultural values | Presence of important historical monuments and their authenticity has changed or modified but does not affect cultural values | Presence of important historical monuments and their authenticity is well preserved |
| Handicrafts                                   | Traditional techniques and handicraft products are only used by a few people | Traditional techniques and handicraft products are only used by less than half of population | Traditional techniques and handicraft products are only used by more than half of population | Traditional techniques and handicraft products are still used and preserved |
| Religious places                              | Presence of historical religious places that have changed or modified so as to eliminate the authenticity | Presence of historical religious place and its authenticity has changed or modified and is no longer used in religious activities | Presence of historical religious place and its authenticity has changed or modified but is still used in religious activities | Presence of historical religious place that still well preserved and still used in religious activities |
| Traditional agriculture and products          | Agricultural activities carried out with conventional techniques and synthetic materials | Agricultural activities with conventional techniques and synthetic materials are more dominant | Agricultural activities with traditional techniques and materials are more dominant | Agricultural activities with traditional techniques and materials are carried out by every farmer |
| Traditional lifestyle                         | Modern lifestyle is more dominant than traditional lifestyle | Traditional lifestyle is more dominant than modern lifestyle | Traditional lifestyle that follow customary rules is more dominant than modern lifestyles | Traditional lifestyle that follow customary rules is used by every people |

Figure 2 Study stages
Criteria | Score 1 | Score 2 | Score 3 | Score 4
--- | --- | --- | --- | ---
Traditional festivals and festivities | Presence of traditional festivals and festivities but their authenticity has changed or modified so as to reduce cultural values | Presence of traditional festivals and festivities and their authenticity has changed or modified but does not affect cultural values | Presence of traditional festivals and festivities but their authenticity has changed or modified so as to eliminate cultural values | Presence of traditional festivals and festivities and their authenticity is well preserved
Traditional fishing | Fishing activities are carried out with conventional techniques and synthetic materials | Fishing activities with traditional techniques and materials are more dominant | Fishing activities are only implemented by less than half of population | Fishing activities are only implemented by more than half of population
Traditional knowledge | Traditional knowledge are only implemented by cultural figure | Traditional knowledge are only implemented by less than half of population | Traditional knowledge are only implemented by more than half of population | Traditional knowledge are only implemented and well preserved
Recreation and aesthetic values | Presence of one unique and aesthetic place that can attract visitors to the traditional community | Presence of two unique and aesthetic places that can attract visitors to the traditional community | Presence of more than two unique and aesthetic places that can attract visitors to the traditional community | Presence of many unique and aesthetic places that can attract visitors to the traditional community

Modified from Ciftcioglu et al [5], Erduran [6], and NSW Heritage[7]

2.2.1.2. Shannon-Wiener Biodiversity Index
The biodiversity index can be calculated using the Shannon-Wiener Index formula [8].

\[
H' = - \sum p_i \ln p_i \quad \cdots (1)
\]

Note:
- \( p_i = \frac{n_i}{N} \) = Number of Species (i)
- \( N = \) Total Number of Individuals
- \( p_i = \) relative abundance

Shannon-Wiener diversity index criteria are divided into 3 namely: \( H' < 1 \): low diversity; \( 1 < H' < 3 \): medium diversity; \( H' > 3 \): high diversity.

Samples were taken with a 20x20 m plot. Based on the guidelines for Periodic Comprehensive Forest Inventory (IHMB) the number of samples taken is adjusted to the area of each sample area with a sampling intensity of 10%.

2.2.1.3. Comparing the Biodiversity Index
The results of the biodiversity index of the Urug Indigenous Villages and Cipatat Non-Indigenous Villages were compared using the two-sample T-Test. This test is a statistical parametric analysis to find out the real difference between averages of two populations with the same distribution.

