

# Effects of Sociodemographic Characteristics on Climate Change Literacy and Adaptation Strategies among Small-Scale Fishers in Takisung District, Tanah Laut Regency, South Kalimantan

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## ABSTRACT

Uncertainty in seasonal patterns and marine conditions requires small-scale fishers to understand climate information and adjust their fishing activities. This study aimed to analyze the effects of sociodemographic characteristics on climate change literacy, the effect of literacy on adaptation strategies, the direct effect of sociodemographic characteristics on adaptation, and the mediating role of literacy. A survey of 100 small-scale fishers was conducted in Takisung District, Tanah Laut Regency, South Kalimantan, from January to June 2026. Respondent eligibility criteria were established purposively, while participants were recruited through convenience sampling. Data were collected using questionnaires, structured interviews, observation, and documentation, and analyzed using partial least squares structural equation modeling (PLS-SEM). Sociodemographic characteristics were modeled as a formative construct, while literacy and adaptation were modeled as reflective constructs. Literacy had a positive and significant effect on adaptation strategies ( $\beta = 0.366$ ;  $t = 4.128$ ;  $p < 0.001$ ). The effects of sociodemographic

characteristics on literacy ( $\beta = 0.273$ ;  $p = 0.297$ ) and adaptation ( $\beta = 0.386$ ;  $p = 0.183$ ) were not significant. The indirect effect through literacy was also not significant ( $\beta = 0.100$ ;  $p = 0.317$ ). The model explained 7.5% of the variance in literacy and 36.0% of the variance in adaptation. Following respecification, adaptation was represented by fishing gear modification and changes in fishing locations. Climate literacy was a direct predictor of operational adaptation in the model, but its role as a mediator of the effect of sociodemographic characteristics was not established. These findings support the development of climate education linked to fishing decisions, while accounting for measurement limitations and the nonprobability sample.

**Keywords:** sociodemographic characteristics; climate change literacy; adaptation strategies; small-scale fishers; PLS-SEM.

## INTRODUCTION

Small-scale fisheries depend on ecological and weather conditions that determine opportunities to go to sea, fish locations, safety, and operating costs. Climate variability and change can disrupt

livelihoods by altering resource conditions and reducing households' ability to sustain fishing activities. Understanding adaptation therefore requires linking environmental changes to fishers' resources and decisions, rather than merely describing the physical characteristics of the climate (Badjeck et al., 2010).

Adaptation is the process of adjusting to environmental pressures or changes, whereas adaptive capacity refers to the ability to make such adjustments. This capacity is shaped by social, economic, informational, technological, and institutional conditions within a local context (Smit and Wandel, 2006). In coastal communities, assets, flexibility, social organization, learning, and agency are important dimensions of adaptive capacity (Cinner et al., 2018). Resource availability must therefore be considered alongside fishers' ability to interpret the changes they face.

In this study, climate change literacy was operationalized through an understanding of temperature changes, seasonal patterns, extreme weather, and sea-level changes. This understanding may help fishers select appropriate responses in their fishing activities. Knowledge may also be acquired through local observation and experience passed down or shared within communities (Berkes et al., 2000). However, the ability to recognize change does not necessarily translate into action when fishers face constraints related to information, technology, capital, or institutional support (Islam et al., 2014).

Sociodemographic characteristics, such as age, education, household size, fishing experience, and asset ownership, may shape learning opportunities and adaptation choices. Age and experience relate to accumulated knowledge; education relates to access to and comprehension of information; household members represent both labor and dependents; and assets influence the capacity to finance adjustments. These relationships need not be uniform because household characteristics

interact with environmental and institutional conditions (Cinner et al., 2018; Smit and Wandel, 2006).

Research on small-scale fisheries shows that adaptation encompasses a range of actions. Galappaththi et al. (2021) describe adaptation learning in communities with different social and knowledge contexts. Mozumder et al. (2023) also examine adaptation among Hilsa fishers from social, economic, and ecological perspectives. This literature indicates that fishing strategies and household livelihood strategies should be conceptually distinguished when incorporated into a measurement model.

