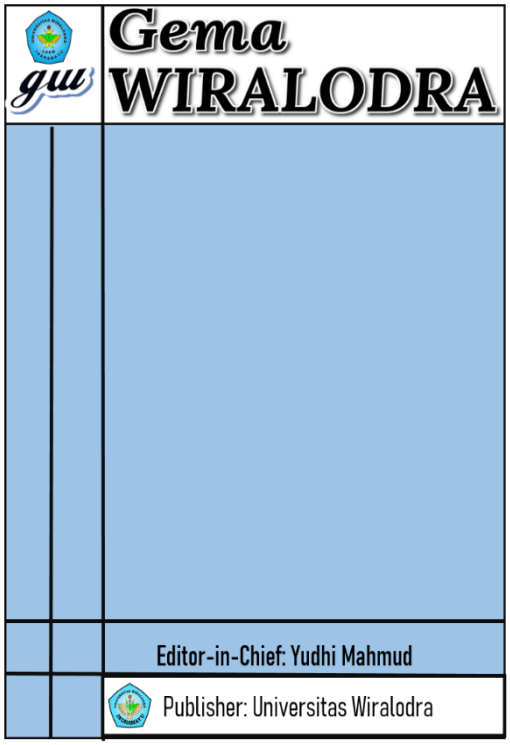
Gema Wiralodra

Publication details, including instructions for authors and subscription information:
https://gemawiralodra.unwir.ac.id



Socio-Ecological Resilience of Coastal Communities in Indramayu Integrating Population Dynamics, Environmental Behavior, and Local Capacity

Wiji Febriani Rizkiyah[a*]
[a*] Wiralodra University, Indramayu, West Java, Indonesia, wijifebriyani86@gmail.com

To cite this article:
Rizkiyah, W. F. (2025). Socio-Ecological Resilience of Coastal Communities in Indramayu Integrating Population Dynamics, Environmental Behavior, and Local Capacity. *Gema Wiralodra*, 6(3), 491 – 506.
To link to this article:
https://gemawiralodra.unwir.ac.id/index.php/gemawiralodra/issue/view/58
Published by:
Universitas Wiralodra
Jln. Ir. H. Juanda Km 3 Indramayu, West Java, Indonesia

Gema Wiralodra, 16(3), 491 – 506
https://gemawiralodra.unwir.ac.id/index.php/gemawiralodra
p – ISSN: **1693 – 7945**
e – ISSN: **2622 – 1969**

Orginal Article

Socio-Ecological Resilience of Coastal Communities in Indramayu Integrating Population Dynamics, Environmental Behavior, and Local Capacity

Wiji Febriani Rizkiyah[a*]
[a*] Wiralodra University, Indramayu, West Java, Indonesia, wijifebriyani86@gmail.com

***Correspondence: wijifebriyani86@gmail.com**

Abstract
The coastal region of Indramayu Regency faces complex socio-ecological pressures resulting from the interaction between population growth, environmental degradation, and limited human capacity. This study aims to analyze the interrelationship between population dynamics, environmental conditions, and the role of Population and Environmental Education (PKLH) in strengthening the socio-ecological resilience of coastal communities. The research employs a descriptive qualitative approach using a case study design based on secondary data, including the Indramayu Regency Regional Statistics 2024 publication, previous research articles, policy documents, and theoretical literature. Thematic analysis was carried out using the writing-as-inquiry principle and theoretical triangulation to ensure interpretive depth. Findings reveal that high population growth, educational disparities, and economic dependence on the agriculture–fisheries sector have intensified pressure on coastal ecosystems, particularly through abrasion, seawater intrusion, and fishpond land conversion. On the other hand, various local initiatives based on environmental education and social wisdom—such as mangrove restoration in Karangsong and educational tourism management in Juntinyuat—indicate a shift in community ecological behavior from dependence to awareness. Through the Population–Environment–PKLH Nexus framework, this research confirms that population and environmental education act as mediators transforming knowledge into awareness and collective ecological action. The study recommends repositioning coastal development policy from a physical approach to a participatory socio-ecological approach. The resilience of Indramayu's coastal communities depends not only on infrastructure but also on the degree to which PKLH values are internalized in their social life.
Keywords: Coastal Communities, Population, Environment, PKLH, Indramayu, Socio-Ecological Resilience.

1. Introduction

Indramayu Regency is a coastal area located in the northern part of Java Island, playing an important role in regional food security and fisheries. Its coastline stretches for 114.1 km, encompassing 10 districts and 35 coastal villages, with a total population of 1.89 million and an average density of 902 people per km²—reaching as high as 2,396 people per km² in Indramayu District, which serves as the administrative center (Kusuma & Rudianto, 2024). The lowland geographical setting and the presence of more than 31 major and minor river streams make Indramayu rich in water resources but also highly vulnerable to coastal abrasion, tidal flooding (rob), and seasonal floods that are exacerbated by climate change. Its tropical climate, with temperatures ranging from 21–34°C and maximum rainfall of 10,061 mm² in December, indicates significant environmental stress (Kusuma & Rudianto, 2024).

The phenomenon of environmental degradation in Indramayu's coastal areas has been identified in various studies. Sodikin et. al (2024) found that abrasion in Sukra District reached 2–14.3 meters per year, resulting in the loss of fishponds and fishing settlements. Meanwhile, Gumilar (2018) noted that despite mangrove rehabilitation efforts since 1995, community participation remained low. Conservation activities such as Pertamina's CSR program Perisai Jaga Bumi in Juntinyuat have brought positive local impacts but have not yet transformed ecological behavior in a sustainable manner (Ayodya et al., 2024). These conditions indicate a

p – ISSN: **1693 – 7945**
e – ISSN: **2622 – 1969**

weak internalization of sustainability values among coastal communities and the limited influence of conservation policies on socio-ecological behavior.

Demographically, Indramayu experiences considerable population pressure. The population pyramid shows a dominance of young age groups and a relatively rapid growth rate (Kusuma & Rudianto, 2024). According to Boserup's (1976) population pressure theory, population growth can drive adaptive innovation; however, in resource-limited areas such as Indramayu, population pressure instead accelerates resource exploitation without being balanced by environmentally friendly technological innovation (De Sherbinin et al., 2007). Thus, population dynamics in Indramayu's coastal areas are not merely a matter of numbers but also concern the adaptive capacity of communities in managing their environment.

