Account and Financial Management Journal e-ISSN: 2456-3374
Volume 11 Issue 01 January 2026, Page No.-4024-4031
DOI: 10.47191/afmj/v11i1.05, Impact Factor: 8.167

Coastal Erosion in Togo: Land Losses, Income Decline, and The Urgency of Climate Justice

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ABSTRACT: The objective of this study is to analyze the effects of coastal erosion on the living conditions of coastal households in Togo, using cross-sectional household survey data collected in 2024. Relying on descriptive statistics and an ordered Probit model, the analysis highlights the significant negative impacts of shoreline retreat on household income, housing, and overall well-being. The results indicate, in particular, that exposure to coastal erosion increases by approximately 90 percent the probability of income decline among affected households. These findings confirm the high socio-economic vulnerability of coastal populations in Togo. The conclusions underscore the urgency of ambitious public policies aimed at coastal adaptation, shoreline protection, and compensation mechanisms, within a climate justice framework, in order to curb sea-level rise impacts and sustainably restore the livelihoods of affected populations.

KEYWORDS: Coastal erosion; Household living conditions; Ordered Probit; Vulnerability; Togo
JEL Classification : Q54 ; Q56 ; I32 ; C25

INTRODUCTION

Coastal erosion (CE) is a long-standing natural phenomenon resulting from interactions between marine dynamics, sediment transport, and shoreline morphology. However, its recent intensification is largely attributable to anthropogenic activities and climate change. Sea-level rise, uncontrolled sand mining, rapid coastal urbanization, and the construction of port infrastructure that alters sediment dynamics are among the main factors exacerbating the progressive and often silent advance of the sea (Bird, 2008; Temmerman & Kirwan, 2015; Alves et al., 2020).

This phenomenon now constitutes a major threat to the living conditions of coastal households, particularly in areas where livelihoods depend heavily on marine resources and coastal ecosystems. In West Africa, and more specifically in Togo, coastal vulnerability is intensified by high population density, limited coastal protection infrastructure, and weak institutional and financial capacities for climate adaptation (IPCC, 2023; WACA, 2020).

From an analytical standpoint, theoretical and empirical approaches used to study coastal erosion and its socio-economic impacts remain heterogeneous. Quantitative approaches primarily rely on econometric models to estimate the direct and indirect effects of erosion on infrastructure, income, and poverty (Nicholls & Tol, 2006; Dasgupta & al., 2009). In contrast, qualitative approaches emphasize household perceptions, social and cultural norms, and social and institutional vulnerability, dimensions often inadequately captured by purely statistical models (Adger & Kelly, 1999).

Empirical evidence shows that coastal erosion leads to land losses, housing destruction, reduced economic opportunities, and increased forced migration (Nicholls & Tol, 2006; Dasgupta et al., 2009). Other studies, notably IPCC (2023), also highlight indirect effects such as the deterioration of social capital, widening inequalities, and increased pressure on urban infrastructure. Although the resilience of socio-ecological systems is often promoted as a solution (Folke, 2006), some scholars criticize this approach for obscuring structural inequalities and shifting the burden of adaptation onto the most vulnerable populations (Pelling, 2011).

Despite national and regional initiatives aimed at improving integrated coastal zone management (Alves et al., 2020), the living conditions of coastal households in Togo remain highly threatened. This article therefore seeks to analyze the effects of coastal erosion on the living conditions of households along the Togolese coastline, with a particular focus on income and well-being. The originality of this research lies in the use of recent microeconomic data and in the econometric estimation of the probability of living-condition deterioration associated with shoreline retreat.

The remainder of the paper is organized as follows. Section 1 reviews the literature. Section 2 presents the methodological framework and econometric modeling. Section 3 analyzes and discusses the empirical results. The final section concludes and proposes policy recommendations.