Takisung District is a coastal area of Tanah Laut Regency facing the Java Sea. Small-scale fishing activities in this area are closely linked to wind, waves, seasons, and fishing-ground conditions. The research report identifies limitations in knowledge, technology, and facilities as important contextual factors affecting adjustments to fishing activities. The empirical question examined is whether sociodemographic differences are associated with adaptation directly or through climate literacy. Testing these three constructs simultaneously provides a more focused explanation than assuming that experience or asset ownership automatically leads to adaptation.

This study aimed to examine the effect of sociodemographic characteristics on climate change literacy, the effect of literacy on adaptation strategies, the direct effect of sociodemographic characteristics on adaptation strategies, and the indirect effect through literacy. The study contributes empirical evidence from small-scale fishers in Takisung and distinguishes literacy's role as a direct predictor from its role as a mediator within the same model.

## **MATERIALS AND METHODS**

### **Study area and research design**

The study was conducted in Takisung District, Tanah Laut Regency, South Kalimantan Province, from January to June 2026. A survey design was used to quantitatively analyze relationships among

constructs. Interviews, observation, and documentation provided supporting contextual information. The unit of analysis was the individual small-scale fisher. Given the observational design, the term effect refers to an estimated structural relationship and does not, in itself, establish causality.

### **Respondents and data collection**

The sample comprised 100 small-scale fishers. Eligibility criteria were established purposively: respondents had to be active fishers whose primary livelihood was fishing, reside or operate in Takisung District, be principal fishing operators or vessel owners, and use vessels of less than 5 GT. Vessel size served as an operational criterion for the study sample. Eligible respondents encountered at fish auction sites, docks, or fish landing sites were recruited through convenience sampling until the target sample size was reached.

The report determined the sample size using a rule of thumb based on a multiple of the number of indicators:  $14 \text{ indicators} \times 7 = 98$ , rounded to 100 respondents. This basis is reported as the procedure used in the study, rather than as evidence that statistical power was established through power analysis. Nonprobability sampling also limits the sample's representativeness of small-scale fishers beyond those reached by the study.

Primary data were obtained through questionnaires, structured interviews, and observation. Questions were read aloud or explained when necessary, and responses were recorded on the instrument. The data covered sociodemographic characteristics, climate literacy scores, and adaptation strategy scores. Secondary data were drawn from documents issued by Statistics Indonesia (BPS), the Tanah Laut Regency Fisheries Office, SiKakap, and relevant literature. Secondary information was used to describe the regional context and support the discussion, rather than replace measurements obtained from respondents.

### **Constructs and hypotheses**

Sociodemographic characteristics (SD) constituted a formative construct comprising age (SD1), education (SD2), household size (SD3), fishing experience (SD4), and asset ownership (SD5). Formative indicators represent distinct components and need not be interchangeable. Accordingly, they were evaluated using indicator weights, collinearity, and content considerations, rather than the internal consistency criteria applied to reflective constructs (Diamantopoulos and Winklhofer, 2001).

Climate change literacy (LP) was a reflective construct with indicators covering temperature changes (LI1), seasonal patterns (LI2), extreme weather (LI3), and sea-level changes (LI4). Adaptation strategies (SA) were initially measured through fishing gear modification (SA1), changes in fishing locations (SA2), non-fishing income (SA3), multiple livelihood activities (SA4), and additional business activities (SA5). Following measurement assessment, only SA1 and SA2 were retained in the final model.

The hypotheses tested were H1, sociodemographic characteristics have a positive effect on literacy; H2, literacy has a positive effect on adaptation; H3, sociodemographic characteristics have a direct positive effect on adaptation; and H4, literacy mediates the effect of sociodemographic characteristics on adaptation. Structurally, the model estimated  $LP = \beta_1 SD + \varepsilon_1$  and  $SA = \beta_2 LP + \beta_3 SD + \varepsilon_2$ . The indirect effect was represented by the product of  $\beta_1$  and  $\beta_2$ .