The quality of human resources is a key factor determining such adaptive capacity. The average length of schooling among Indramayu residents is only 6.94 years, while 72.01% of the workforce has an education level of junior high school or below, with most working in the agricultural and fisheries sectors (Kusuma & Rudianto, 2024). This condition affects low levels of knowledge and participation in environmental management. The concept of Population and Environmental Education (Pendidikan Kependudukan dan Lingkungan Hidup—PKLH) emphasizes the integration of cognitive, affective, and psychomotor aspects to foster responsible ecological behavior (Rauf et al., 2023). However, research by Syaputra et al. (2024) in Dadap Village shows that 91.7% of households do not meet the criteria for a healthy home, even though 72.2% of respondents have good knowledge of sanitation. This indicates that knowledge and positive attitudes do not necessarily lead to ecological action without adequate economic and infrastructural support.

Economically, Indramayu faces challenges of income inequality and structural poverty. In 2023, the poverty rate reached 12.13% with a Gini ratio of 0.344—the highest in the Ciayumajakuning region (Kusuma & Rudianto, 2024). Empowerment programs such as the Coastal Community Economic Empowerment Program (PEMP) have increased income, yet Asmara (2007) found high credit arrears due to the low educational level of recipients and the large size of loans. This aligns with the poverty–environment trap concept (Hansen, 1992), in which poverty exacerbates environmental degradation, and environmental degradation deepens poverty.

Beyond economic factors, institutional dimensions also influence the success of coastal resource management. Gumilar (2018) demonstrated that community participation in mangrove conservation in Indramayu remains at the level of "tokenism," meaning formal involvement without genuine partnership. (Lestari Sitorus et al., 2025) further noted that the low level of environmental citizenship stems from limited community access to resources and the absence of ecological justice. From a political ecology perspective, environmental degradation is not merely the result of individual behavior but rather the outcome of structural inequality in resource control and policy (Hartmann, 1998). Therefore, solutions to coastal problems in Indramayu must be holistic, involving social, political, and environmental education dimensions.

Government policies have actually provided a legal framework, such as Law No. 32 of 2009 on Environmental Protection and Management and Government Regulation No. 32 of 2019 on Marine Spatial Planning. However, implementation is often hindered by fragmented authority and low environmental literacy among officials. Many local policies prioritize physical infrastructure over community-based socio-ecological strengthening. As a result, a gap emerges between policy and ecological behavior, causing such policies to lose their transformative power.

Based on these phenomena, the problem addressed in this study is the reciprocal relationship between population dynamics, socio-ecological behavior, and environmental

p – ISSN: **1693 – 7945**
e – ISSN: **2622 – 1969**

conditions among Indramayu's coastal communities, and how the PKLH approach can strengthen their socio-ecological resilience. The ultimate goal is not only to describe the existing conditions but also to propose a conceptual intervention model based on the Population–Environment–PKLH Nexus that integrates social, economic, and ecological factors in regional development policy.

The novelty of this research lies in its integrative qualitative approach using secondary data, combining classical theories such as Malthusian and Boserupian with contemporary political ecology theory and the PKLH paradigm. Previous studies in Indramayu have been sectoral—focusing on abrasion (Sodikin et al., 2024), participation (Gumilar, 2018), or sanitation Syaputra et al. (2024). This study attempts to unify these various aspects into a systemic analysis that positions coastal communities as holistic socio-ecological systems, thereby producing new insights into coastal resilience grounded in population and environmental education.

This research is important because existing studies in Indramayu tend to examine coastal issues in a fragmented manner—focusing separately on abrasion, participation, sanitation, or economic conditions—without integrating population pressure, environmental change, and educational dimensions into a single analytical framework. By adopting the Population–Environment–PKLH Nexus, this study contributes a more holistic understanding of coastal resilience and emphasizes the role of population and environmental education in transforming awareness into collective ecological action.

2. Research Methodology

2.1 Research Approach and Type

This study employs a descriptive qualitative approach with a case study design focused on the dynamics of coastal communities in Indramayu Regency. The qualitative approach was chosen because it allows for a deep and contextual explanation of social phenomena, thereby not only highlighting statistical data but also interpreting the social, economic, and ecological meanings that surround them. The case study design was used to examine phenomena holistically within a region possessing distinct social and environmental characteristics. According to (Njie & Asimiran, 2014), a case study is an approach that emphasizes an in-depth understanding of a bounded social system, in which the researcher seeks to comprehend the relationships among various causal factors, situations, and contexts.

This approach is relevant because the complexity of population and environmental issues in Indramayu's coastal areas cannot be explained by numbers alone but requires an interpretive understanding. Using a descriptive approach, this research systematically describes the relationships between population, community behavior, and ecological conditions, while remaining grounded in valid secondary data and strong theoretical interpretation. In line with (Dodgson, 2017) perspective, qualitative research requires clarity of researcher positioning and transparency in the analytical process to achieve high validity and trustworthiness.

2.2 Research Location and Focus

This research was conducted in Indramayu Regency, West Java Province, located along the northern coast of Java Island at coordinates 107°51' – 108°32' E and 06°13' – 06°40' S. Indramayu Regency covers an area of approximately 208,782.98 hectares, with a coastline stretching around 147 kilometers along the northern shore of the Java Sea, situated between Cirebon Regency to the east and Subang Regency to the west. Administratively, Indramayu Regency consists of 31 districts, 309 villages, and 8 urban wards, of which 11 districts and 38 villages directly border the sea. Trisi District

p – ISSN: **1693 – 7945**
e – ISSN: **2622 – 1969**

is recorded as the largest area, covering 17,721.63 hectares, while Karangampel District is the smallest, covering 3,075.60 hectares (Kusuma & Rudianto, 2024).