1. LITERATURE REVIEW

1.1. Theoretical contributions

From a theoretical perspective, the literature converges on recognizing coastal erosion as a major negative externality of climate change and human activities. The most frequently cited adaptation strategies include the construction of seawalls and breakwaters, ecosystem restoration (mangroves and reefs), and the planned relocation of exposed populations, in line with Sustainable Development Goal 13 on climate action (Bolle et al., 2021).

Several authors emphasize that human activities accelerate sea-level rise and disrupt sedimentary balance, leading to land losses, forced displacement, and livelihood degradation (Gomez et al., 2020; Lassey et al., 2024). Other studies highlight localized accretion phenomena that generate temporary land gains, although these remain marginal compared to the overall scale of erosion.

The literature thus remains divided between a techno-economic vision of adaptation and a critical approach emphasizing the social, institutional, and distributive dimensions of coastal erosion. This divergence continues to fuel scientific and policy debates, particularly in highly exposed developing countries (Alves et al., 2020).

1.2. Empirical evidence: coastal erosion and living conditions of coastal households in Togo

Most scientific studies examining coastal erosion in relation to household living conditions focus primarily on the damages it causes. Coastal populations typically face a double vulnerability: on the one hand, infrastructure and housing destruction leads to direct economic losses; on the other hand, income-generating activities such as fishing, market gardening, and coastal agriculture experience severe disruptions (Pouye et al., 2024). These impacts are particularly pronounced in developing countries, where poverty levels are high and climate adaptation capacities remain weak or nearly nonexistent (IPCC, 2023).

Barbier et al. (2011) highlight the role of mangroves and coral reefs in mitigating coastal erosion and safeguarding livelihoods. However, ecosystem degradation exacerbates socio-economic inequalities, leaving the most vulnerable populations disproportionately exposed to erosion risks. Furthermore, Neumann (2015) shows that the economic impacts of coastal erosion extend beyond immediate losses to include long-term effects on economic growth.

Against this backdrop, the present study aims to analyze the relationship between coastal erosion and the living conditions of affected households along the Togolese coastline, identifying the mechanisms through which this phenomenon undermines livelihoods and, in the absence of adequate adaptation measures, could lead to further shoreline retreat by 2054. A deeper understanding is essential to formulate appropriate economic policies aimed at strengthening the resilience of coastal communities in the face of advancing sea levels.

2. Econometric modeling and empirical estimation

To analyze the effect of coastal erosion on the living conditions of coastal households in Togo, the study employs descriptive statistics and an ordered Probit model. The ordered Probit framework allows for the estimation of the probability of income decline associated with shoreline retreat, based on household perceptions, and is widely used in the existing literature.

2.1. Conceptual framework

The analytical framework builds on the work of Nicholls and Tol (2006), Dasgupta et al. (2009), and Pouye et al. (2024), which demonstrate that shoreline retreat directly affects household living conditions through income losses, housing destruction, and forced displacement. These effects are moderated by household socio-demographic characteristics, adaptation strategies, and institutional support

2.2. Econometric specification

An ordered Probit model is adopted to analyze the effect of coastal erosion on household living conditions, measured on an ordinal scale (poor, average, good). This approach is particularly suitable for ordered dependent variables and is widely used in the well-being and vulnerability literature (Dasgupta et al., 2009).

2.2.1. Model structure

The overall specification of the ordered Probit model is as follows:

$$COMD\_VIE = \beta_0 + \beta_1 SEX + \beta_1 AGE + \beta_2 NIV\_EDUC + \beta_3 SIT\_MATR + \beta_4 REV\_MGES + \beta_5 STRA\_ADAPT + \beta_6 AIDE\_GOUV + \varepsilon$$

The dependent variable represents household living conditions (COND_VIE), classified on an ordinal scale (poor, average, good).

The vector of explanatory variables includes: gender of the household head (SEX), age of the household head (AGE), education level (NIV_EDUC), marital status (SIT_MATR), household income (REV_MGES), adaptation strategies or protection measures against coastal erosion (STRA_ADAPT), and government assistance received (AIDE_GOUV).

