# The Relationship between salinity and pond area in the Mahakam Delta, East Kalimantan

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**ABSTRACT**

*This study aims to analyze the relationship between salinity and the extent and type of mangrove vegetation in ponds within the Mahakam Delta, East Kalimantan. Sampling was conducted in ponds with different salinity levels: 0–10 ppt, 11–20 ppt, and 21–30 ppt, with each salinity category represented by 10 pond plots. Data analysis was performed using linear regression. The results showed a strong relationship between salinity variation and pond area, with an r-value of 0.630. The extent of pond expansion is related to the original mangrove type present in the pond area. This information can be used as a basis for determining suitable aquatic species for cultivation based on salinity levels. In other words, the selection of aquatic species for cultivation can be adjusted according to the appropriate pond area. Further research is needed to determine whether other factors influence the relationship between salinity levels and pond area in the Mahakam Delta region.*

## INTRODUCTION

The Mahakam Delta region is predominantly mangrove forest and is considered one of the most unique coastal areas due to its ecosystem's presence in river estuaries or estuarine areas. The ponds in the Mahakam Delta consist of non-vegetated ponds and ponds with Rhizophora sp. vegetation. Traditional pond systems are adopted by all pond farmers in the Mahakam Delta using an extensive system, which involves increasing aquaculture production by expanding the cultivation area or land. The total pond area in the Mahakam Delta is 60,288.52 ha, accounting for 55.69% of the total 108,251.311 ha of the Mahakam Delta (Kutai Kartanegara Regency Marine and Fisheries Office, 2008).

Studies by Zwieten et al. (2006), Sidik (2010), and Bosma et al. (2012) indicate that large-scale mangrove ecosystem changes have primarily resulted from the conversion of mangrove forests into aquaculture ponds. The low productivity of these ponds has also led many pond owners to abandon them, leaving them neglected. According to Noryadi et al. (2006), the salinity levels in Mahakam Delta ponds range from 0 to 30 ppt, with salinity distribution affecting pond productivity levels.

This study aims to analyze the relationship between salinity and the extent and type of mangrove vegetation in aquaculture ponds within the Mahakam Delta, East Kalimantan.

## METHODOLOGY

The study was conducted in traditional aquaculture ponds within the Mahakam Delta, Kutai Kartanegara Regency, East Kalimantan Province. Sampling locations were selected based on salinity differences, categorized as 0–10 ppt, 11–20 ppt, and 21–30 ppt. According to Sidik et al. (2014), pond sizes ranging from 5 to 10 hectares exhibit better productivity compared to other pond sizes. The total number of ponds in the study area is approximately 300 plots, with 10% (30 plots) selected as sample locations, equally divided among the three salinity categories, with each salinity range represented by 10 ponds. The measured variables included salinity, pond area, and mangrove vegetation.