The topography of Indramayu Regency varies from flat to slightly undulating surfaces; however, most of it comprises lowland areas with an average slope of 0–2% and an elevation of 0–100 meters above sea level. Approximately 89.70% of the total area lies at an elevation of 0–3 meters above sea level, resulting in high inundation potential during tidal floods (rob) in coastal zones. Land use types are diverse, but the most dominant is irrigated paddy fields, covering 108,031.81 hectares or 49.99% of the total area, followed by fishpond aquaculture areas with 19,775.26 hectares or 9.15%. This geographical condition indicates that Indramayu is a lowland coastal area highly dependent on water resources and marine products, while also being vulnerable to climate change and coastal hazards such as abrasion and tidal flooding.

The research focus is directed toward understanding the interrelationship between population factors, socio-ecological behavior, and the quality of the environment in Indramayu's coastal areas. These three aspects are integrated into the Population–Environment–PKLH Nexus analytical framework, which positions humans as the main actors within a socio-ecological system. This research focus simultaneously emphasizes the effort to view coastal communities not merely as objects of development but as active subjects in managing and preserving their environmental sustainability.

2.3 Types and Source of Data

This study relies entirely on secondary data, meaning all information is collected from credible and verified written sources. These secondary data were obtained from three main sources: official statistical data, previous academic research, and policy documents as well as conceptual literature. The primary statistical data source is the Indramayu Regency Regional Statistics 2024 publication by BPS Indramayu Regency. This publication provides demographic, labor, education, health, poverty, environmental, and agricultural indicators.

In addition to statistical data, this research also utilizes findings from previous studies at both local and national levels. Relevant local studies include Sodikin et al. (2024) on coastal abrasion in Sukra; Gumilar (2018) on community participation in mangrove conservation; Syaputra et al. (2024) on healthy home sanitation in Dadap Village; and (Asmara, 2007) on factors affecting credit arrears in coastal economic empowerment programs. Global theoretical references used include population–environment theories by (Boserup, 1976), Ehrlich et al. (1993), and Bartlett (1994), as well as the Population–Poverty–Environment Nexus models by Hansen (1992) and De Sherbinin et al. (2007).

The third data source comes from environmental education and policy literature, such as Pendidikan Kependudukan dan Lingkungan Hidup (PKLH) by Rauf et al. (2023) and Rende (2024), along with national regulations such as Law No. 32 of 2009 on Environmental Protection and Management and Government Regulation No. 32 of 2019 on the National Marine Spatial Plan. These three types of sources complement one another in providing empirical, theoretical, and normative foundations for this research.

2.4 Data Collection Techniques

The data collection techniques in this study were carried out through literature review and documentation. The process began with a systematic search for relevant statistical publications, journal articles, books, and regulations using the principles of the Systematic Literature Review (SLR). All identified documents were then classified according to themes such as population, environment, education, economy, and policy.

p – ISSN: **1693 – 7945**
e – ISSN: **2622 – 1969**

Subsequently, a content analysis was conducted to identify patterns and relationships among the variables under study. The BPS documents served as the primary source for quantitative data, while articles and books provided qualitative interpretation sources. All data were reduced and filtered so that only information relevant to the research focus was retained. During this process, the researcher also recorded the time, location, and methodological context of each source to ensure that data interpretation remained accurate and proportional.

2.5 Data Analysis Techniques

Data analysis was conducted using a thematic analysis approach structured under the writing-as-inquiry principle as described by (Mitchell & Clark, 2021). This approach views writing not merely as the presentation of results but as part of the analytical process itself. Thematic analysis was carried out in three main stages: data reduction, data presentation, and interpretation.

The data reduction stage involved selecting essential information from various sources, removing irrelevant data, and grouping information into thematic categories such as demography, economy, social behavior, and environment. The data presentation stage involved synthesizing the findings in the form of narrative descriptions and descriptive tables to clarify relationships among variables. The interpretation stage then connected these findings to population–environment theories and the PKLH concept, forming a comprehensive framework for understanding the relationship between population dynamics and coastal environmental conditions.

Throughout the analytical process, the researcher applied the principle of reflexivity to maintain interpretive integrity. All analytical decisions were systematically documented in the form of an audit trail to allow traceability and verification by readers or other researchers. This approach aligns with the principles of validity in qualitative research, which emphasize transparency and openness (Dodgson, 2017).

2.6 Data Validity

Validity in this research was ensured through source and theoretical triangulation. Source triangulation was conducted by comparing results from various documents—ranging from official statistics, local studies, to global theoretical works—to ensure consistency of information. Theoretical triangulation, on the other hand, was achieved by employing multiple theoretical perspectives: the Malthusian and Boserupian theories on population–environment relationships, political ecology theory that highlights aspects of power and policy, and the PKLH paradigm emphasizing educational and ecological awareness dimensions. The combination of these theories is expected to provide a comprehensive understanding of the socio-ecological complexity of Indramayu's coastal communities.

2.7 Conceptual Framework of the Study

The conceptual framework of this research was constructed from a synthesis of theoretical and empirical findings. The researcher positions Indramayu's coastal communities as a socio-ecological system in which population dynamics (such as population growth, education, and employment), environmental conditions (abrasion, sanitation, and land-use change), and socio-cultural aspects (participation and ecological awareness) interact dynamically. These three dimensions were analyzed through the Population–Environment–PKLH Nexus framework, which emphasizes the importance of education and community participation as key elements of sustainability.

Through this approach, the study seeks to illustrate the complex causal relationships between humans and their environment while reaffirming the need for

p – ISSN: **1693 – 7945**
e – ISSN: **2622 – 1969**

data-driven and education-based policy integration. This conceptual framework serves as a guiding structure for the analysis and discussion presented in the following chapter.

The descriptive qualitative approach with a case study design is suitable for this research because the study aims to understand complex socio-ecological interactions rather than to test causal relationships statistically. The research focuses on interpreting how population dynamics, environmental conditions, and socio-ecological behavior interact within a specific coastal context.

Using secondary data allows the study to synthesize official statistical data, previous empirical research, and policy documents into a comprehensive socio-ecological analysis. Thematic analysis and the writing-as-inquiry approach enable the integration of empirical findings with population–environment and political ecology theories, which is essential for developing the Population–Environment–PKLH Nexus framework.

Accordingly, this method supports the research objective of providing contextual, interpretive, and policy-relevant insights rather than generalizable numerical predictions.