2.3. Data

The data are drawn from a cross-sectional survey conducted in 2024 among 262 households along the Togolese coastline. The variables of interest and control variables are consistent with those identified in the relevant literature. Descriptive statistics are presented in Tables 1 and 2.

2.3.1. Descriptive Statistics

Table 1: Descriptive Statistics

Variable	Obs	Mean	Std. ev.	Min	Max
COND_VIE	264	2.061	0.466	1	3
SEX	264	1.496	0.501	1	2
AGE	263	48.711	16.639	17	89
NIVO_EDUC	261	2.015	0.881	1	4
STUA_MATRI	263	2.954	0.591	1	4
REV_MGES	251	4.39	2.103	1	7
STRA_ADAPT	264	1.977	0.149	1	2
AIDE_GOUV	264	1.678	0.468	1	2

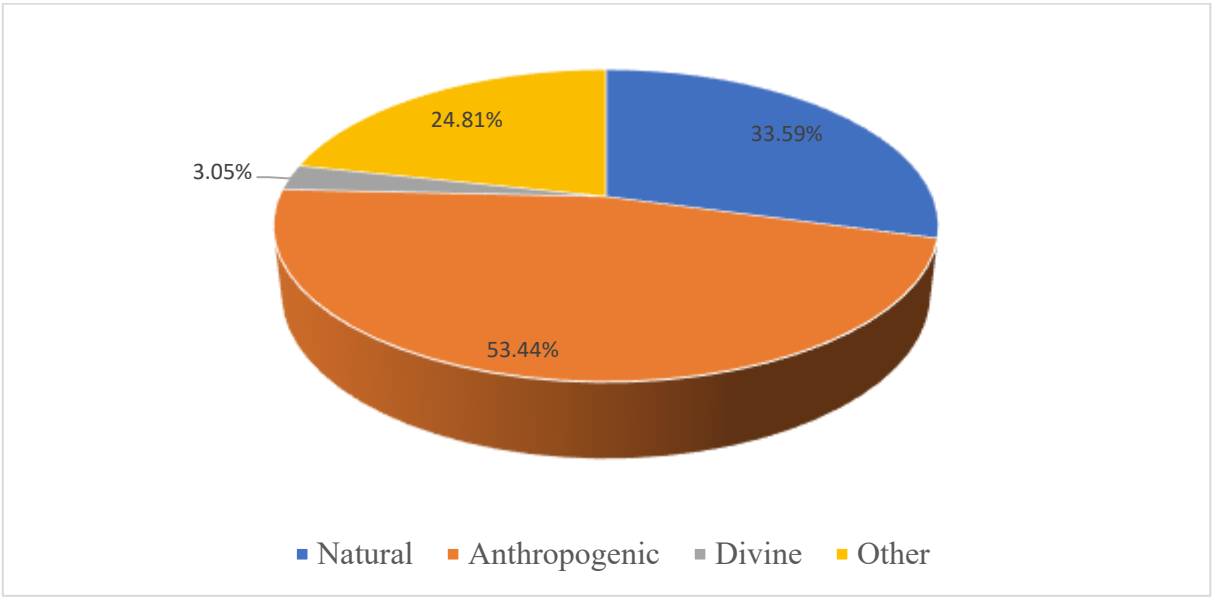
Source : Gbegnon (2025)

2.3.1.1. Perception of coastal erosion

Based on the survey of 262 residents living along the Togolese coastline, the descriptive statistics reveal a very strong perception of shoreline retreat, reported by nearly 100 percent of respondents. This phenomenon is primarily attributed to a combination of anthropogenic and natural factors. More than 78 percent of households report a deterioration in their living conditions, while only 32 percent indicate having received public assistance.