2.2.2. Output
The output of this study are in the form of an analysis of the correlation of biodiversity with local wisdom and recommendations for management plans for biodiversity based on local wisdom on indigenous village. Correlation analysis is done by logistic regression analysis which is used when the variable is dichotomous. In this research, data on local wisdom is transformed into nominal data. The indigenous village is symbolized as 1. The non-indigenous village is symbolized as 0. The formula for logistic regression is as follows:
\[ p = \frac{e^{\beta_0 + \beta_1 X}}{1 + e^{\beta_0 + \beta_1 X}} \] ... (2)

Note

\( P \) = Probability \( Y = 1 \)
\( X \) = Variable \( X \) (biodiversity index)
\( e \) = Exponential
\( \beta \) = Constants

Formulating the management plan recommendations was done by SWOT analysis. SWOT analysis compares internal factors (strengths and weaknesses) and external factors (opportunity and threat). Strategies are designed to maximize strengths and opportunities, and minimize weaknesses and threats [9].

3. Results and Discussions

3.1 General Conditions

Urug Indigenous Village is located in Urug Village, Sukajaya District, Bogor Regency, West Java Province. Urug Indigenous Village has an area of 24.2 ha. The village is bordered by Nanggung Village in the East, Kampung Urug Tengah in the West, Harkatjaya Village in the North, and Urug Gardu Kampung in the South. Urug Indigenous Village is located in a mountainous area so that the landforms are bumpy. Some of the hills around Urug Indigenous Village are Mount Manapa, Mount Larangan, Mount Manis, and Mount Leutik. Like most areas in the Bogor Regency area, Kampung Adat Urug has high average rainfall and humidity. The average annual rainfall of Kampung Adat Urug is 4,086 mm/year with 77% humidity and a daily average temperature of 25 \(^\circ\)C.

Cipatat Non-Indigenous village is located in Kiarapandak Village, Sukajaya District, Bogor Regency, West Java Province. Cipatat Non-Indigenous Village has an area of around 10 ha. The name Cipatat is taken from the name of the plant 'Patat' which often used as food and medicines. This village is bordered by Urug Village in the East, Kiarapandak Village in the South, Wates Village in the West, and Pasir Walang Village in the North. The biophysical condition of Cipatat Non-Indigenous Village is not much different from Urug Indigenous Village. The average rainfall of 4,000 mm/year. The humidity is 77% and the daily average temperature is 25 \(^\circ\)C. However, unlike Urug Village, the formation of Cipatat Non-Indigenous Village land is relatively flat.

3.2 Cultural Landscape Assessment

The total score on the evaluation of cultural factors of the Urug Indigenous Village is 12, so it belongs to the very high category of cultural landscape diversity. The highest cultural factors are in the criteria for traditional festivals or festivities and traditional knowledge. While in Cipatat Non-Indigenous Village there are not many cultural factors found. The total score on the cultural factor evaluation of Cipatat Non-Indigenous Village is 2 so it belongs to the category of medium cultural landscape diversity. The results of the evaluation ratings of cultural factors can be seen in Table 2.
Table 2 Cultural landscape assessment result

| Criteria                                      | Urug Indigenous Village | Cipatat Non-Indigenous Village |
|-----------------------------------------------|-------------------------|--------------------------------|
| Presence of historical and archaeological sites | 3                       | -                              |
| Presence of traditional architecture          | 1                       | -                              |
| Important historical monuments                | -                       | -                              |
| Handicrafts                                   | -                       | -                              |
| Religious places                              | -                       | -                              |
| Traditional agriculture and products          | 1                       | 1                              |
| Traditional lifestyle                         | 1                       | 1                              |
| Traditional festivals and festivities         | 4                       | -                              |
| Traditional fishing                           | -                       | -                              |
| Traditional knowledge                         | 3                       | -                              |
| Recreation and aesthetic values               | -                       | -                              |
| **Total**                                     | **13**                  | **2**                          |

3.3 Assessment of Biodiversity Index

3.3.1 Assessment of Biodiversity Index in Urug Indigenous Village

Land use in the Urug Indigenous Village is forest, Larangan forest, Sago Palm plantations, rice fields, and settlements. The biodiversity assessment in the Urug Indigenous Village was carried out only in Larangan forest and forest. Biodiversity assessments are not carried out on Sago Palm plantations and paddy fields because there is no vegetation diversity. The settlements in are densely populated and the majority did not have yards. According to Boon and Tideman in Soerianegara and Indrawan [10] the sampling intensity for an area of less than 1000 ha is 10%. The Larangan forest has an area of 2 ha so that the number of sample plots taken is 5 plots. The forest has an area of 2.5 ha so that the number of sample plots taken is 7 plots. The calculation results of the Biodiversity Index of Urug Indigenous Villages can be seen in Table 3.