3. Result and Discussions

3.1 Demographic and Socio-Economic Conditions of Coastal Communities in Indramayu

Indramayu Regency exhibits distinctive demographic characteristics compared to other coastal regions in West Java. Based on Indramayu Regency Regional Statistics 2024, the total population reached 1,894,325 people, consisting of 950,963 males and 943,362 females, with a sex ratio of 100.81, indicating gender balance (Kusuma & Rudianto, 2024). The average population density is recorded at 902 people per km², while in coastal areas such as Indramayu, Balongan, and Karangsong districts, it exceeds 2,000 people per km². The uneven population distribution reveals disparities in regional development: urban coastal areas tend to be densely populated with broader economic access, while outer coastal areas such as Sukra and Patrol rely more heavily on traditional primary sectors.

The age structure of Indramayu's population shows a youthful demographic pyramid, where the proportion of children and adolescents remains high. This phenomenon represents a potential demographic bonus but also a challenge, as the large number of productive-age residents is not necessarily accompanied by sufficient employment opportunities (Kusuma & Rudianto, 2024). In the context of coastal communities, this condition creates pressure on living space and natural resources. In line with Malthusian theory, rapid population growth without socio-economic innovation leads to increased resource exploitation and decreased environmental carrying capacity Ehrlich et al. (1993). In Indramayu, such population pressure is reflected in the high conversion rate of fishpond and residential land in low-lying areas that once served as buffer zones for coastal ecosystems.

From a socio-economic perspective, most coastal residents in Indramayu depend on agriculture, fisheries, and marine product trade. BPS (2024) data show that 31.22% of the workforce is engaged in agriculture and fisheries, about 17.19% in industry, and 51.59% in services and trade. This economic structure reflects local characteristics still dependent on natural resources and vulnerable to climate fluctuations and global market dynamics. The average income of coastal residents remains low, with a poverty rate of 12.13% and a Gini ratio of 0.344, indicating widening economic inequality compared to the previous year (Kusuma & Rudianto, 2024).

p – ISSN: **1693 – 7945**
e – ISSN: **2622 – 1969**

This socio-economic gap strongly correlates with educational levels. The average length of schooling is only 6.94 years, and 72.01% of workers have no more than junior high school education (Kusuma & Rudianto, 2024). This condition limits the community's adaptive capacity to economic and environmental change. According to Rauf et al. (2023), education is a fundamental variable in shaping ecological awareness and adaptive behavior toward the environment. Low education levels make it difficult for communities to understand the importance of sustainable resource management, perpetuating traditional patterns of exploitation.

Socio-economic inequality is also reflected in housing and basic facility ownership patterns. About 81.9% of households own their homes, while 18.1% live in rented or shared housing. Most households (95.85%) have brick walls, but only 81.02% have access to safe drinking water (refilled water or bore wells) (Kusuma & Rudianto, 2024). Meanwhile, Syaputra et al. (2024) found that 91.7% of households in Dadap Village failed to meet healthy home standards, mainly due to poor ventilation and improper waste disposal habits. This indicates that improvements in physical infrastructure have not yet been accompanied by behavioral changes in environmental health.

Employment conditions in Indramayu's coastal areas also exhibit distinctive patterns. The Labor Force Participation Rate (LFPR) in 2023 stood at 63.88%, a decrease from the previous year (69.06%), while the Employment Rate was relatively high at 93.54% (Kusuma & Rudianto, 2024). However, most jobs are informal, seasonal, and highly vulnerable to weather fluctuations. Gender inequality is also evident, as men dominate the workforce (65.43%) while women constitute only 34.57%. This finding aligns with Hartmann (1998), who argued that gender roles in environmental economics remain unbalanced, with women often marginalized in economic access and environmental participation.

Overall, the demographic and socio-economic conditions of Indramayu's coastal communities reveal a strong interconnection among education level, economic status, and environmental vulnerability. Limited education and economic access hinder communities from adapting to environmental changes or adopting new technologies. This aligns with the poverty–environment nexus (Hansen, 1992), wherein poverty exacerbates environmental degradation because people tend to exploit resources instantly to meet short-term needs. Conversely, environmental damage such as abrasion and declining fishpond productivity deepens coastal poverty, creating a self-reinforcing cycle that is difficult to break without structural intervention.

Ultimately, demographic pressure, economic inequality, and educational limitations in Indramayu's coastal zones generate complex socio-ecological challenges. With a young population, high density, and a resource-based economy, coastal communities in Indramayu are effectively "trapped" between economic needs and limited environmental carrying capacity. Hence, an in-depth analysis of environmental dynamics and community behavior is essential to understand adaptive strategies and the potential of environmental education in strengthening their socio-ecological resilience.

3.2 Environmental Dynamics and Ecological Pressures in Indramayu's Coastal Areas

The coastal region of Indramayu is among the fastest-degrading areas in West Java over the past two decades. Geographically, most of its coastal zones are lowlands at an elevation of 0–3 meters above sea level, making them highly vulnerable to abrasion and tidal inundation (rob) (Kusuma & Rudianto, 2024). Sodikin et al. (2024) reported that the abrasion rate in Sukra District ranges from 2 to 14.3 meters per year, causing shoreline retreat and loss of productive fishpond areas. This rate not only threatens

p – ISSN: **1693 – 7945**
e – ISSN: **2622 – 1969**

fishing settlements but also alters the configuration of coastal ecosystems that once supported the local economy.

Such physical degradation is closely linked to land-use changes. BPS (2024) data show that irrigated paddy fields cover 108,031.81 hectares (49.99%), while aquaculture ponds occupy 19,775.26 hectares (9.15%). However, in the past decade, there has been a significant shift from fishponds to residential and infrastructure areas, particularly in northern coastal districts such as Balongan, Karangsong, and Juntinyuat. These conversions are often carried out without considering ecological aspects such as soil carrying capacity and seawater intrusion risk. This condition illustrates an imbalance between spatial demand driven by demographic pressure and the environment's ability to sustain it (Boserup, 1976).