Overall, coastal populations unanimously acknowledge the existence of coastal erosion. According to respondents' perceptions, the causes of erosion in the study area are diverse: anthropogenic factors (53.44 percent), natural causes (33.59 percent), non-compliance with social norms and traditional beliefs (3.05 percent), and other factors (24.81 percent).

Figure 3.1: Proportion of Households According to Their Perceptions of the Causes of Coastal Erosion

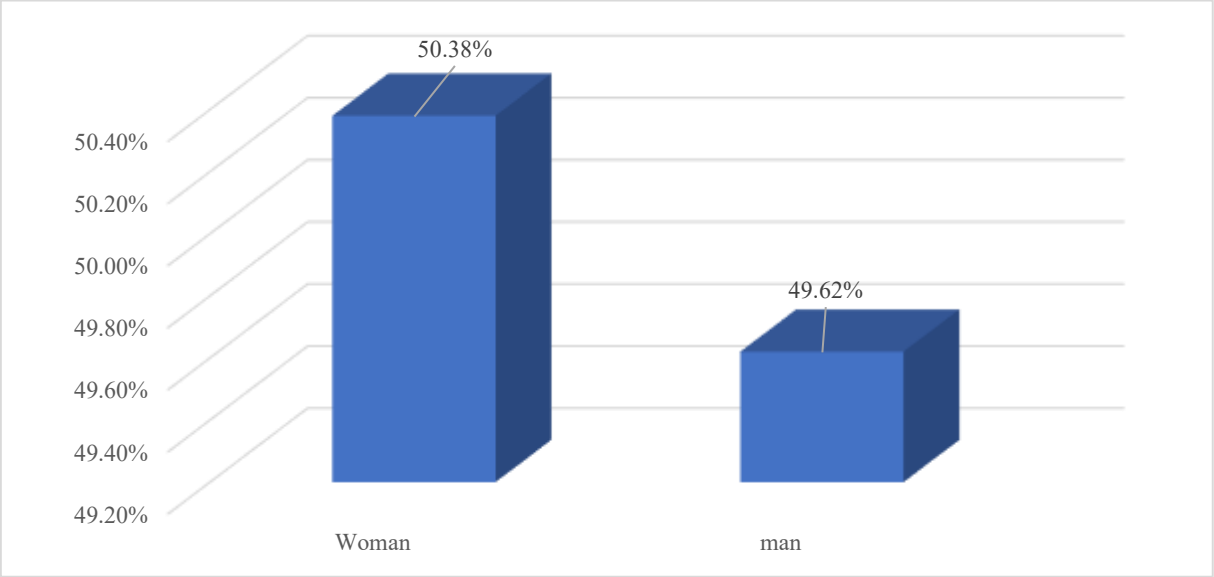


Source : Gbegnon, 2025

2.3.1.2. Analysis of coastal erosion by gender

Household survey results (Figure 3.2) indicate that more than 50 percent of women living along the Togolese coastline are affected by coastal erosion, compared with 49 percent of men.