Table 3 Biodiversity index in Urug Indigenous Village

| Landuse     | Plot | Biodiversity Index | Average | Category |
|-------------|------|--------------------|---------|----------|
| Larangan Forest | Plot 1 | 1.20               | 1.70    | Medium   |
|              | Plot 2 | 2.10               |         |          |
|              | Plot 3 | 1.70               |         |          |
|              | Plot 4 | 1.77               |         |          |
|              | Plot 5 | 1.71               |         |          |
| Forest       | Plot 1 | 2.32               | 2.16    | Medium   |
|              | Plot 2 | 2.14               |         |          |
|              | Plot 3 | 1.93               |         |          |
|              | Plot 4 | 2.28               |         |          |
|              | Plot 5 | 2.21               |         |          |
|              | Plot 6 | 2.22               |         |          |
|              | Plot 7 | 1.99               |         |          |
| **Average**  |       | 1.96               |         | Medium   |

Larangan Forest is located south of Urug Indigenous Village. This forest is very strictly guarded by customary rules. Twenty one species of vegetation was found in Larangan Forest. The most commonly found species are the Sago Palm (*Metroxylon sago*), Saninten tree (*Castanopsis argentea*), and Puspa tree (*Schima wallichii*). The sago palm tree is mostly found because their leaves are still used as roofing materials for traditional houses and some community houses. The Saninten tree that is mostly found in the prohibited forest mostly grows on its own by the seed. Puspa trees are commonly not only in the prohibited forest but also in almost all villages.

The forest is located north of the Indigenous Village of Urug. Although it is not a prohibited forest, this forest is still protected by the community. Thirty three species of vegetation was found in the forest. The most commonly found species were the puspa tree
(Schima wallichii) and bamboo (Bambusa sp.). The forest area near the ancestral tomb is a cliff area so that the presence of bamboo plants can prevent erosion and landslides.

According to the traditional leader there is a proverb used as a guide in preserving nature. The proverb says, “gunung dikayuan, lemping diawian, legok di balongan”. The meaning of this proverb is that mountains cannot be bare and must be planted with trees, cliffs must be planted with bamboo, and valleys are used as storage areas for water. The existence of rules regarding preserving nature and the community's need for a variety of plants has caused the Urug Indigenous Village community to protect the natural resources in the forest and prohibited forest. The maintained condition of the forest and the prohibited forest has resulted a fairly high biodiversity index value.

3.3.2 Assessment of Biodiversity Index in Cipatat Non-Indigenous Village
Cipatat Non-Indigenous Village had no forest area because most of it was surrounded by oil palm plantations. Biodiversity assessment in Cipatat Non-Indigenous Village was carried out on Cultivation Rights Title (HGU) land and private property planted by residents of various types of trees. The sampling intensity used was the same, which was 10%. HGU land has an area of 1.32 ha so the number of sample plots was taken was 4 plots. Private land has an area of 0.64 ha so that the number of sample plots taken is 2 plots. The results of the calculation of the biodiversity index in Cipatat Non-Indigenous Village can be seen in Table 4.

| Landuse       | Plot | Biodiversity Index | Average | Category |
|---------------|------|--------------------|---------|----------|
| HGU land      | Plot 1 | 0.94               | 1.19    | Medium   |
|               | Plot 2 | 1.04               |         |          |
|               | Plot 3 | 1.13               |         |          |
|               | Plot 4 | 1.65               |         |          |
| Private land  | Plot 1 | 1.44               | 1.64    | Medium   |
|               | Plot 2 | 1.83               |         |          |
| Average       |       | 1.34               |         | Medium   |

