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SUSTAINABILITY STATUS ANALYSIS OF ESTUARIAN MANAGEMENT (CASE STUDY: KUALA TRIPA ESTUARIAN WATERS) NAGAN RAYA REGENCY

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ABSTRACT

The damage in Kuala Tripa Estuary needs sustainable management. This study is aim to determine the sustainability status of the ecological, social, economic, technological and institutional dimension as well as alternative directions for development policies in sustainable management of the Kuala Tripa estuary. This study uses a descriptive approach with the maintenance of survey methods and case studies. The study was conducted from May to July 2021. A total of 11 respondents were selected using purposive sampling and proportional sampling methods. Water quality measurements were also conducted (Salinity, dissolved oxygen, pH, temperature, BOD and COD) at three station points. To test the water quality, BOD (Bisolved Oxygent Demand) and COD (Chemical Oxygent Demand) were analyzed at the Aceh Health Laboratory. The data were analyzed using RAPFISH (Rapid Apprasial for Fisheries) software. The measured attributes are the ecological, social, economic, technological and institutional dimensions. The status of the Multi-Dimensional Scaling estuarine sustainability index status of Kuala Tripa is quite sustainable with a score of 55.41. The most sensitive attributes from the leverage analysis are used to identify efforts (policy recommendations) through the AHP (Analytical Hierarchy Process) method. The first alternative is water extension policy with a priority value of 0.29.

***Keywords**: estuary; sustainability; RAPFISH*

INTRODUCTION

Peatlands in the tropics cover an area of 38 million ha out of a total area of 200 million ha found worldwide (Daryono 2009). Aceh province has peat swamps along the west coast of Aceh including Tripa, Kluet and Singkil. One of the largest peat swamps damaged is the Tripa peat swamp area. According to Sufardi *et al.* (2016) The area of peat swamp forests as native ecosystems continues to shrink from 34,218.07 ha to 11,455.45 ha from 2006 to 2013, but observations in the primary forest field are now 80% more has been turned into agricultural land for oil palm plantations and mixed gardens. The level of peat maturity in the Tripa Makmur area is hemic with a peat depth as high as 3 meters (Afrijal *et al.* 2019).

Damage upstream also disrupts the hydro-ecology of the region, water drought during the dry season and flooding in the rainy season. Almost every rainy season also kuala tripa area becomes a subscription flood. Another causative factor is low topography, so there is an overflow of *Krueng* Tripa river water when rainfall is high and not balanced with *drainage* (Marina *et al.* 2021) .

If the estuary waters continue to be damaged, the lack of integration in estuarine management will disrupt the food chain mechanism resulting in reduced distribution, abundance and diversity of plankton, nekton and benthos in estuarine waters. Potential fishery resources will also affect regional social and economic development. This means that it will directly provide social and economic benefits to the coastal community as a whole, especially fishermen. If there is a balanced development plan, it is hoped that equity, growth and sustainability will be achieved (Erwina 2015).

The holistic assessment of sustainable ecosystems aims to synthesize information from biogeochemical drivers, biota, human activities, and communities, to social values and the objectives of managed systems are transparent, since effective stakeholder engagement is the basis of the process, with the ultimate goal of providing managers with timely and relevant scientific advice and informing the general public about the current status of natural resources (Muffley *et al.* 2020). Therefore, research is needed on the sustainability of Kuala Tripa estuary management.

RESEARCH METHODS

Time and Place

This research has been conducted from May 11, 2021 to July 16, 2021 in Estuaria Kuala Tripa, Tripa Makmur Subdistrict, Nagan Raya Regency. The research picture is shown in figure 1.

Research Procedures and Approaches

The research approach uses a descriptive approach that is a research method that aims to provide an explanation of a current situation or phenomenon, with the maintenance of case*study*methods to answer actual problems (Indrayana *et al.* 2014).

A case study is an exploration of "a bound system" or "a case/ variety of cases" that over time through deep data collection and involves various sources of information that are

"rich" in a context. This bound system is bound by time and place while cases can be studied from a program, event, activity or an individual (Wahyuningsih 2013).

Judging from the cases studied, according to Endraswara (2012), this research case study is a deviation from curative fairness and is called*retrospective case study*,which allows for follow-up healing or improvement of a case (treatment). The act of healing does not have to be done by the researcher, but by someone else who is competent. Researchers only provide input from the results of the study.