Figure 3.2: Distribution of Populations Affected by Coastal Erosion by Gender

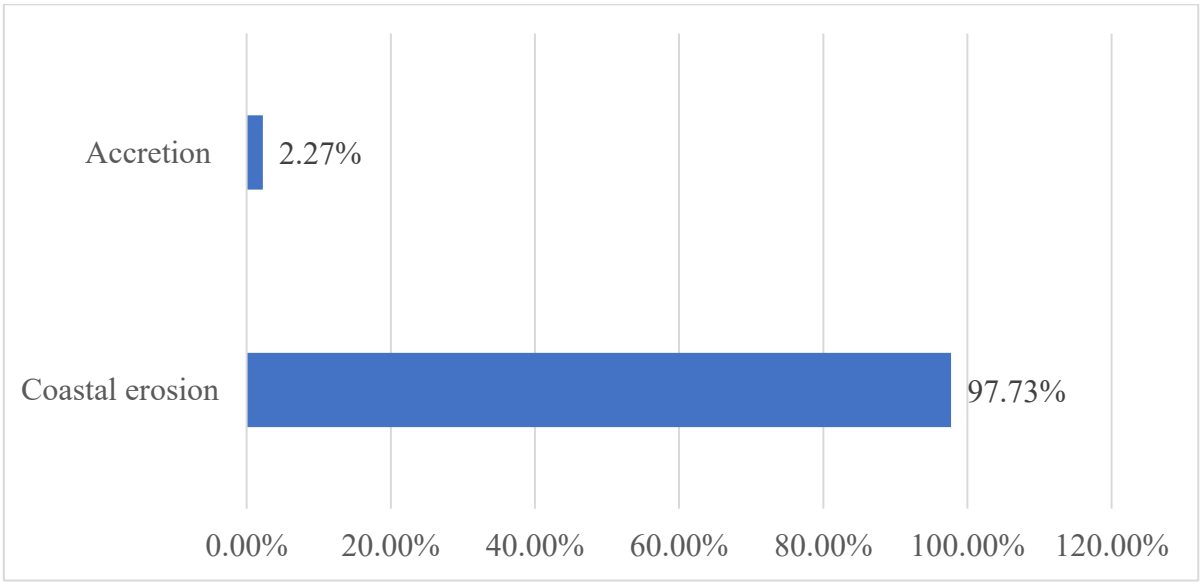


Source : Gbegnon, 2025

2.3.1.3. Comparison Between coastal erosion and accretion

La quasi-totalité du littoral togolais est exposée au phénomène d'érosion côtière, qui concerne plus de 97 % de la côte, tandis que les zones connaissant un gain de plage demeurent marginales, représentant à peine 2 %. Cela se résume dans la figure ci-dessous.

Figure 3.3 : Proportion of coastal erosion versus accretion

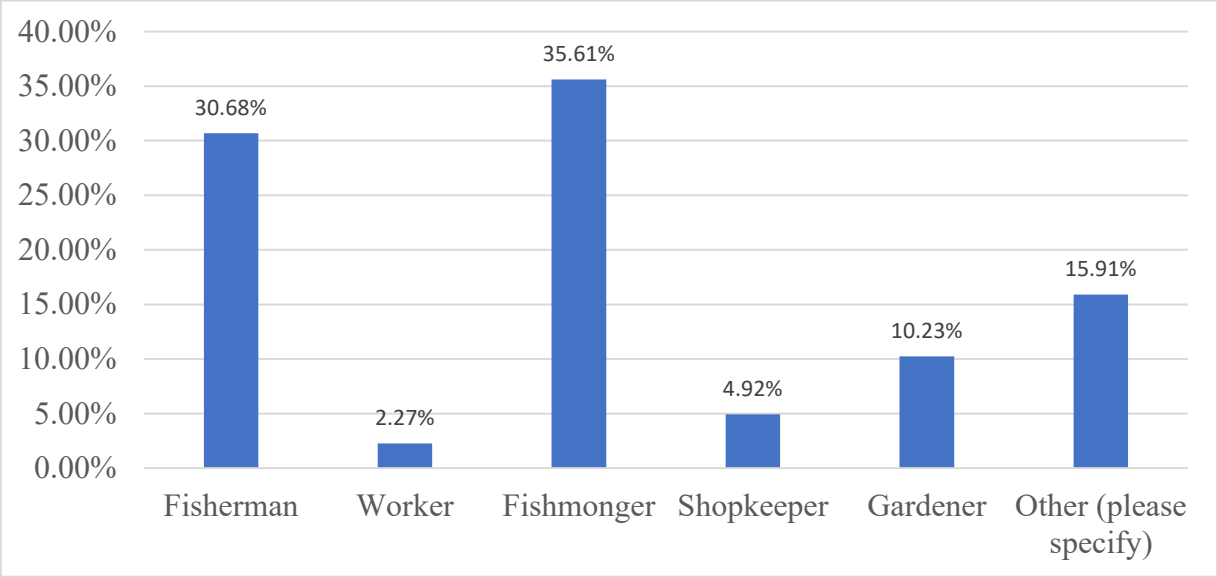


Source : Gbegnon, 2025

2.3.1.4. Comparison of income-generating activities

Households living along the Togolese coast engage in various income-generating activities. Specifically, 35.61 percent are fish traders, 30.68 percent are fishers, 10.23 percent are gardeners, 4.92 percent are traders, and only 2.27 percent are wage laborers.

