Geosfera Indonesia
p-ISSN 2598-9723, e-ISSN 2614-8528
available online at : https://jurnal.unej.ac.id/index.php/GEOSI
Vol. 8 No. 3, December 2023, 316-331

https://doi.org/10.19184/geosi.v8i3.40131

Research Article

The Impact of Citarum Harum Project on Ecoliteracy Among Upper Citarum Residents

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ARTICLE INFO

Received :
15 June 2023

Revised :
14 November 2023

Accepted :
2 December 2023

Published :
21 December 2023

ABSTRACT

The Citarum River is facing pollution and damage due to domestic and industrial activities. The provincial and national governments have implemented several programs to address the Citarum issue. One key aspect of rehabilitating the Citarum River basin is the increase in environmental awareness among the community. This research aims to examine the influence of the Citarum Harum Program on the formation of Eco-literacy among the communities in Upper Citarum. A survey was conducted with 393 respondents who reside along the banks of the Upper Citarum River, distributed across the 8 sectors of the Citarum Harum Program. The research instruments used include structured questionnaires, documentary studies, and interview guidelines. Data analysis was performed using the Structural Equation Modeling (SEM) technique with SmartPLS software version 3.2.9. The results of the study indicate that Eco-literacy (ECO) has a positive correlation with the handling of existing problems (HP) with a t-value of 1.136. Eco-literacy (ECO) has a negative correlation with the physical, social, and environmental characteristics (CH) with a t-value of -0.486, as well as with the occurrence of problems with a t-value of -0.237. This suggests that the formation of eco-literacy among the communities in Upper Citarum is highly dependent on the efforts undertaken by the task force. However, there is currently no connectivity between the knowledge and attitudes of the community towards actions in the restoration of river pollution and damage.

Keywords : Bandung Basin; Ecoliteracy; Upper Citarum

INTRODUCTION

Watershed Areas (DAS) are unique ecosystems characterized by the presence of rivers and their tributaries, functioning as a unified system that collects, stores, and naturally transports rainwater to lakes or seas. The topography of these areas is delineated by the ridges of hills (Ekawaty et al., 2018). According to Article 1 Clause 5 of the Indonesian Government Regulation No. 38/2011 on Rivers, a watershed area is a terrestrial region that is integrated with its rivers and tributaries, serving as a natural receptacle, storage, and conduit for rainwater to lakes or seas. The land boundaries represent topographic separators, while the boundaries at sea extend to the affected coastal waters (Sofyan et al., 2015).

Vienastra (2018) stated that a Watershed Area (DAS) is an area bounded by the ridges of hills, functioning as a collector, reservoir, and conduit for water, sediments, and nutrients within a river system, all of which exit through a single outlet. This area is determined by topography, which is based on surface flow. Watershed areas are crucial sites for interactions between humans and their environment. To ensure sustainable interactions, appropriate and beneficial management strategies must be considered (Sofyan et al., 2015).

As defined by Asdak (2004), watershed management is the formulation and implementation of activities or programs that manipulate natural resources and human activities within a watershed area to obtain productive benefits and services without causing damage to water and soil resources. This includes identifying the connections between land use, soil, and water, as well as the interrelationships between the upstream and downstream areas of a watershed. Polie et al. (2015) emphasize that effective watershed management should be supported by well-formulated policies. These policies should encourage land management practices conducive to preventing soil and water degradation. It is crucial to recognize that the cost of rehabilitating a watershed is much higher than the cost of prevention and protection efforts.

Prevention and protection of watershed areas, specifically the preservation of riverbanks, are sustainable actions. It refers to Earth's capacity and human adaptability to survive, develop, and change environmental conditions in the long term (Miller & Spoolman, 2014). This also applies to engineering or intervention in watershed areas. River engineering, defined by Ishak & Herman (2020), is the science of understanding river behavior and efficiently utilizing the potential of rivers. The purpose of river engineering is to preserve and maintain the existence of rivers on Earth's surface. This is also relevant to the Citarum River Basin in West Java and DKI Jakarta.