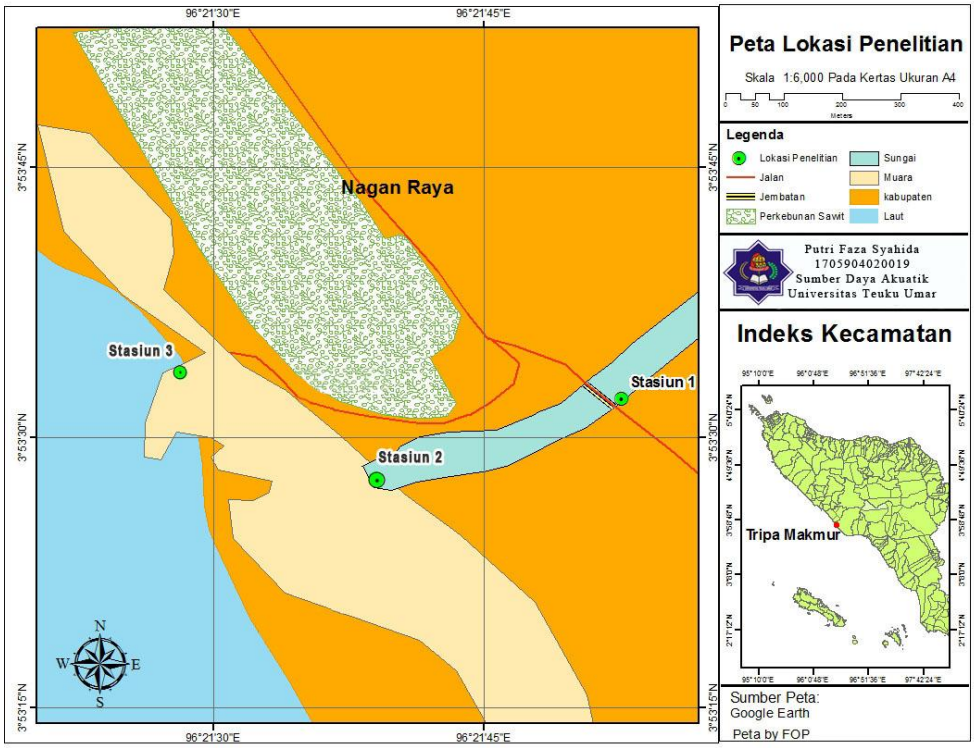

Figure 1. Research Location

Methods of Data Collection / Sampling

The study used primary data and secondary data related to sustainability dimension attributes: ecological dimensions (9 attributes), social (6 attributes), economics (5 attributes), technology (5 attributes) and institutional (4 attributes). Attributes in each dimension are determined based on relevant sources of previous research. The attributes in this study are:

The survey method is a process that is preceded by observation and then systematic, logical, objective, and rational recording of various phenomena in the actual situation (Kristanto 2018). The survey method is used to measure *in-situ* and *ex-situ* water quality at 3 sampling point locations. The distance of station 1 to station 2 is 0.46km while station 2 to station 3 is 0.43km. Secondary data is obtained from related agencies, such as the Village Office and other research results related to this research.

Data Analysis

To find out the sustainability status of Kuala Tripa's estuary utilization efforts, an analysis of the sustainability of the ecological, social, economic, technological and institutional dimensions using RapFish software developed by *the Fisheries Center, University of British Colombia was conducted.* RapFish is one of the recommended methods to assess the effectiveness and predict the sustainability of natural resource management, especially in coastal areas (Adiga *et al.* RapFISH's approach in Brazil has been applied to fisheries management practices since the mid-1990s and today the approach has gained space and credibility from managers who see the method as an important tool for more realistic consolidation of public policy by modifying existing fisheries patterns (Braz Neto *et al.* 2021).

RESULTS AND DISCUSSIONS

Overview of Research Locations

Geographically Nagan Raya Regency is located at 2°-4° North Latitude and 25°-97°10' East Longitude. Nagan Raya regency has an areaof 311,480 km2 (Diana and Ananingtyas 2018). Nagan Raya Regency is one of the districts in Aceh Province located on the west-south coast of Aceh, which is the expansion of West Aceh Regency, with the name of the capital of Nagan Raya Regency is Suka Makmue and has 10 sub-districts. Tripa Makmur District is one of the expansion subdistricts in Nagan Raya Regency from its parent district Darul Makmur District.