Figure 3.4 : Comparative diagram of income sources among populations affected by coastal erosion in Togo

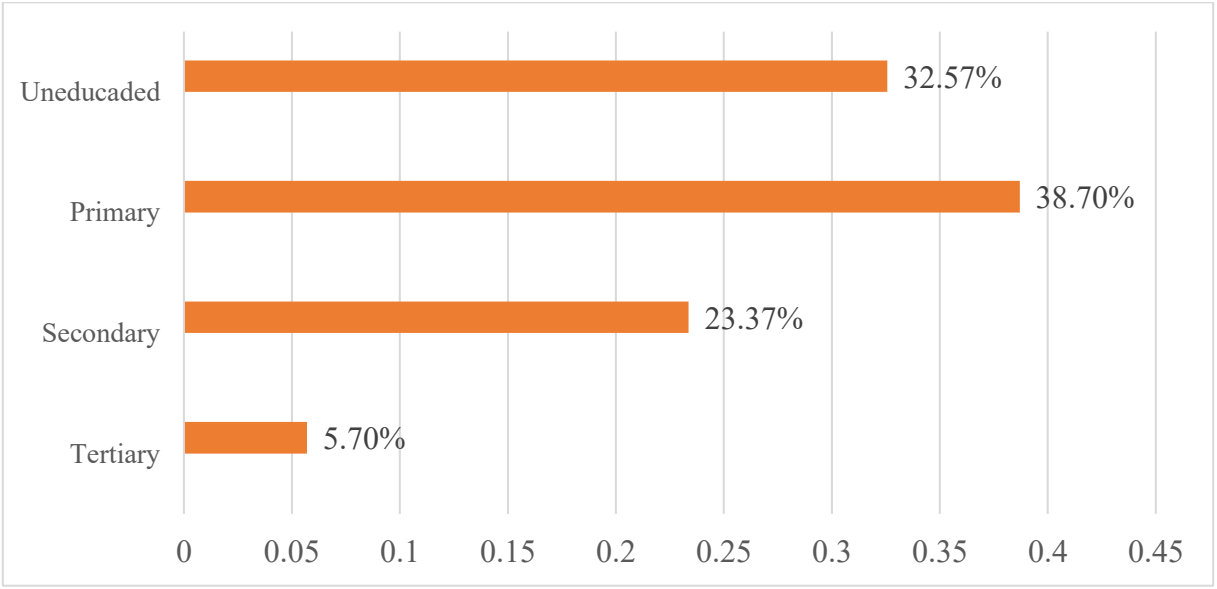


Source : Gbegnon, 2025

2.3.1.5. Proportion of households affected by coastal erosion by education level

Among the surveyed population, more than 65 percent have attended school, whereas 32.57 percent have never received formal education.