Beyond abrasion, seawater intrusion and coastal pollution have become critical issues. In coastal areas such as Balongan and Karangampel, residents have reported increasingly saline and oily well water—an indication of contamination from seawater mixing and oil industry activities (Ayodya et al., 2024). The rise of processing industries and port facilities along the coast contributes to macroeconomic growth but simultaneously reduces water and soil quality. This reflects a paradox of coastal development: as the industrial sector expands, environmental capacity declines.

Indramayu's mangrove ecosystems also face similar threats. Gumilar (2018) revealed that mangrove areas in the coastal zone continue to decline due to pond conversion and illegal logging. Yet mangroves play a vital role in preventing coastal abrasion, maintaining water quality, and providing natural habitats for marine life. Several rehabilitation programs have been implemented by local governments and communities, but success rates vary widely. Social factors such as low community participation, weak supervision, and top-down policy approaches have hindered long-term sustainability.

Additionally, climate change exacerbates the degradation of Indramayu's coastal environment. Rising average temperatures of up to 34°C and extreme rainfall fluctuations (Kusuma & Rudianto, 2024) increase the risk of erosion and crop failure in fishpond areas. Extreme weather events—such as storms and tidal floods—occur more frequently, forcing many fishermen to reduce their fishing frequency. Heavy economic dependence on fisheries makes these communities particularly vulnerable to environmental shifts, prompting spontaneous adaptation strategies such as livelihood diversification or seasonal migration to other regions.

However, such adaptive responses remain reactive rather than strategic. From the perspective of political ecology, these reactions reveal the community's limited access to resources and information (Hartmann, 1998). While local governments focus policy efforts on physical infrastructure development, coastal residents bear the ecological consequences. Such disparities in power and access often constitute the root causes of environmental degradation.

Within the population–environment framework, the ecological pressures in Indramayu's coastal region result from the interaction between population pressure, extractive economic structures, and unsustainable resource management (De Sherbinin et al., 2007). Population growth increases demand for land and water, while economic activities accelerate resource degradation. This situation demonstrates that coastal environmental issues cannot be viewed merely as "natural disasters" but as outcomes of ongoing imbalances within the socio-ecological system.

Interestingly, amidst these challenges, several community-based initiatives have emerged that signal positive change. For example, in Karangsong, local groups and

p – ISSN: **1693 – 7945**
e – ISSN: **2622 – 1969**

environmental NGOs have implemented mangrove restoration projects centered on environmental education, involving elementary school students in planting and maintaining mangroves. Such initiatives reflect the rise of environmental citizenship at the local level—a concept that positions citizens as agents of change rather than passive recipients of policy (Lestari Sitorus et al., 2025). Although still limited, these local practices represent early signs of growing ecological awareness among Indramayu's coastal communities, marking a shift toward more participatory and equitable environmental management approaches.

The complex environmental conditions of Indramayu's coastal region demonstrate that ecological problems do not exist in isolation but are intertwined with social, economic, and policy structures. In other words, environmental pressure manifests from how communities and institutions manage their living spaces. To fully understand this, it is necessary to examine the socio-ecological behavior of coastal residents—how they interact with, adapt to, and interpret the environment in which they live.

3.3 Social–Ecological Behavior and Community Participation in Indramayu's Coastal Areas

The social–ecological behavior of Indramayu's coastal communities shows a close relationship between social conditions, education, and economic structure. Gumilar's studies (2018), serve as important references for understanding patterns of community participation in environmental management. He found that the level of community participation in mangrove forest management was in the category of tokenism, meaning involvement that is symbolic and lacks autonomy in decision-making. This occurs because most conservation programs are top-down—determined by the government or donor agencies—without processes of consultation and adaptation to local needs.

However, recent field observations and reports from several environmental organizations indicate a change in the behavioral pattern of Indramayu's coastal communities toward greater participation. In Karangsong and Juntinyuat, for example, communities that previously only acted as recipients of mangrove rehabilitation programs are now forming self-help groups that maintain mangrove areas, manage educational tourism, and even produce mangrove-based processed products such as syrups, soaps, and teas (Sugianto, 2019). This change not only signals increased ecological awareness but also a shift in values from mere survival strategies toward collective ecological responsibility.

This emerging tendency can be seen as the embryo of civic environmentalism at the local level, where residents take the initiative to protect the environment out of collective awareness rather than by instruction or project rewards. Within the Population and Environmental Education (PKLH) framework, such behavior reflects the successful internalization of ecological values through non-formal channels such as community groups, religious leaders, or environment-based schools Rauf et al. (2023). PKLH emphasizes not only cognitive knowledge but also the formation of attitudes and ecological habits through everyday social interactions.

Unfortunately, such participatory practices have not yet become mainstream. Many other coastal communities in Indramayu, such as in Dadap or Eretan Wetan, still display short-term adaptive behaviors oriented toward economic needs. Syaputra et al. (2024) show that good knowledge and attitudes toward healthy-home sanitation are not followed by actual practices due to constraints in economy, time, and infrastructural support. This phenomenon underscores the importance of strengthening structural

p – ISSN: **1693 – 7945**
e – ISSN: **2622 – 1969**

dimensions in shaping ecological behavior. Without adequate economic support and policy, community environmental awareness is unlikely to transform into sustainable collective action.

In the coastal socio-economic context, ecological behavior is often influenced by pragmatic logic—protecting the environment as long as it provides direct economic benefits. For instance, Karangsong fishermen plant mangroves not solely for conservation reasons but because mangroves can protect their ponds from abrasion and increase fish populations (Gumilar, 2018). This logic remains instrumental, but it can become an entry point for deeper behavioral change. When communities recognize the causal relationship between a healthy environment and economic well-being, they are more likely to sustain ecological behaviors over time.

This tendency also signals the emergence of a new local paradigm in understanding sustainability: communities no longer wait for external intervention but begin to develop adaptive practices based on their own experience. Practices such as building "green embankments" from sandbags by Sukra fishermen or innovations in household waste management in Balongan are examples of local ecological knowledge that grow from empirical experience. This pattern aligns with the bottom-up environmental governance approach, where policies are no longer imported from the center but are designed based on local experience and knowledge (Lestari Sitorus et al., 2025).