### **Data analysis**

PLS-SEM was used for the analysis; the report identified SmartPLS 4 as the software used. Reflective measurement assessment covered outer loadings, Cronbach's alpha, composite reliability, average variance extracted (AVE), and discriminant validity. The operational thresholds in the report were loadings  $\geq 0.60$ , alpha and composite reliability  $> 0.60$ , and AVE  $> 0.50$ . Loadings below 0.70 and relatively low

alpha values were nevertheless discussed as limitations, even when they met the study's thresholds (Hair et al., 2021).

The formative construct was evaluated using outer weights and the variance inflation factor (VIF), with a threshold of  $VIF < 5$ . Structural model assessment included the coefficient of determination ( $R^2$ ), model fit measures, and  $Q^2$  reported from a blindfolding procedure. Hypotheses were tested using bootstrapping, with thresholds of  $t > 1.96$  and  $p < 0.05$ . Mediation was assessed based on the significance of the specific indirect effect, rather than solely on the presence or absence of a direct relationship (Nitzl et al., 2016). Values displayed as  $p = 0.000$  in the statistical output were reported as  $p < 0.001$ .

## RESULTS AND DISCUSSION

### Respondent characteristics

The largest age group was 36–45 years (44%), followed by 46–55 years (22%). The

most common categories of fishing experience were 11–20 years (40%) and 21–30 years (33%). This profile indicates that most respondents had engaged in fishing for more than a decade. Extensive experience may provide local knowledge, but does not independently demonstrate high climate literacy or successful adaptation.

A total of 70% of respondents were recorded as having no formal schooling, while 2% left the education item unanswered. These categories were retained as reported; having no formal schooling does not automatically imply an inability to read. Nevertheless, this finding is relevant to designing information delivery using simple language, oral explanations, and illustrations related to fishing activities. Regarding household characteristics, 36% of respondents had four household members and 25% had five.

**Table 1 Respondent characteristics**

| Characteristic     | Category                | n (%)   |
|--------------------|-------------------------|---------|
| Age                | 24–35 years             | 16 (16) |
|                    | 36–45 years             | 44 (44) |
|                    | 46–55 years             | 22 (22) |
|                    | >55 years               | 18 (18) |
| Education          | No formal schooling     | 70 (70) |
|                    | Primary/lower secondary | 18 (18) |
|                    | Upper secondary         | 9 (9)   |
|                    | Diploma/bachelor's      | 1 (1)   |
|                    | No response             | 2 (2)   |
| Fishing experience | 2–10 years              | 12 (12) |
|                    | 11–20 years             | 40 (40) |
|                    | 21–30 years             | 33 (33) |
|                    | >30 years               | 15 (15) |
| Household size     | 1 person                | 4 (4)   |
|                    | 2 people                | 13 (13) |
|                    | 3 people                | 22 (22) |
|                    | 4 people                | 36 (36) |
|                    | 5 people                | 25 (25) |
| Asset code         | 1                       | 60 (60) |
|                    | 2                       | 31 (31) |
|                    | 3                       | 6 (6)   |
|                    | 4                       | 3 (3)   |

*Source: Primary data reported in Lasriyanto's thesis (2026).*

Asset ownership was dominated by code 1 (60%) and code 2 (31%). The report did not specify the asset types or values represented

by each code; these categories were therefore not interpreted as wealth classes or lists of particular possessions. This

limitation matters because the meaning of the sociodemographic construct depends on how assets are coded, particularly when the asset indicator carries a greater weight than the other indicators.

### Reflective measurement model assessment

In the initial model, adaptation indicators SA3, SA4, and SA5 had loadings of 0.145, -0.566, and -0.481, respectively. These indicators were removed and the model was re-estimated. Cronbach's alpha for adaptation increased from 0.297 to 0.616, composite reliability from 0.082 to 0.839, and AVE from 0.326 to 0.723. This statistical improvement was accompanied by a narrowing of the construct from broad livelihood adaptation to operational adjustments in fishing.