Figure 3.5: Comparative diagram of household education levels

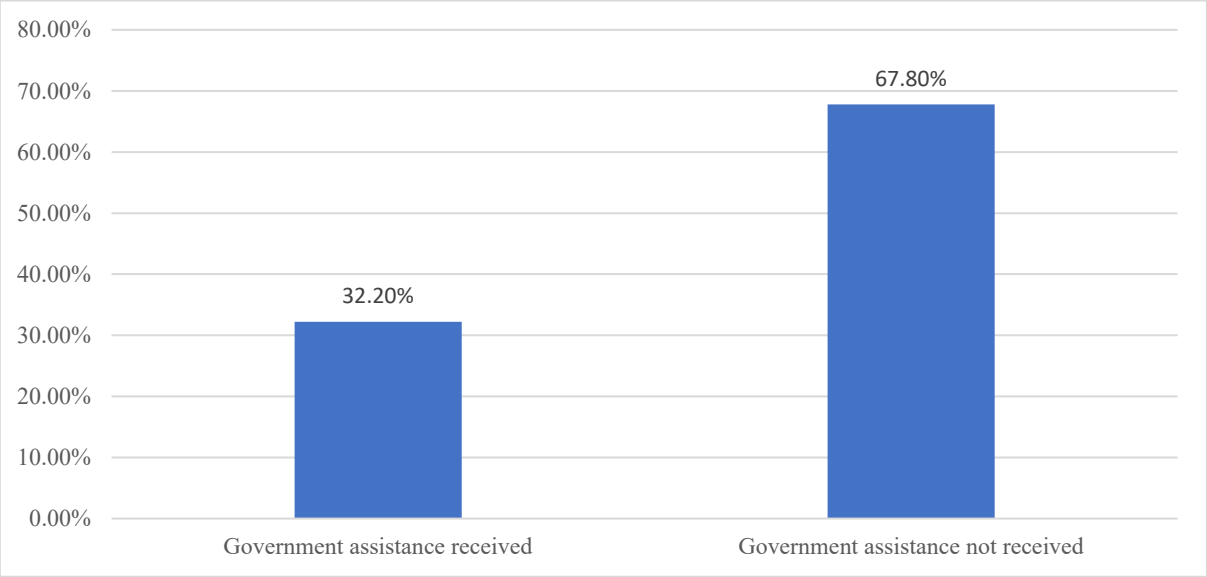


Source : Gbegnon, 2025

2.3.1.6. Distribution of government assistance

Among all populations affected by coastal erosion, only 32.20 percent report having received government support.