The environmental degradation phenomenon in the Citarum River Basin currently extends from upstream to downstream. The environmental damage in this watershed area affects the availability of water resources, including groundwater and surface water, and leads to a decline in the groundwater level within the Citarum River Basin due to the reduced catchment area, coupled with increased groundwater exploitation. Rapid and uncontrolled land-use changes are suspected as the primary cause of environmental degradation in the watershed. This is supported by Salim et al. (2019), who reveal that forest cover in the Citarum River Basin accounts for only 15.96% of its total area, with a mere 4.94% in the upstream region. Salim further explains that a 10% reduction in forest cover from the existing condition results in 58% of rainfall becoming surface runoff.

The challenges faced by the Upper Citarum River are highly complex, primarily due to the existing topographic conditions and the development of urban and industrial areas. The population growth in the Bandung Raya region, which includes the cities of Bandung and Cimahi, as well as Bandung and West Bandung Regencies, has been rapid, especially since the 1970s. The population growth in this area requires infrastructure and housing support, ultimately leading to changes in land use, increased demand for raw water, and declining environmental quality as a result of failures in environmental management, particularly in wastewater and waste treatment (Puslitbang Sumberdaya Air, 2018).

The issues in the Citarum River are not limited to the upstream, middle, or downstream areas alone; they are closely interconnected. Problems occur throughout the Citarum River Basin, starting from the upper reaches (Segments 1, 2, 3: From the upstream in Mount Wayang to Majalaya Bridge, Dayeuh Kolot Bridge, and Saguling Estuary). These issues include floods, deforestation of protected areas (encroachment), unplanned urban development, critical land, erosion, sedimentation, livestock waste, environmentally unfriendly agricultural practices, industrial and domestic waste, solid waste, and spatial planning issues. In the Central Citarum area (Segment 4: Saguling-Cirata-Jatiluhur), the challenges include suboptimal operation of the cascade reservoir system, the presence of floating nets, reservoir siltation, pollution from household and solid waste, industrial waste, and sand mining.

The government's efforts to control the river include the issuance of Presidential Decree No. 12 of 2012, which declares rivers as National Strategic Areas. The Governor of West Java has implemented the Citarum Harum program, which focuses on improving the conditions of the Citarum River. This improvement includes controlling damage, pollution, and restoring the Citarum River Basin. According to Rohmat et al. (2018), the Citarum Harum program is a collaborative effort involving various ministries, including the education sector, to develop a strategic concept for integrating these activities in a synergistic and sustainable manner.

The handling of the Citarum River issues, as studied Andri & Aziz (2021), began in 2001 through the Citarum Bergetar program (Clean, Beautiful, Sustainable), which was then followed by the Integrated Citarum Water Resources Management Investment Program (ICWRMIP) in 2010. From 2013, the handling of the Citarum River Basin issues has been carried out through the Citarum Bestari Program (Clean, Healthy, Sustainable). However, it was only in 2018, in response to the failure to achieve river management targets, that the central government implemented the Citarum Harum Program through a presidential regulation. This program employs a sector-based approach, allowing for targeted and locally specific interventions in accordance with the social and cultural characteristics of each sector.

In the Citarum Harum program, the region is divided based on sectors. Sectorization is crucial for mapping the issues occurring in a particular area, especially in relation to pollution in the river basin (Imansyah, 2012). Sectorization serves as a tool to divide different areas within the river basin based on the specific characteristics of the problems in those areas. The purpose of this division is to map the existing issues and facilitate problem analysis, leading to effective and targeted solutions. The advantage of sectorization lies in its implementation structure, where each sector is led by an Indonesian Army (TNI AD) officer with the rank of colonel. This can facilitate command in the implementation of environmental programs.

The primary objective of addressing the issues in the Citarum River Basin is to enhance environmental awareness among the communities residing there. Several studies have highlighted environmental awareness as the key to restoring the pollution and damage that have occurred along the Citarum River Basin. However, it appears that the environmental awareness or eco-literacy studied in many research efforts is only temporary in nature. This aspect can be explored through various studies proposing the improvement of eco-literacy through socialization, education, and community engagement. It is essential to understand that conscious and caring attitudes are just one component of eco-literacy. Re-educated individuals need to possess the knowledge and skills to develop sensitivity, care, and responsiveness to environmental issues.

Research conducted by Juniarti (2020) stated that there is an increase in environmental awareness among the communities living along the Citarum River when they have received counseling and education. Ruyani et al. (2023) examined that environmental awareness is based on an awareness of one's role as part of the community, necessitating a social network among different layers of society. This awareness of roles is built through rewards, including material appreciation. The findings of Rizkiyah et al. (2022) indicate that youth communities play a crucial role in establishing partnerships with society, thus forming a commitment to environmental awareness. Meanwhile, study of Subarsyah (2020) showed that law enforcement strategies through a socio-cultural approach are more effective in maintaining harmony among communities, corporations, and the government in their commitment to preserve the Citarum River Basin.