This context reveals an important shift in how Indramayu's coastal communities interpret the environment: from an economic object to part of social identity. It also marks a change in environmental education in society—from knowledge transfer to a reflective and participatory process. At this point the present study contributes conceptually: not by creating a new theory, but by highlighting the transformation in how communities learn about and act toward their environment.

The phenomenon of shifting participation can be understood as a transitional phase in ecological behavior. In the initial phase, communities act because of economic pressure and disasters; in the next phase, they begin to understand the causal link between human activities and environmental damage; and in a more mature phase, ecological awareness develops into social norms that regulate collective behavior. This process shows how PKLH values can grow organically through local experience without always depending on formal education.

Thus, the social–ecological behavior of Indramayu's coastal communities should not be seen as a static entity but as an ongoing social learning process. Local initiatives emerging in Karangsong, Juntinyuat, and Sukra indicate a move toward a community-based sustainability model, where PKLH values serve as the bridge between knowledge and action. This shift becomes an early indicator of a conceptual transformation in coastal environmental management in Indramayu: from formal participation toward reflective participation rooted in residents' ecological awareness.

3.4 Integration of Population, Environment, and PKLH (Population–Environment–PKLH Nexus)

The relationship between population and the environment in Indramayu's coastal areas is interdependent and cyclical, where pressure on one aspect will repeatedly affect the others. In the Population–Environment–PKLH Nexus framework, coastal communities are understood not merely as populations that utilize resources but as social actors who both shape and are shaped by their ecological conditions.

Empirically, increases in population along Indramayu's coast intensify pressure on space and resources. Settlement growth in northern coastal areas, especially in

p – ISSN: **1693 – 7945**
e – ISSN: **2622 – 1969**

Balongan, Juntinyuat, and Karangsong districts, has led to the conversion of fishponds into residential areas and the narrowing of ecological buffer zones such as mangroves (Kusuma & Rudianto, 2024); Gumilar, 2018)). This phenomenon reinforces the Malthusian assumption that population growth without accompanying social or technological innovation tends to result in environmental degradation (Ehrlich et al., 1993). However, field data also reveal a Boserupian side, where population pressure motivates some community members to innovate and adapt through economic diversification, for example by developing mangrove tourism and processed products derived from marine resources (Sugianto, 2019).

These two dynamics show that Indramayu's coastal communities are not passive. They continuously negotiate their living space between two extremes: exploitation and adaptation. Here PKLH functions as a social mediator that bridges short-term economic needs and long-term ecological sustainability. Through formal, non-formal, and community-social education processes, PKLH internalizes ecological values into community awareness. When people begin to understand that protecting the environment means protecting their livelihoods, the relation between population and environment shifts from destructive to productive Rauf et al. (2023).

In Indramayu's context, the internalization of PKLH values can be observed in several organically emerging social practices. In Karangsong, for instance, mangrove rehabilitation activities initially driven by the government are now managed by local communities and environment-based schools. They transform mangrove areas into not only conservation zones but also learning spaces, tourism sites, and alternative economic. This phenomenon reflects the transformation of community ecological behavior from pragmatic adaptation toward value-based adaptation.

Integration among population, environment, and PKLH dimensions is also evident in health and household behavior aspects. Syaputra et al. (2024) in Dadap Village show that community knowledge and attitudes toward sanitation are fairly good, but practice remains suboptimal due to limited facilities and incomes. In other words, awareness is not enough without access and opportunity to act. PKLH here functions as a driver of collective awareness to pursue structural change, for example through environmental campaigns, beach clean-up gotong royong, or the establishment of sanitation-concerned community groups.

Within the Population–Environment–PKLH Nexus scheme, interactions among these three aspects produce two-directional socio-ecological dynamics. First, a pressure–response–adaptation dynamic, where demographic and ecological pressures trigger social responses in the form of innovations or cross-sectoral collaborations. For example, the emergence of coastal community groups in Sukra that construct green embankments and integrated pond systems as adaptations to abrasion. Second, a knowledge–awareness–action dynamic, where environmental education is the key variable that transforms ecological awareness into concrete practice.

This approach aligns with the coupled human–environment system concept (De Sherbinin et al., 2007), which views humans and the environment not as two separate entities but as a system that mutually influences and shapes one another. In Indramayu's context, this system shows that environmental improvement cannot be achieved solely through technical policies but must occur through social learning processes that involve active community participation.

Through this reading, the Population–Environment–PKLH Nexus is not merely a conceptual model but also a socio-ecological diagnostic tool. It can explain why some coastal communities adapt better than others and how environmental education becomes

p – ISSN: **1693 – 7945**
e – ISSN: **2622 – 1969**

a catalyst for behavioral change. The Nexus also provides new policy directions: coastal development cannot rely solely on physical programs (such as embankments or mangrove rehabilitation) but must be accompanied by strengthening human capacity through contextually relevant population and environmental education.

Implicitly, this framework reveals an innovation in viewing coastal communities not as "environmental victims" but as subjects possessing agency and local knowledge. In other words, coastal sustainability is determined not only by how strong embankments are built but also by how deeply ecological awareness is rooted in the community's capacity to maintain the balance between population and environment.

3.5 Conceptual Transformation and Approach Repositioning: From Dependency to Socio-Ecological Resilience

The behavioral change of Indramayu's coastal communities—from dependence on natural resources toward more reflective adaptive efforts—illustrates a conceptual transformation in human–environment relations. Gumilar's studies (2018) show that in the early 2000s, community participation in mangrove management was still tokenistic—merely following government or NGO programs without independent initiative. However, (Sugianto, 2019) study indicates a significant shift: coastal communities have begun to view mangroves not only as coastal protectors but also as new economic resources through processed products such as pidada syrup, mangrove tea, and kerandang soy sauce. This transformation marks a shift from purely ecological to socio-economic values, without eliminating their conservation function.

This phenomenon aligns with (Boserup, 1976) theory that population pressure can stimulate adaptive innovation and economic diversification. In the context of Indramayu, population density and declining fishpond productivity have encouraged communities to develop environmentally based economic strategies. Thus, population growth is not viewed merely as an ecological burden (as in Malthusian and Ehrlich, 1993 perspectives) but as a social stimulus that drives innovation rooted in local wisdom and ecological education.