Cipatat Non-Indigenous Village does not have many open land area. These lands are mostly HGU and private property. Most of the land in Cipatat Non-Indigenous Village is used by the community as tree plantations where the results can be sold. This causes the biodiversity is not too high. Vegetation found in 4 sample plots in HGU land were 15 species. The species most commonly found is the teak tree (Tectona grandis). This tree was intentionally planted for wood products. The vegetation found in two sample plots in private lands were 13 species. The species most commonly found is the banana (Musa sp.). Communities plant more diverse on privately owned land. The area of privately owned land in Cipatat Non-Indigenous Village is not too large, so that the community utilizes the land by planting a variety of crops that can be harness.

3.4. Comparison of Biodiversity Index in Indigenous and Non-Indigenous Village
The biodiversity index for Urug Indigenous Village is 1.96 and Cipatat Non-Indigenous Village is 1.34. Although the biodiversity value of the Urug Indigenous Village is higher than the Cipatat Non-Indigenous Village biodiversity index, both are in the medium category. To find out whether the difference in the two biodiversity index statistically real, two samples T-tests were performed. The T-test was performed on SPSS software and T-test results are shown in Table 5.
Table 5 T-Test results

| Index | Equal variances assumed | t   | df  | Sig. (2-tailed) | Mean Difference | Std. Difference Error | 95% Confidence Interval of the Difference |
|-------|--------------------------|-----|-----|-----------------|-----------------|-----------------------|------------------------------------------|
|       |                          | -3.732 | 16 | **0.002**      | -0.626          | 0.16769               | -0.981 to -0.270                        |

The significance value for the T Test is 0.002. This value is smaller than 0.05, which means that at a 95% confidence level there are significant differences between the averages of two biodiversity index. So it can be concluded validly that the biodiversity index in Urug Indigenous Village is higher than the biodiversity index in Cipatat Non-Indigenous Village.

The factor that seems to influence the difference in biodiversity index values is land use. In Urug Indigenous Village there is still natural forest while in Cipatat Non-Indigenous Village the land use is almost entirely man-made. The land in Cipatat Non-Indigenous Village was planted by the community and turned into a garden. The forest in Urug Indigenous Village is protected by customary law, both the Larangan forest and the forest in the north of the village. Most vegetation in the forest and Larangan forest grows naturally.

Land use in the Urug Indigenous Village is influenced by local wisdom. There are prohibitions and customary laws governing the use of protected land and areas. Based on the results of research conducted by King et al [11] there is a relationship between religious and spiritual values with nature. Biodiversity is related to living things as a holistic system. Biodiversity is seen as a unity and makes a link between living things.

3.5. Correlation Analysis of Local Wisdom with Biodiversity

Correlation analysis between local wisdom and biodiversity was carried out using logistic regression. Logistic regression analysis was performed using software SPSS.

Table 6 shows the logistic regression coefficient R² (Nagelkerke R square). The value of R² is 0.570, which means 57% of local wisdom can be explained by the index of biodiversity and the remaining 43% is explained by external factors.

Table 6 Summary model logistic regression

| Step | 2 Log likelihood | Cox & Snell R Square | Nagelkerke R Square |
|------|------------------|----------------------|---------------------|
| 1    | 13.401           | 0.411                | **0.570**           |

The variables in the equation table in Table 7 show whether the biodiversity index variable significantly influences the chance of local wisdom. The significance value for the biodiversity index is 0.025 less than 0.05 so it can be concluded that the biodiversity index has a significant effect.