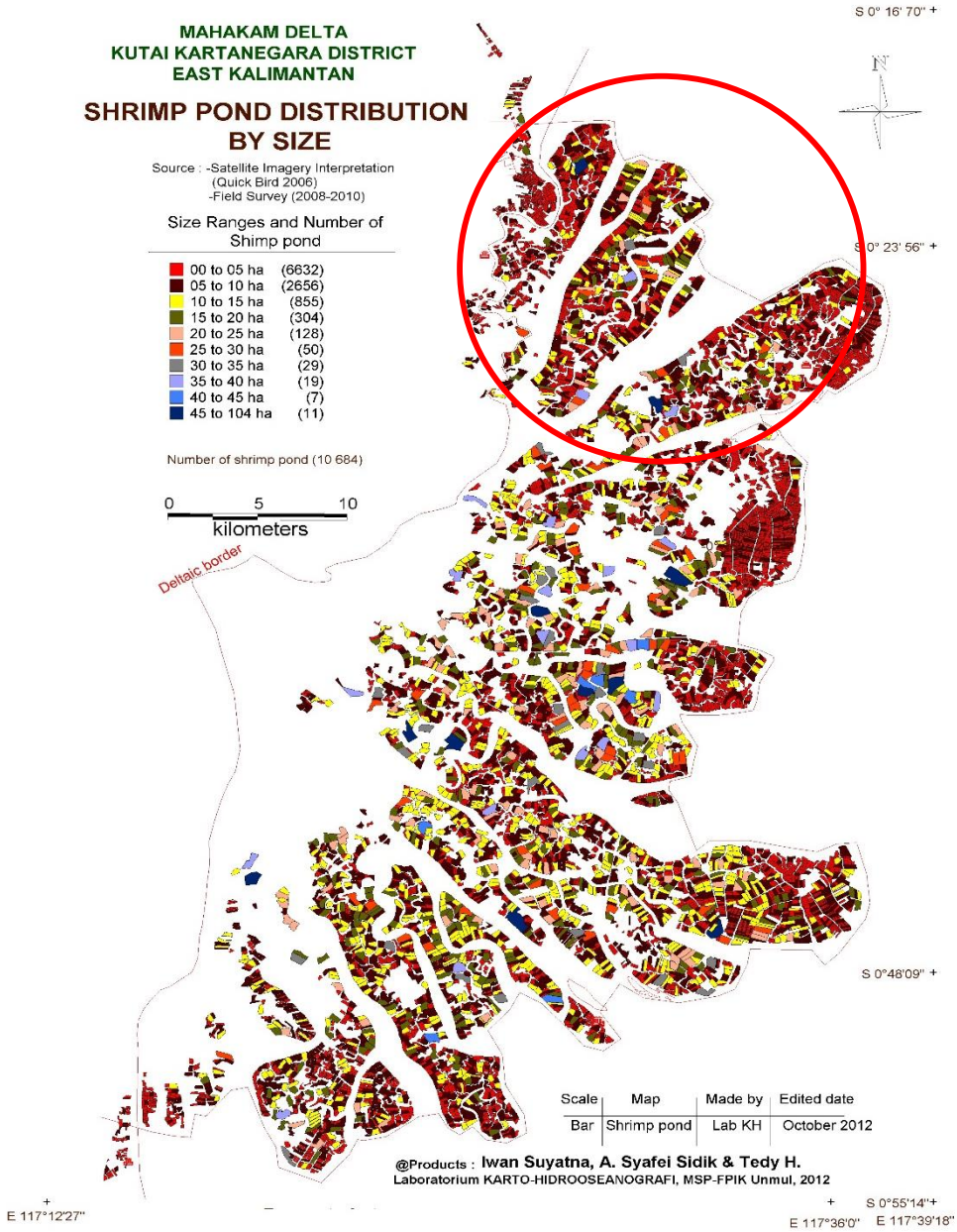


Figure 1. Research Location in Muara Badak District, East Kalimantan
*Source: Suyatna et al. (2012)*

**Data Analysis**

The relationship between salinity and pond area was analyzed using the regression equation (Gosling, 2003):

$$S = aL^b$$

or in logarithmic form:

$$\text{Log } W = \text{Log } a + b \text{ Log } L$$

Where:

W = Salinity (ppt)
L = Pond area (ha)
a = Constant, representing the regression line's intercept with the W-axis
b = Regression coefficient, indicating the slope of the equation relative to the L-axis

The correlation coefficient (**r**) is the square root of the **coefficient of determination ($R^2$)**. Correlation can be either **positive or negative**, depending on the relationship between the variables. A negative correlation means that as one variable increases, the other decreases. According to Sarwono (2006), the strength of correlation is classified as follows:

0.00 – 0.25 → Very weak correlation (considered negligible)
> 0.25 – 0.50 → Moderate correlation
> 0.50 – 0.75 → Strong correlation
> 0.75 – 1.00 → Very strong correlation

## RESULT AND DISCUSSION

Aquaculture in the Mahakam Delta has traditionally utilized sediment deposition areas for pond construction, resulting in variations in pond shape and size. The pond plots in the Mahakam Delta range from 2 to 100 hectares. The vast aquaculture area also contributes to differences in salinity distribution across individual ponds. These salinity variations influence both pond productivity and management methods in the region.

Several studies have been conducted on aquaculture in the Mahakam Delta. Almadi et al. (2008) examined silvofishery pond productivity using a polyculture system. Research on salinity issues in acid sulfate soils in coastal areas was conducted by Fanning (1993). Hadikusumah and Sumanjuntak (2011) investigated a freshwater-salinity-nutrient box model in the Mahakam Delta, focusing on the mechanisms of freshwater mass transport, salinity, and nutrient interactions between the Mahakam River and seawater.

The vertical salinity distribution in the Mahakam Delta exhibits high stratification. Phamvan et al. (2012) modeled salinity distribution and water movement in the Mahakam Delta. Their simulation results indicated that salinity levels at the front of the delta (bordering the Makassar Strait) reach 35 PSU, while in the central delta, salinity is below 20 PSU. Moving 15 km upstream, salinity decreases significantly to around 5 PSU, primarily due to freshwater input from the Mahakam River.