Figure 3.6: Comparative diagram of government assistance

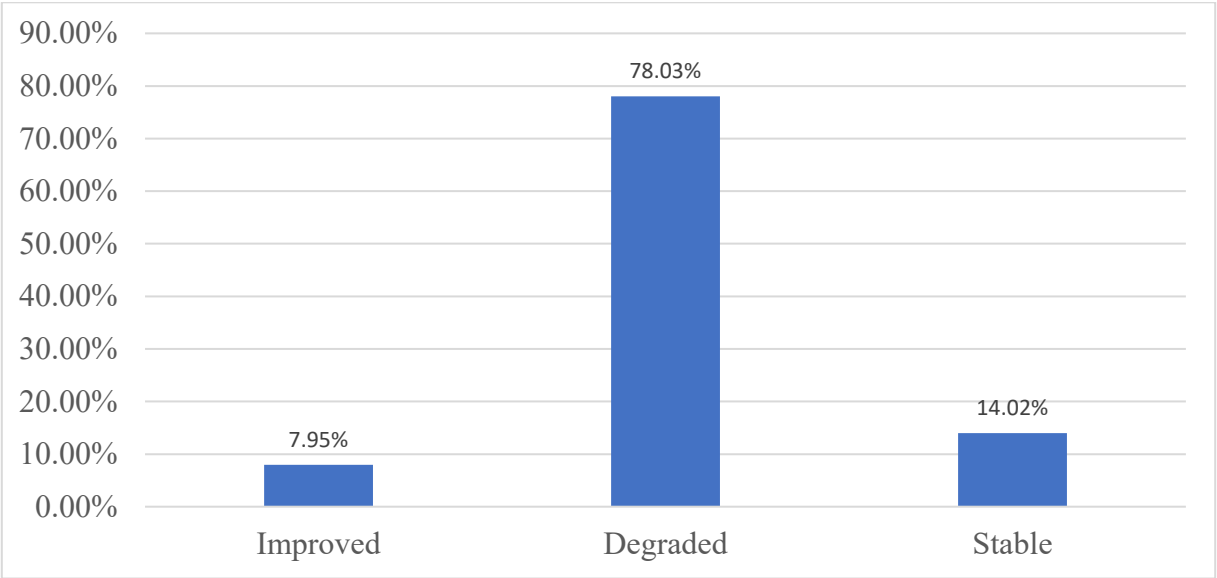


Source : Gbegnon, 2025

2.3.1.7. Living conditions of households affected by coastal erosion

According to the results, 78.03 percent of households affected by coastal erosion report a deterioration in their living conditions, compared to only 7.9 percent who do not perceive such degradation.

Figure 3.7: Condition living conditions of households affected by coastal erosion



Source : Gbegnon, 2025

2.4. Estimation method

Model parameters are estimated using maximum likelihood estimation. Overall model validity is assessed using the Akaike Information Criterion (AIC) and the Bayesian Information Criterion (BIC). The statistical significance of explanatory variables is evaluated using p-values.

3. RESULTS AND DISCUSSION

The results of the econometric analysis are presented in a stepwise manner in order to achieve the objectives of the present study, beginning with descriptive statistics and followed by the ordered Probit model. In an ordered Probit framework, the signs of the estimated coefficients indicate the direction of the effect on the probability of being classified into a higher category of the dependent variable.

Table 2: Ordered Probit model result

COND_VIE	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
SEX	-0,11	0,227	-0,48	0,629	-0,554	0,335	
AGE	0,01	0,006	1,74	0,083	-0,001	0,021	*
NIVO_EDUC	0,056	0,107	0,52	0,002	-0,155	0,267	**
STUA_MATRI	0,119	0,171	0,69	0,489	-0,217	0,454	
REV_MGES	-0,97	0,051	-1,88	0,06	-0,198	0,004	*
STRA_ADAPT	-0,243	0,784	-0,31	0,756	-1,779	1,293	
AIDE_GOUV	-0,087	0,171	-0,51	0,013	-0,422	0,249	**
Mean dependent var		2,057	SD dependent var		0,479		
Pseudo r-squared		0,042	Number of obs		229		
Chi-square		16,111	Prob > chi2		0,024		
Akaike crit. (AIC)		322,683	Bayesian crit. (BIC)		353,586		

*** p<.01, ** p<.05, * p<.1*

The ordered Probit results indicate that the model is globally significant (p = 0.024). Household living conditions are not determined solely by individual characteristics such as gender, education, or marital status, but are strongly influenced by environmental and structural factors, notably coastal erosion itself.

The age of the household head has a positive effect, suggesting that experience and social capital may partially mitigate erosion impacts. Household income exhibits a marginally significant negative effect, possibly reflecting greater exposure of relatively wealthier households located in high-value urban coastal areas. Government assistance shows a marginal effect, suggesting that support mechanisms are either insufficient or poorly targeted. Adaptation strategies and public aid do not significantly improve living conditions, highlighting weaknesses in current policy responses. These findings align with IPCC (2023) conclusions regarding the limited effectiveness of adaptation policies in countries with low institutional capacity.

CONCLUSION

This study analyzed the effects of coastal erosion on the living conditions of coastal households in Togo using 2024 cross-sectional survey data. Descriptive statistics and ordered Probit estimates reveal that shoreline retreat has significant negative impacts on household income, housing, and overall well-being. Approximately 78 percent of affected households report deteriorating living conditions, and exposure to coastal erosion increases the probability of income decline by about 90 percent. These findings call for strengthened coastal adaptation and protection policies, including the construction of seawalls and breakwaters, restoration of coastal ecosystems, and enhanced compensation mechanisms grounded in climate justice principles. Future research could employ advanced forecasting tools, such as Kahlman filters, to anticipate shoreline retreat and more precisely estimate associated economic losses.

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