Ecological Dimensions

Based on the history and morphological condition of the Tripa Area Below has a relatively sloping land character so that the wetland area is formed in the form of swamps. The threat of flooding in the settlement of Kuala Tripa occurs due to the geographical conditions of the area in low-lying areas and water / swamp environments. The number of rivers and waterways around settlements also increases the threat of flooding, especially due to high tides.

Salinity in the waters of Estuaria Kuala Tripa ranges from 6-23 ppt. The mouth of kuala tripa's Estuari river includes *biochemical filter*areas. *Biochemical filters* are limited to salinity of 15-30 ppt and have a high level of biological

productivity because the sea has high salinity and ionic strength going upstream with fresh water that has low salinity and low ionic strength. The condition is almost the same as hamzah and saputro research (2013) the salinity of Estuaria Perancak at the time of tide 7km from the mouth of the river has a salinity of 26.4%o. The mixing of the mass of seawater with fresh water makes the salinity of the estuary fluctuate. This variation in salinity determines the life of marine/brackish organisms.

Dissolved oxygen content increases due to the diffusion of air to water. In the estuary area of Perancak, the value of dissolved oxygen content tends to be below 5mg /l, this is due to the confinement of the level of solubility of dissolved oxygen *(solubility)* at a higher salinity (Hamzah and Saputro 2013). But in Estuary Kuala Tripa, the DO value is higher at the mouth of the estuary/Station 3 than at Station 1 at 5.8mg/l due to greater use of oxygen to decompose organic compounds. The results of dissolved oxygen (DO) tests in the waters of Kuala Tripa showed that their value decreased as BOD and COD levels increased. In accordance with the theory that if the dissolved oxygen content is low, then the waste material

Organic in high water and vice versa. Organic matter lowers the oxygen content will have an impact on the life of aquatic organisms. BOD parameters are generally widely used to determine the level of water pollution. High BOD indicates the occurrence of organic pollution in the waters. The high BOD is in Staiun 1 which is in settlements and community plantations. The BOD Value of Station 1 is 17mg/l.

Agricultural intensification waste results such as fertilizers, greases and pesticides will affect the water quality in the lower watershed, so the need for oxygen to decompose these organic compounds is high which causes cod levels to be also high at Station 1. The results of COD Analysis at Station 1 are 41.6 mg / l while Station 2 and Station 3 are analyzed below the quality standard. The results of the analysis of Station 2 are 38.4 mg / l and Station 3 is 2mg / l. The same results were also found in the results of the IRHAM ET AL COD *test.* (2017) in the waters of Krueng Cut where the confectionation of organic compounds is more dominant from upstream than the marine area.

The process of decomposition of organic matter can produce acids to decrease the process of mineralization of organic matter (Yuningsih *et al.*2014). The pH range of Estuary Kuala Tripa tends to be acidic with a ph value range of 5.6-6.2. The results are the same as the research of Amri *et al.* (2018b) in May the degree of water security at the mouth of the Siak River is much lower with a pH of 5.9. If identified based on the color of water such as tea water color and water mass with low pH indicates the dominance of peat water. The acidity (pH) value of an ocean characterizes the balance between acids and bases in water and is a measurement of the concentration of hydrogen ions in solution. Because of the pH.

Social Dimension

Learn through experiences that have been passed and learn from the experiences of others, both neighbors and from other villages that are constructive. However, the background of formal education is inadequate there will be a tendency of those who are less able to see opportunities and dynamic in carrying out their performance and activities (Riskawati *et al.* Kuala Tripa community education has been better for the last five years 55% of the community continued secondary school, 23% of elementary schools and 22% did not pursue formal education.

Conflict between fishermen in the utilization of fish resources in Kuala Tripa, relatively high, which is an average of >5 times / year. Conflicts that often occur are*fishing ground*areas. The big conflict that occurred this year is sand dredging for the construction of ponds. The community is worried about abrasion in addition to trucks going in and out of polluting the villagers of Kuala Tripa. The conflict was resolved in deliberation on the condition that each truck taking sand pay 20 thousand / village and the people of Kuala Tripa get the opportunity to work in the pond.