The communities living along the upper Citarum Sub-Basin are aware of the pollution and damage issues and their underlying causes. However, there is still a lack of understanding regarding the processes occurring in the Citarum River Basin and their impact on various aspects of life. This lack of understanding has led to a minimal sensitivity among the communities towards environmental issues in the Citarum River Basin. This research aims to assess eco-literacy from the perspective of the alignment between physical, social, and environmental characteristics, coupled with the existing issues and implementation of interventions. Therefore, the goal of this study is

to obtain a measurable eco-literacy overview not only based on the expressions of attitudes within the community but also considering the knowledge, experiences, and habits they demonstrate.

METHODS

This research was conducted in the Citarum Harum Sectorization Area, specifically in the Upper Citarum Sub-Basin. The study area covered a total of 8 sectors, starting from the Situ Cisanti area to Curug Jompong in Bandung Regency. The respondents were selected using the Cluster Sampling technique, considering the representation of each sector as a cluster comprising several sub-districts (kecamatan). With a population of 9,773,547 inhabitants in the 8 sectors of the Upper Citarum Sub-Basin, a sample of 393 respondents was drawn using the Leach formula (Leach, 2013).

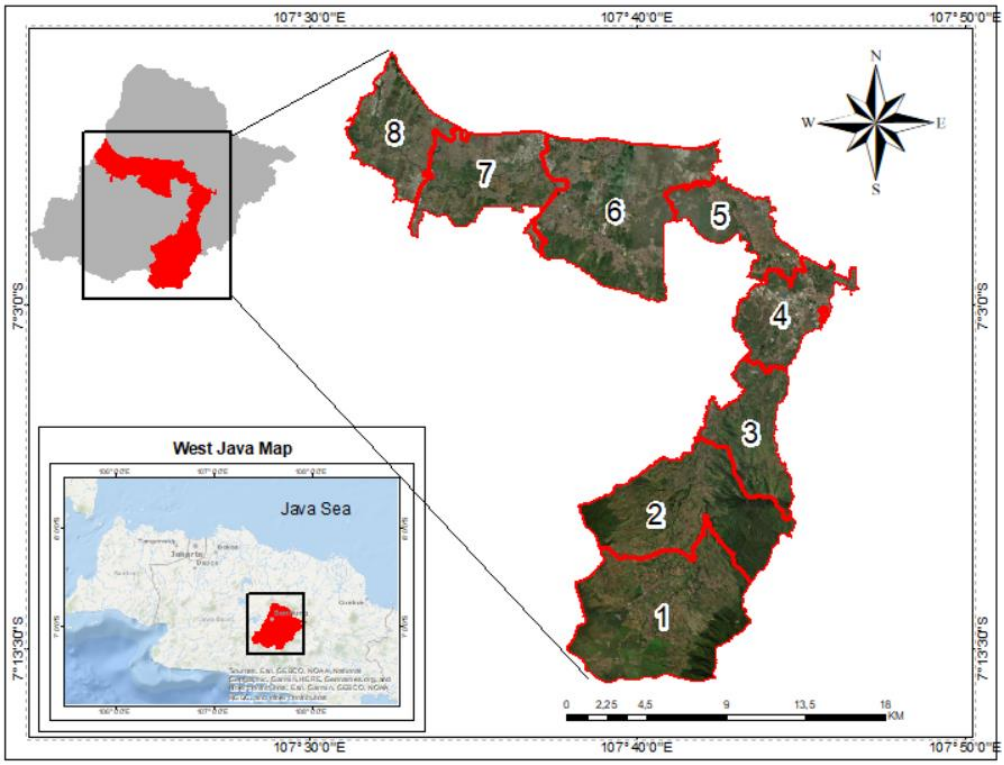

Figure 1. Study Area

There are two variables in this study: the Citarum Harum Sectorization Variable of the Upper Citarum Sub-Basin Problem Handling (X) and the Community Eco-literacy (Y). Variable X is divided into three sub-variables: Physical, Social, and Environmental Characteristics of the Community (X1), Existing Problems (X2), and Problem Handling (X3). Meanwhile, the community eco-literacy variable consists of four indicators: Knowledge (Y1), Environmental Attitudes (Y2), Skills (Y3), and Participation (Y4). The relationship pattern established between these variables, which forms the basis of the analysis, is as follows.