**Table 2 Outer loadings in the final model**

| Construct  | Indicator | Loading |
|------------|-----------|---------|
| Literacy   | LI1       | 0.846   |
|            | LI2       | 0.882   |
|            | LI3       | 0.842   |
|            | LI4       | 0.681   |
| Adaptation | SA1       | 0.859   |
|            | SA2       | 0.841   |

*Source: Primary data reported in Lasriyanto's thesis (2026).*

**Table 3 Reliability and AVE in the final model**

| Construct  | Alpha | CR    | AVE   |
|------------|-------|-------|-------|
| Literacy   | 0.830 | 0.888 | 0.666 |
| Adaptation | 0.616 | 0.839 | 0.723 |

*Source: Primary data reported in Lasriyanto's thesis (2026).*

All loadings in the final model met the study's threshold. LI4 had the lowest literacy loading, at 0.681, indicating that the sea-level change indicator requires further refinement in future instrument development. The alpha value for adaptation, 0.616, met the operational threshold but indicated more limited internal consistency than that of literacy. The reported CR and AVE values supported reliability and convergent validity; meeting these criteria does not remove the limitation

imposed by measuring adaptation with only two indicators.

Removing the diversification indicators does not imply that non-fishing income, multiple livelihoods, and additional business activities are unimportant to fishers. Rather, the findings indicate that these three indicators did not adequately reflect the same construct in this model and sample. Studies of adaptation in small-scale fisheries show diverse social and economic responses that may require separate measurement dimensions (Galappaththi et al., 2021; Mozumder et al., 2023).

### Formative construct and discriminant validity

**Table 4 Sociodemographic weights and VIF values**

| Indicator          | Weight | VIF   |
|--------------------|--------|-------|
| Age                | -0.354 | 1.734 |
| Education          | -0.079 | 1.025 |
| Household size     | 0.065  | 1.036 |
| Fishing experience | 0.239  | 1.761 |
| Asset ownership    | 0.889  | 1.056 |

*Source: Primary data reported in Lasriyanto's thesis (2026).*

VIF values ranged from 1.025 to 1.761, below the threshold of 5, indicating no excessive collinearity among the sociodemographic components. Asset ownership had the largest weight (0.889), while age and education had negative weights. These weights represent relative contributions to the composite and should not be interpreted as the individual effects of each indicator on adaptation. The report's results table also did not provide bootstrapping significance values for each weight; consequently, the significance of an indicator's contribution cannot be inferred solely from its weight.

The Fornell-Larcker assessment in the report showed square roots of AVE of 0.816 for literacy and 0.850 for adaptation. Both exceeded the literacy-adaptation correlation of 0.471. The correlations of sociodemographic characteristics with literacy and adaptation were 0.273 and 0.486, respectively. These findings support

the distinctiveness of the two reflective constructs (Fornell and Larcker, 1981). However, discriminant validity assessment remained limited to the criterion presented; HTMT results were unavailable in the report. HTMT could be considered in subsequent analyses to complement the assessment of discriminant validity (Henseler et al., 2015).

### Model fit and explanatory power

**Table 5 Structural model summary**

| Measure        | Literacy | Adaptation |
|----------------|----------|------------|
| R <sup>2</sup> | 0.075    | 0.360      |
| Q <sup>2</sup> | 0.042    | 0.220      |

*Source: Primary data reported in Lasriyanto's thesis (2026).*

The model's SRMR was 0.079, while its NFI was 0.725. The d\_ULS, d\_G, and chi-square values were 0.411, 0.159, and 93.952, respectively. SRMR was slightly below the report's threshold of 0.08, but NFI did not reach 0.90. Model fit should therefore be interpreted cautiously alongside measurement quality and structural results, rather than described as excellent on the basis of a single index.