Economic Dimensions

The selling price of TBS oil palm farmers tripa Makmur district frangko garden according to the results of research Nasution *et al.* (2017) in table 4.3 is Rp. 1,329,-. For the business rate of oil palm oil farmers the average people's production like this is good.

Based on the results of the analysis obtained that income from plantation products is more than fishing which results less than UMR. So that people prefer to be oil palm farmers compared to being fishermen because the results do not settle on the catch. Like the current western season people can not go to sea and get catches only in Krueng Kuala Tripa. Therefore, Kuala Tripa village fishermen belong to the group of side fishermen or additional part-time fishermen, namely fishermen whose small working time is used to do fishing work, other aquatic animals and aquatic plants.

Technological Dimensions

Sedimentation dredging using heavy equipment has been done thanks to the help of the village community.. The fishing fleet is about 12 ships. Fishing gear used in Estuaria Kuala Tripa is bubu,*cast net*,bag trawler*(seine net)*,and fishing rod (handline).

Fishing gear with high selectivity becomes an important factor so that fish caught have a uniform size (Sulistiono *et al.* 2001). With a net eye size of 1/4 inch to 2inch and a width of 2 meters of fish caught variously, the main catch in the estuary kuala tripa is belanak fish *(Mugilidae)*. August is the peak of spawning belanak (Wigati and Syafei 2013). For that in order to sustainable fishing should not be done at all times including when the fish colonize.

Estuaria Kula Tripa is also in the process of building a shrimp farm but based on interviews from the community the owner of the pond is not from the local community. In this case, the community has not been able to utilize existing resources to be sustainable.

Based on interviews, there are differences of opinion between the Marine and Fisheries Service and the fishing community regarding technological assistance from the government according to the Fisheries and Marine Service has been done the distribution of fishing gear to the community but recognition from the community has never been done the distribution of fishing gear or the capture fleet. Even today there are some ships that have been damaged and are no longer in use.

Rapfish's analysis of the technology dimension (Figure 2)shows a technology dimension sustainability index value of 48.41 (less sustainable) with the most sensitive attributes based

on *leverage* results (Figure 3) namely: knowledge of technology.

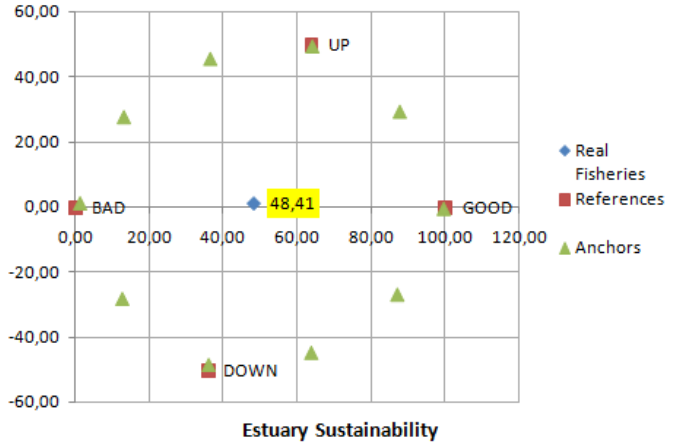

Figure2. Rapfish Analysis Results of Technological Dimensions

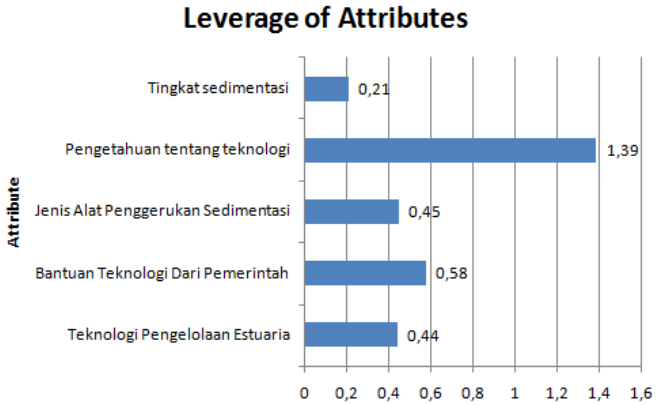

Figure 3. Results of Technology Dimension Leverage Analysis

Institutional Dimensions

From the results of interviews with several stakeholders showed that nagan raya district institutions have not managed in kuala tripa estuary. Institutions have also tried to apply for funds to conduct management.