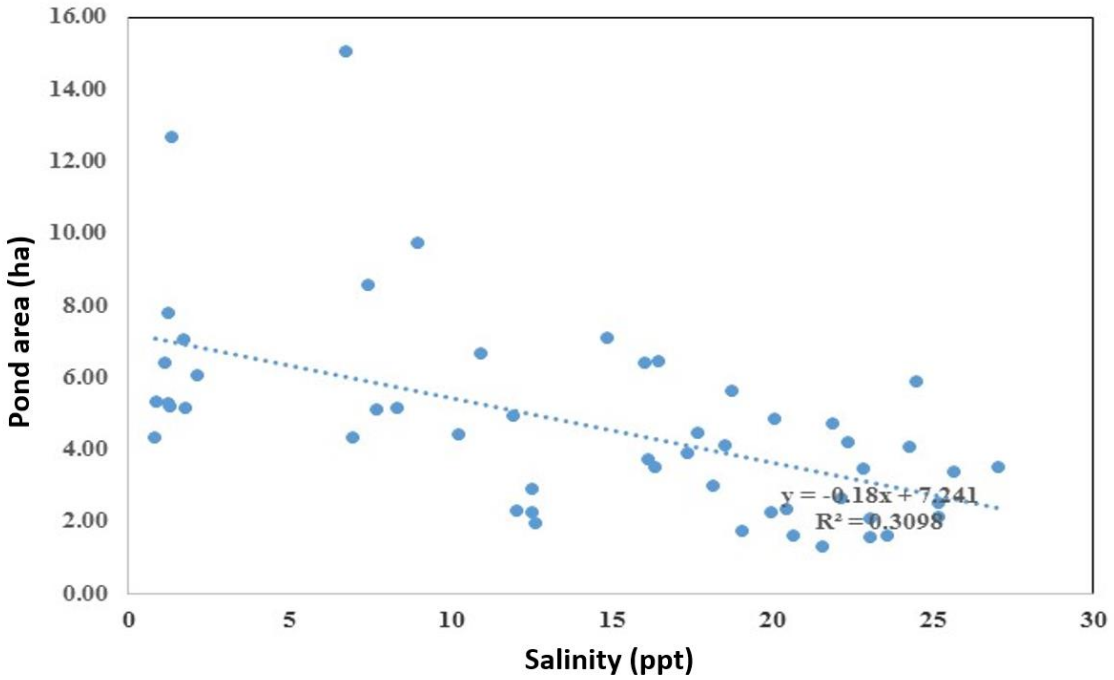


Figure 2. Regression of Salinity and Pond Area in the Mahakam Delta

The Figure 2 above shows an $R^2$ value of 0.556, which, when converted, corresponds to an r value of 0.630. This indicates a strong relationship between the salinity distribution pattern and the pond area. This relationship exists because the extent of pond development is linked to the type of mangrove present. The Nypa mangrove, which typically thrives in low-salinity areas, is easier to clear compared to true mangrove species such as Rhizophora sp., Avicennia sp., Bruguiera sp., and others. This also reflects the ability of fish farmers to establish ponds in the Mahakam Delta. Additionally, developing ponds in true mangrove areas requires substantial costs for renting equipment.

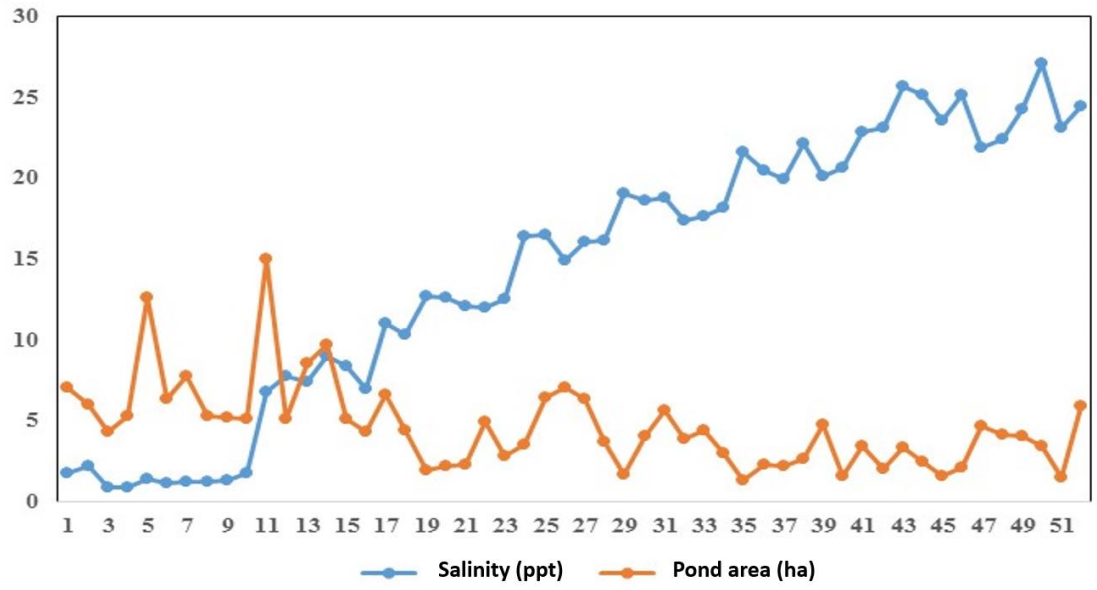


Figure 3. Relationship Between Salinity and Pond Area in the Mahakam Delta

According to Noryadi et al. (2006), aquaculture in the Mahakam Delta is generally of the "traditional plus" type. The ponds used in this study belong to H. Sukri, with an area of approximately 10 hectares for Rhizophora sp. ponds and another 10 hectares for ponds without vegetation. This region is part of the Mahakam Delta, or the estuarine area of the Mahakam River, which has a well-developed mangrove ecosystem. The research site is characterized by the presence of numerous Nypa palm trees growing along the Mahakam Delta's edges.

## CONCLUSION

The correlation results show an r value of 0.630, indicating a relationship between the salinity distribution pattern and pond area. The extent of pond development is related to the original habitat type within the ponds. This information can be used as a basis for determining suitable aquatic species for cultivation based on salinity levels. In other words, the selection of aquatic species for cultivation can be adjusted according to the appropriate pond area.

Further research is needed to determine whether other factors influence the relationship between salinity levels and pond area in the Mahakam Delta region

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