Sociodemographic characteristics explained 7.5% of the variance in literacy, indicating limited explanatory power for literacy development. Together, sociodemographic characteristics and literacy explained 36.0% of the variance in adaptation. The remaining 92.5% and 64.0% represent variance unexplained by the model, rather than evidence that particular variables outside the model have been shown to exert an effect. R<sup>2</sup> measures explanatory power within the sample used and does not guarantee predictive accuracy for all fishers.

The reported Q<sup>2</sup> values were positive for literacy (0.042) and adaptation (0.220), with greater predictive relevance for adaptation. These values are not equivalent to evidence of out-of-sample predictive performance. Shmueli et al. (2019) recommend assessing prediction by comparing prediction errors on data withheld from estimation. Because the report did not provide PLSpredict results, the model's ability to predict

outcomes for new respondents remains uncertain.

### Direct relationships and mediation testing

**Table 6 Path coefficients and hypothesis tests**

| Path            | $\beta$ | t     | p      |
|-----------------|---------|-------|--------|
| H1 SD → LP      | 0.273   | 1.043 | 0.297  |
| H2 LP → SA      | 0.366   | 4.128 | <0.001 |
| H3 SD → SA      | 0.386   | 1.334 | 0.183  |
| H4 SD → LP → SA | 0.100   | 1.002 | 0.317  |

*Source: Primary data reported in Lasriyanto's thesis (2026).*

Only H2 received statistical support at the 5% level. H1, H3, and H4 were not supported. These conclusions follow the estimates presented in the report and were not derived from a reanalysis of the raw data. The distinction between coefficient magnitude and statistical significance is important: the direct coefficient for sociodemographic characteristics on adaptation was numerically larger than the literacy coefficient, but uncertainty in the estimate meant that the former relationship was not significant.

### Sociodemographic characteristics and climate literacy

The relationship between sociodemographic characteristics and literacy was positive but not significant ( $\beta = 0.273$ ;  $t = 1.043$ ;  $p = 0.297$ ). This result does not support the assumption that the combination of age, education, household size, fishing experience, and assets consistently differentiates respondents' literacy. A nonsignificant relationship also does not demonstrate that each characteristic is entirely irrelevant. The analysis tested the effect of the sociodemographic composite, rather than five separate individual effects.

Substantively, literacy may develop through learning processes that are not fully captured by household profiles. Local ecological knowledge is acquired through experience and knowledge exchange, while adaptation learning is also shaped by community context (Berkes et al., 2000; Galappaththi et al., 2021). Access to

forecasts, the intensity of extension services, and group interaction are potential explanatory factors worth investigating. However, these factors were not measured as predictors in this model and cannot therefore be identified as causes of the nonsignificant result.

### **Climate literacy and operational adaptation**

Literacy was positively and significantly associated with adaptation ( $\beta = 0.366$ ;  $t = 4.128$ ;  $p < 0.001$ ). Within the scope of the final model, fishers with higher literacy scores tended to have higher scores for adjustments to fishing gear and fishing locations. The value of 0.366 is a standardized path coefficient, not a percentage increase in catch or income. The study did not test whether these adjustments had improved welfare, safety, or fishing efficiency.

This relationship is consistent with the importance of learning for adaptive capacity in coastal communities (Cinner et al., 2018). Understanding seasonal patterns and extreme weather may provide relevant information when fishers consider how and where to fish. This explanation is an interpretation of the relationship between variables, rather than an experimental observation of decision-making processes. Resource constraints may also limit the application of knowledge, as discussed by Islam et al. (2014).

The practical implication is a need for learning activities that connect climate information to actual fishing choices. Materials could include examples of how to interpret forecasts, illustrations of changes in marine conditions, and discussions of respondents' experiences. Given the sample's educational profile, activities should not rely solely on technical reading materials. The effectiveness of these learning approaches still requires evaluation, as this study did not compare a training group with a comparison group.