However, this transformation is not yet uniform. Syaputra et al. (2024) in Dadap Village found that although community knowledge and attitudes toward healthy-home sanitation were relatively good, implementation remained low—only 8.3% of houses met healthy-home standards. This indicates that knowledge does not automatically translate into action, especially when economic structures and infrastructure support remain inadequate. Meanwhile, (Latif, 2016) found that physical environmental factors of houses, such as the distance between toilets and water sources and ventilation conditions, remain the primary causes of environment-related diseases. These two studies underscore the importance of a holistic approach: ecological behavioral change requires a combination of education, economic incentives, and structural support from local governments.

Cross-study comparisons reveal that previous research mostly focused on single dimensions of the problem—whether environmental (Gumilar, 2018; Latif, 2016), economic ((Asmara, 2007), or health behavior (Syaputra et al., 2024). This study, adopting the Population–Environment–PKLH Nexus framework, expands the analysis to a systemic level—linking population pressure, ecological conditions, and environmental education within a single social ecosystem. This approach aligns more closely with the coupled human–environment system model proposed by De Sherbinin et al. (2007), but contextualized for Indramayu through the dimension of ecological education based on PKLH.

p – ISSN: **1693 – 7945**
e – ISSN: **2622 – 1969**
Orginal Article

Furthermore, the concept of environmental citizenship introduced by (Lestari Sitorus et al., 2025) offers a new lens for understanding the rise of ecological awareness at the grassroots level. Coastal residents of Indramayu are beginning to exhibit forms of ecological citizenship through collective actions—planting mangroves, managing waste, and educating others. Such activities are no longer driven solely by projects but by moral and social consciousness to protect shared living spaces. Within the framework of political ecology (Hartmann, 1998), this form of participation can also be seen as a citizen strategy for negotiating with power structures and development policies that have historically been exploitative toward coastal areas.

The conceptual transformation occurring in Indramayu also marks a paradigm shift from project-based development toward social-awareness-based development. While Asmara's study (2007) study revealed that the success of coastal economic empowerment programs was heavily influenced by the educational level of credit recipients, today education functions not only to enhance economic capacity but also ecological capacity—the ability to understand the interconnection between economic activity and environmental sustainability. PKLH serves as the meeting point that bridges these two objectives: welfare and conservation.

Accordingly, the findings of this study demonstrate that Indramayu's coastal communities are moving toward socio-ecological resilience. This resilience is formed through three main mechanisms. First, ecological adaptation, namely the community's ability to modify behaviors and technologies to address environmental pressures—such as integrated pond innovations and mangrove restoration. Second, social adaptation, reflected in the formation of local community networks and environmental self-help groups that strengthen social solidarity. Third, cognitive adaptation, where PKLH values are internalized through social learning processes and collective reflection.

Conceptually, the transformation from dependency to resilience also represents a repositioning of the role of coastal communities in regional development. They are no longer positioned as objects of development but as agents of socio-ecological transformation. This aligns with (Bartlett, 1994) view that genuine sustainability cannot be achieved without population awareness of environmental carrying capacity limits. In the local context, such awareness manifests in the collective behavior of Indramayu's communities, who are beginning to redefine their relationship with natural resources—not merely out of economic pressure, but through a renewed understanding of life's sustainability.

Specifically, discussions related to demographic pressure, education level, and economic vulnerability were integrated into a single coherent subsection. Similarly, paragraphs addressing coastal abrasion, land-use change, and mangrove degradation were consolidated to avoid repetition. This revision improves readability while maintaining analytical depth and theoretical linkage.

4. Conclusion

The findings of this study reveal that the relationship between population and the environment in the coastal region of Indramayu Regency is complex, interdependent, and dynamic. Rapid population growth, high density, and low levels of education and economic quality among residents have created significant pressure on living spaces and coastal ecosystems. Empirical data from the Central Bureau of Statistics (BPS) of Indramayu Regency (2024) confirm that the region's characteristics—dominated by lowlands with an elevation of 0–3 meters above sea level and a high dependency on the agricultural–fisheries sector—make

p – ISSN: **1693 – 7945**
e – ISSN: **2622 – 1969**

Indramayu's coastal areas highly vulnerable to abrasion, tidal flooding (rob), and seawater intrusion.

Various local studies reinforce this depiction. Gumilar (2018) identified low community participation in mangrove management, while Sodikin et al. (2024) found that the abrasion rate in Sukra reached 2–14.3 meters per year. Syaputra et al. (2024) showed that most households in Dadap Village do not meet healthy home sanitation standards, and Asmara (2007) highlighted the weak sustainability of coastal economic programs due to educational factors. Collectively, these findings form a consistent thread demonstrating that social, economic, and environmental pressures are inseparable, and partial mitigation efforts tend to fail in achieving sustainable change.

Through the Population–Environment–PKLH Nexus framework, this study emphasizes the crucial role of Population and Environmental Education (PKLH) as a key variable mediating the relationship between humans and their ecosystems. PKLH functions not only as a process of awareness-building but also as a means of transforming ecological values and behaviors. Case studies in Karangsong and Juntinyuat illustrate the emergence of new ecological awareness at the community level: people no longer plant mangroves merely because of government projects, but because they understand that mangrove preservation is synonymous with the preservation of their economic livelihoods. Thus, environmental education has played a pivotal role in transforming dependency into resilience.

The main implication of these findings is the need to reposition coastal development approaches. Development, which has long focused on physical and economic aspects, must shift toward a socio-ecological model grounded in community awareness and participation. Programs such as mangrove rehabilitation, abrasion control, or sanitation improvement will be more effective if integrated with environmental education processes within schools, households, and communities. Local governments can mainstream PKLH into public policy—not merely as a formal education program but as part of climate adaptation and disaster mitigation strategies.

Moreover, this research demonstrates that the success of coastal community adaptation depends not only on material resources but also on social and cognitive capital. When communities possess collective awareness, reflective capacity, and strong social networks, they are better equipped to face ecological pressures. This is what constitutes socio-ecological resilience—the ability of a community to learn, adapt, and innovate amid change.