Table 7 Variables in the equation logistic regression

| Step | B     | SE    | Wald | df | Sig. | Exp (B) | 95% CI for EXP (B) |
|------|-------|-------|------|----|------|---------|-------------------|
| 1    | Index | 4.704 | 2.097 | 5.035 | 1 | **0.025** | 110.432 to 6725.74 |
|      | Constant | -7.177 | 3.521 | 4.156 | 1 | 0.041 | 0.001 |

The logistic regression equation was obtained by entering the value of B which is in Table 7. The logistic regression equation obtained are as follows,

\[ p = \frac{e^{-7.177+ 4.704X}}{1+ e^{-7.177+ 4.704X}} \] ... (3)
Information

\[
P = \text{Opportunity \quad Y = 1} \\
Y = \text{Local Wisdom} \\
X = \text{Biodiversity Index}
\]

The value of \( B_0 \) shows the kind of correlation that occurred. In the acquired equation the value of \( B_0 \) for the biodiversity index shows a positive value. This means that biodiversity and local wisdom have a positive correlation. The higher the value of the biodiversity index can increase the chances of the existence of local wisdom. Also the preservation of local wisdom can affect the biodiversity index.

3.6. Biodiversity Management Strategies based on Local Wisdom in Indigenous Village

Recommendations on biodiversity management strategies based on local wisdom were formulated using the SWOT analysis method. This method was carried out by interviewing expert namely, the traditional leader of the Urug Indigenous Village, community figure, the Head of the Urug Indigenous Village, and the Culture and Tourism Office.

Management strategies can be broadly grouped into 3 recommendations namely, 1) increasing collaboration between related parties, 2) strengthening cultural factors that can affect biodiversity levels, and 3) increasing community capacity through training and outreach. The first strategy is Pentahelix collaboration between the community, government, academics, entrepreneurs, and the media is very important in the sustainability of local wisdom and biodiversity in indigenous villages. Government support in legal aspects and financial assistance can be an opportunity to help maintaining the existence of traditional values.

Some cultural factors found in the Urug Indigenous Village can affect the level of biodiversity. Based on research conducted by Hasibuan et al [12], the type of vegetation can strengthen the characteristics of the cultural landscape. The existence of various kinds of plants also plays an important role in the culture of the Urug Indigenous Village. Traditional celebrations and ceremonies in Urug Indigenous Village are inseparable from ceremonial equipment obtained from the surrounding environment. Especially at Ceremonies Seren Taun various kinds of fruits are needed for offerings and food. Various types of flowers are also needed for the pilgrimage of ancestral tombs. Traditional architecture tends to use raw materials available in the surrounding environment. The traditional house of the Urug Indigenous Village uses wood as the basic material and a Sago leaf roof. This raw material will be re-planted and maintained if traditional architecture is re-applied. Re-application of traditional architectural elements will not only retain the character of the cultural landscape of the indigenous village, but also can preserve biodiversity. In addition, building a traditional house requires special expertise, such as weaving roof made of Sago palm leaf and carvings. This will create jobs for people who have these skills. Socialization regarding customary rules and cultural values needs to be done to the community of indigenous villages and surrounding areas. People who have knowledge of customary rules tend to obey the rules because they still believe that there is karma that will apply if they violate customary rules.

Training on environmental management also needs to be done considering that the Urug Indigenous Village community has a bad habit of littering. Garbage is thrown into the forest and reduces soil fertility and affects the growth of plants on it. Training on composting or 3R can reduce these bad habits.

4. Conclusion

The results of the calculation of biodiversity index in the Indigenous Villages of Urug and Cipatat Non-Indigenous Villages are 1.96 and 1.34. The species most commonly found in the Urug Indigenous Village are Sago Palm (Metroxylon sago), Saniten trees (Castanopsis argentea), Puspa trees (Schima wallichii), and Bamboo (Bambusa sp.). The species most commonly found in Cipatat Village are Teak trees (Tectona grandis) and banana (Musa sp.).
T-Test results show that there are significant differences in the two biodiversity indexes. So it can be validly concluded that the Urug Indigenous Village has a higher biodiversity index than Cipatat Non-Indigenous Village.

Logistic regression analysis shows that biodiversity and local wisdom have a positive correlation. The higher the value of the biodiversity index can increase the chances of the existence of local wisdom.

Management strategies can be broadly grouped into 3 recommendations namely, 1) increasing collaboration between related parties, 2) strengthening cultural factors that can affect biodiversity levels, and 3) increasing community capacity through training and outreach.

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