### **Direct sociodemographic effects and the mediating role of literacy**

The direct effect of sociodemographic characteristics on adaptation was not significant ( $\beta = 0.386$ ;  $t = 1.334$ ;  $p = 0.183$ ). This finding suggests that resource ownership and demographic profiles do not necessarily translate into uniform operational adjustments. The adaptive capacity literature considers resources in interaction with flexibility, learning, and institutions (Cinner et al., 2018; Smit and Wandel, 2006). These interactions were not tested in this study and are therefore not presented as additional empirical findings.

The indirect effect of sociodemographic characteristics through literacy was 0.100 and was also not significant ( $t = 1.002$ ;  $p = 0.317$ ). The product of the path coefficients,  $0.273 \times 0.366$ , is approximately 0.100 and is consistent with the reported indirect effect. Evidence of mediation must be based on a test of the indirect effect itself (Nitzl et al., 2016). Thus, a significant literacy–adaptation path is insufficient to conclude that literacy mediates the effect of sociodemographic characteristics.

In this model, literacy is more appropriately regarded as a direct predictor of adaptation than as an established mediator. This finding distinguishes two questions that are often conflated: whether literacy is associated with adaptation, and whether literacy transmits the effect of sociodemographic characteristics. The data supported the first question but not the second. There was no basis for concluding either full or partial mediation.

### **Implications and study limitations**

The Fisheries Office, extension officers, and the Indonesian Agency for Meteorology, Climatology, and Geophysics (BMKG) could consider providing learning activities on weather and seasonal information to fishers with diverse sociodemographic profiles. Demographic characteristics alone are insufficient for identifying recipients of assistance. Materials should be linked to adjustments in fishing gear and locations,

accompanied by an assessment of needs and barriers to applying information. This recommendation is an implication of the study, rather than a claim that any particular agency's program has succeeded among Takisung respondents.

The first limitation is the use of nonprobability sampling with 100 respondents, which restricts generalizability. Second, the observational design does not establish causal ordering and allows for the influence of uncontrolled factors. Third, removing three indicators limited adaptation to operational aspects. Future instrument development should distinguish fishing adaptation from livelihood diversification so that conceptual breadth is not sacrificed for statistical consistency.

Fourth, the report did not specify the meanings of the asset codes, the treatment of the two missing education responses in estimation, or all parameters required for replication, including the number of bootstrap subsamples and confidence intervals for the coefficients. The report identified SmartPLS 4 and presented  $Q^2$  values labeled as blindfolding results, but the source and calculation steps for  $Q^2$  need clarification from the analysis output. These values are presented as reported, without reconstructing unavailable procedures.

Further research could measure access to weather information, the intensity of extension services, group participation, and technological and financing barriers using a theoretical framework. Repeated observations or evaluations before and after learning activities could help assess changes in literacy and adaptation. Larger samples and out-of-sample prediction tests are also needed to assess the model's applicability. These developments should aim to strengthen substantive explanations, particularly because the model explained only 7.5% of the variance in literacy.

## CONCLUSION

Among 100 small-scale fishers in Takisung District, sociodemographic characteristics had no significant effect on climate change

literacy ( $\beta = 0.273$ ;  $p = 0.297$ ) or direct effect on adaptation strategies ( $\beta = 0.386$ ;  $p = 0.183$ ). Literacy had a positive and significant effect on adaptation ( $\beta = 0.366$ ;  $p < 0.001$ ), while the indirect effect of sociodemographic characteristics through literacy was not significant ( $\beta = 0.100$ ;  $p = 0.317$ ); thus, mediation was not established. The model explained 7.5% of the variance in literacy and 36.0% of the variance in adaptation. Conclusions about adaptation are limited to fishing gear modification and changes in fishing locations, the indicators retained in the final model. The findings support the development of climate education linked to fishing decisions, but program effectiveness, causal relationships, and generalizability to all fishers require further testing.

## Declaration by Authors

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