Fishermen in kuala tripa waters have local regulations / wisdom in the management of estuary resources and have been agreed together with fishermen. Local wisdom such as supervision of fishing areas and fishing procedures at sea *(Meupayang)* by the commander of laot, *Adat Uroe Abstinence Meulaot* (Abstinence Day) is not to sea Friday and religious holidays. Violations of the rules in the form of social sanctions such as reprimands by the fishing community and fines.

Supervision is also carried out by the Environment Agency with water quality controllers every month in companies and waters that are indicated to have an influence on pollution burdens or based on reports from the community such as cases of dead fish in lamie waters. However, water quality control has never been carried out in the waters of Kuala Tripa. This is because the result of several kilo meters of control of water cauldrons from the indication point is already in good condition (unpolluted).

Based on suranda and zakaria research (2018), the extent of the impact of pollution carried out by PT. Sawit Nagan Raya Makmur based on community statements that the impact has been widespread not only Ujong Lamie village is affected by the waste but also extends to several villages, such as Kuta Trieng, Lamie, Tripa Ateuh, Tripa Bawah and up to the sea of liquid waste brought by river currents, so that people who use the river to bathe, wash clothes and net fish in the river, experiencing hives.

Sustainability of Multi-dimensional Kuala Tripa Estuary Management

The results of statistical value measurement in rapfish analysis there are five dimensions of sustainability management of Estuaria Kuala Tripa can be seen graphically in (Figure 4.13) obtained the ordnation value of 57.90 which shows that the sustainability status of kuala tripa estuary management is quite sustainable and the results of statistical value measurement in RAPFISH analysis there are five dimensions of sustainability management estuaria Kuala Tripa can be seen graphically in (Figure 4.13) in Obtained an ordination value of 57.90 which shows that the sustainability status of Kuala Tripa estuary management is quite sustainable and the *Stress* and R2 Value (coefficient of determination) serves to determine the need to add attributes to accurately assess the dimensions (close to the actual condition) (Rozi 2018). The *stress* value obtained is 0.13 (13%) or close to 0 (zero). Based on the research of Yusuf et *al.* (2016) Tallo watershed estuary management stress value with a value of 0.12 (12%). According to Edwarsyah (2008) *the value of stress* that can be allowed is if the value is below 0.25. The *stress* value is close to zero, the more the output produced is similar to the actual state or the lower the *stress* value, the better the model. Conversely, the higher the value of stress, the more inappropriate the model.

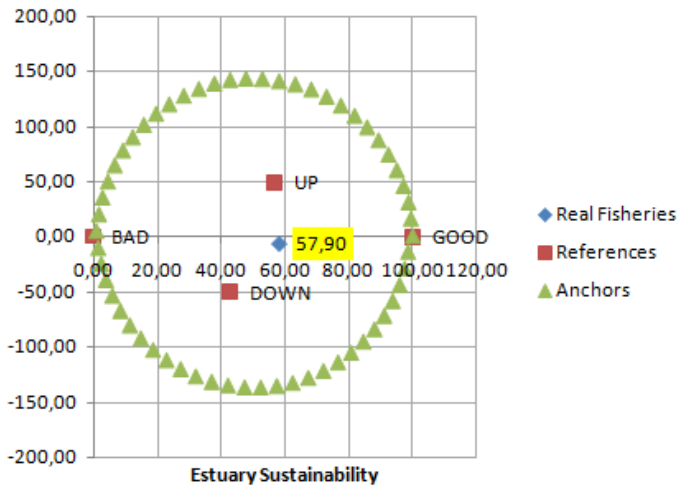

Figure 4. Multi-Dimensional RAPFISH Analysis

According to Kavanagh (2001) *a Squared Correlation* (R) value of more than 80% indicates that the sustainability index forecasting model is well and adequately used. The coefficient of determination of Kuala Tripa's estuary management is 0.93 (93%) or close to 1. These values show that all attributes studied from all five dimensions and multi-dimensional analysis are accurate enough to provide good analytical results and can be accounted for.