Therefore, the Population–Environment–PKLH Nexus provides a new perspective on coastal communities: they are not passive victims of environmental change but active agents with the potential to build sustainability from the ground up. For policymakers, this implies that development interventions must no longer be linear or project-centric but should facilitate social learning processes that empower communities to lead their own ecological transformations.

Theoretically, this study reinforces the Boserupian view that population pressure can drive innovation when accompanied by the enhancement of human capacity. It also expands the political ecology concept by incorporating education as a force for social transformation. Practically, these findings provide an empirical foundation for developing PKLH-based policies at the regional level that are more contextual, participatory, and ecologically just.

Ultimately, the experience of Indramayu's coastal communities demonstrates that environmental sustainability is not merely a matter of technology or macro policy, but fundamentally a matter of human awareness and social values. When population knowledge, ecological consciousness, and social solidarity unite, coastal resilience ceases to be merely a policy aspiration—it becomes a social reality that grows organically from the ground up.

p – ISSN: **1693 – 7945**
e – ISSN: **2622 – 1969**

Orginal Article

5. References

Asmara, A. (2007). Faktor-faktor yang Mempengaruhi Nilai Tunggakan Kredit pada Program Pemberdayaan Ekonomi Masyarakat Pesisir di Kabupaten Indramayu. *Jurnal Ilmu Pertanian Indonesia*, *12*(2), 100–107.

Ayodya, F. P. A., Vany Ardianto, & Yedo Kurniawan. (2024). CSR Strategy of The Oil and Gas Industry to Enhance the Wellbeing of Coastal Communities Amid Climate Change: A Case Study of PT Pertamina Gas Operation West Java Area in Juntinyuat, Indramayu. *Indonesian Journal of Social Responsibility Review (IJSRR)*, *3*(2). https://doi.org/10.55381/ijsrr.v3i2.380

Bartlett, A. A. (1994). Reflections on Sustainability, Population Growth, and the Environment. *Population and Environment: A Journal of Interdisciplinary Studies*, *16*(1), 5.

Boserup, E. (1976). Environment, Population, and Technology in Primitive Societies. *Population and Development Review*, *2*(1), 21–36.

De Sherbinin, A., Carr, D., Cassels, S., & Jiang, L. (2007). Population and environment. *Annual Review of Environment and Resources*, *32*, 345–373. https://doi.org/10.1146/annurev.energy.32.041306.100243

Dodgson, J. E. (2017). About Research: Qualitative Methodologies. *Journal of Human Lactation*, *33*(2), 355–358. https://doi.org/10.1177/0890334417698693

Ehrlich, P. R., Ehrlich, A. H., & Daily, G. C. (1993). Food Security, Population and Environment. In *Development Review* (Vol. 19, Issue 1).

Gumilar, I. (2018). Partisipasi Masyarakat Pesisir dalam Pelestarian Ekosistem Hutan Mangrove (Studi Kasus di Kabupaten Indramayu Jawa Barat). *Sosiohumaniora - Jurnal Ilmu-ilmu Sosial dan Humaniora*, *20*(2), 145–153.

Hansen, S. (1992). Population and The Environment. *African Development Review, African Development Bank*, *4*(1), 118–164.

Hartmann, B. (1998). Population, environment and security: a new trinity. In *Environment and Urbanization* (Vol. 10, Issue 2).

Kusuma, D. R., & Rudianto. (2024). *Statistik Daerah Kabupaten Indramayu: Badan Pusat Statistik Kabupaten Indramayu*.

Latif, I. (2016). Analisis Deskriptif Masalah Kesehatan Masyarakat Pesisir Desa Karangsong - Indramayu. *Kesehatan Indra Husada*, *4*(2), 29–36.

Lestari Sitorus, Nurullaeli Uswatun H, Suci Ananda Sitompul, & Nazwa Feryal Kamila. (2025). Transparansi dan Akuntabilitas dalam Pengelolaan Keuangan Negara. *Economic Reviews Journal*, *4*(1). https://doi.org/10.56709/mrj.v4i1.632

Mitchell, K. M., & Clark, A. M. (2021). Enhance Your Qualitative Analysis with Writing: Four Principles of Writing as Inquiry. In *International Journal of Qualitative Methods* (Vol. 20). SAGE Publications Inc. https://doi.org/10.1177/16094069211057997

Njie, B., & Asimiran, S. (2014). Case Study as a Choice in Qualitative Methodology. *IOSR Journal of Research & Method in Education (IOSR-JRME)*, *4*(3), 35–40. www.iosrjournals.orgwww.iosrjournals.org

Rauf, B., Ardi, M., Amir, F., Dirawan, G. D., Arsal, A. F., Awaluddin, & Asnur, S. (2023). *Pendidikan Kependudukan Lingkungan Hidup dan Implementasinya* (N. Pertiwi, Ed.; 1st ed.). Agma. www.penerbitagma.com

Rende, J. C. (2024). *Buku Ajar: Pendidikan Kependudukan dan Lingkungan Hidup (PKLH)* (Pertama). Tahta Media Group.

Sodikin, S., Ardiansyah, A. N., Arif, M., Syaripulloh, S., Ilyas, Y., & Astriyandi, A. A. (2024). Analisis Kerusakan Pantai dan Prioritas Penanganannya di Wilayah Pesisir Kecamatan Sukra Kabupaten Indramayu Provinsi Jawa Barat. *Journal of Marine Research*, *13*(4), 671–680. https://doi.org/10.14710/jmr.v13i4.43276

p – ISSN: **1693 – 7945**
e – ISSN: **2622 – 1969**

Sugianto, S. (2019). Diversifikasi Produk Olahan Mangrove Bisa Meningkatkan Kesejahteraan Masyarakat Pesisir Indramayu. *Mangifera Edu*, *4*(1), 73–79. https://doi.org/10.31943/mangiferaedu.v4i1.557

Syaputra, E. M., Luxiarti, R., Fitriyah, S., Rahmawati, A., Basri, S., Ayati, & Nadani, M. S. (2024). Faktor Yang Berhubungan Dengan Penerapan Sanitasi Rumah Sehat Pada Masyarakat Pesisir Desa Dadap Indramayu Tahun 2024. *Afiasi: Jurnal Kesehatan Masyarakat*, *10*(1), 58–63.