Leverage Attributes in Kuala Tripa Estuarial Management

To determine the attributes that have an influence on the sustainability index, leverage*analysis*is carriedout. The most sensitive attributes will contribute to sustainability in the form

of Root Mean *Square* (RMS) changes on the X axis (sustainability scale). The greater the value of rms changes the greater the role of these attributes or the more sensitive in the formation of sustainability values on the sustainability scale. This leverage analysis is basically to see how it affects sustainability scores (Nababan *et al.* 2007).

Based on the results of *leverage* analysis obtained from five dimensions there are 5 main attributes that are lever attributes or attributes that give the highest influence / role to the sustainability of Kuala Tripa estuary management. The five attributes selected are *Disolved Oxygent* Level (8.15), Water Extension (17.81), Business Diversification (3.13), Knowledge of technology (11.28), and Socialization of fisheries regulations (31.93). These important and most sensitive attributes are sorted using the AHP (Analytical*Hierarchy Process)*method to identifyefforts (policy recommendations) that can be made to improve sustainability of management in Estuaria Kuala Tripa.

Alternative Kuala Tripa Estuary Management Recommendations

The AHP *(Analytical Hierarchy Process)* is used to determine the priorities of several alternative options. The main priority is the extension of the waters with a priority weight of 0.29. With the efforts of water extension from competent experts it will affect the knowledge, skills, and attitudes of the community about the conflation of oil palm land to the waters because of the ecological continuity of aquatic ecosystems with terrestrial ecosystems (Policy on the use of oil palm fertilizer that can affect groundwater). According to Riska *et al.* (2021) oil palm plantations have an impact on the residential water of the community smelling, oily, and more murky water. Extension Definition based on Government Regulation No. 62 of 2014 concerning the Implementation of Education, Training, and Extension of Fisheries is interpreted as a learning process in order to increase the capacity of the main actors and business actors of the marine and fisheries sector to organize themselves in developing fisheries business to increase their income and welfare while considering the preservation of environmental functions. In the management of tallo watershed alternative I is the strengthening of institutional managers who will provide clarity in the management and utilization of resources, the implementation of programs from various sectors, as well as various rules and policies that can be harmonized, so that there is no overlap of interests and programs (Yusuf *et al.*2016).
The new economic policy is the fourth alternative with a priority weight of 0.16 through diversification of fisheries activities by developing the entrepreneurial spirit of fishermen who aim to penetrate the global market and can support the nagan raya government's plan as a minapolitan area. It is also supported by the help of business capital that needs to be considered.

The fifth alternative with a weight of 0.15 is to provide assistance with fishing facilities and infrastructure to increase fishing production through the development of environmentally friendly technology and assistance so that fishermen are able to operate their technology. According to Nababan *et al.* (2007) When there is an aid subsidy, fishermen will exploit resources to the maximum therefore subsidies are directed to high high stocks of fish. So that there is no overexploitation in the estuary of Kuala Tripa, estuaria is used during certain seasons only.

CONCLUSIONS

The sustainability status of Estuaria Kuala Tripa management belongs to the category of quite sustainable with an index value of 57.90. Sustainability scores for ecological, social, and economic dimensions are in the range of 52-57 with fairly sustainable status. Meanwhile, the institutional dimension is in the status of sustainability, while the technological dimension is at a less sustainable status..

To improve the sustainability of Kuala Tripa estuary management, here are some recommendations and policy alternatives in the form of:

a. The first alternative through counseling or assistance by the Marine and Fisheries Service of Nagan Raya regency and the Plantation Office with a value of 0.29.
b. The second alternative is to enforce the regulation of fishery resource management in Estuaria Kuala Tripa responsibly with a value of 0.24.
c. The third alternative approach to maintaining environmental quality through the concept of Multiculturalism and the implementation of peat swamp forest conservation strategies with a value of 0.17.
d. The fourth alternative of new economic policies through diversification of fisheries activities and business capital assistance needs to be considered at a value of 0.16.
e. The fifth alternative to the technology subsidy policy through providing assistance with the means and infrastructure of arrest with a value of 0.15.

The sustainability status of Estuaria Kuala Tripa management is the result of this research is an *existing* condition and may change in the future. Therefore, for similar research can be done in the next period by adding a more complete range of attributes, so as to describe the sustainability status for the management of Kuala Tripa estuary resources based on the relevant time series.

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