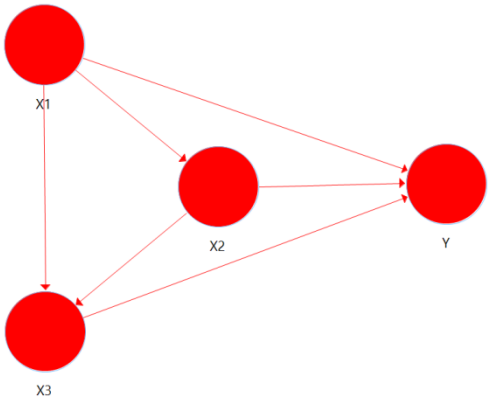

Figure 2. Relationshop Pattern between Variables

This research utilizes the survey method. The research procedure to be conducted in this survey research, according to Singarimbun & Effendi (1998), is as follows: (1) Formulating the research problem and determining the survey objectives; (2) Determining concepts and hypotheses and conducting literature review. Sometimes hypotheses are not required, for example, in operational research; (3) Sampling; (4) Questionnaire development; (5) Fieldwork, including selecting and training interviewers; (6) Data processing; and (7) Analysis and reporting.

This research method is used to obtain data on: 1) Obtaining data on the physical, social characteristics of the community and the environment in each sector of the Citarum River in the Citarum Harum program in the Bandung Basin area. 2) Obtaining data on the problems that occur and the resulting impacts due to problems that arise in the sectorization of the Citarum River in the Citarum Harum program in the Bandung Basin area. 3) Obtaining data on the handling (approach, form, system, and techniques) of problems that occur in the sectorization of the Citarum River in the Citarum Harum program in the Bandung Basin area. and 4) Obtaining data on the relationship value of river characteristics, problems that occur, and the handling carried out with the escalation of community eco-literacy (environmental awareness) based on the sectorization of the Citarum River in the Citarum Harum program in the Bandung Basin.

Data analysis in accordance with these objectives is performed using path analysis technique using Smart-PLS software version 3.2.9. The requirement for conducting SEM analysis is a minimum sample size of 100-200 people (Kusnendi, 2008). Jöreskorg & Sörbom (1996) stated that the minimum number of variables for SEM is three variables with a sample size of 200 people. Therefore, based on these references, SEM analysis technique can be performed in this research with a sample size of 400 people and using 4 variables. The measurement using the Structural Equation Modeling (SEM) procedure is preceded by validity and reliability tests, the computation of Average Variance Extracted (AVE) values, and the correlation values between constructs.

RESULTS AND DISCUSSION

Sectorization Study in The Upper Citarum Region

Issues in the Citarum River Basin are not caused by a single segment of the river but rather by interconnected phenomena in the upstream and downstream areas. Problem-solving efforts need to be focused and conducted based on studies of each river segment. Sectorization is one approach chosen to address the issues in the Citarum River Basin through territorial division. The aim of sectorization in this context is to achieve effective and targeted solutions. The Citarum River is divided into 22 sectors, categorized into upstream, middle, and downstream areas. This research focuses on the area around the Bandung Basin, which consists of 8 sectors, starting from Situ Cisanti to Curug Jompong.

Examining the issues, the Citarum River flowing through the Bandung Basin is confronted with heavy pollution and poor water quality. This has led to the labeling of this river segment as one of the most polluted rivers in the world. Through sectorization, various environmental preservation activities have been carried out through community empowerment (Juliandar & Rohmat, 2019), including community awareness campaigns, tree planting, wastewater channel management, biopore hole construction, and community engagement.

In Sector 1 of Citarum Harum at Situ Cisanti, the main environmental issue faced is severe pollution caused by pollutants from agricultural, livestock, fisheries, industrial, and domestic activities. Since 2015, the water quality status has changed to Class D, indicating severe pollution (Putra, 2016). The causes of pollution in this area are the high population density combined with low environmental awareness. The local community generally lacks proper domestic wastewater systems, leading to increased levels of BOD, COD, and E. Coli bacteria in the river water. Without proper management, the increasing population exacerbates environmental degradation.

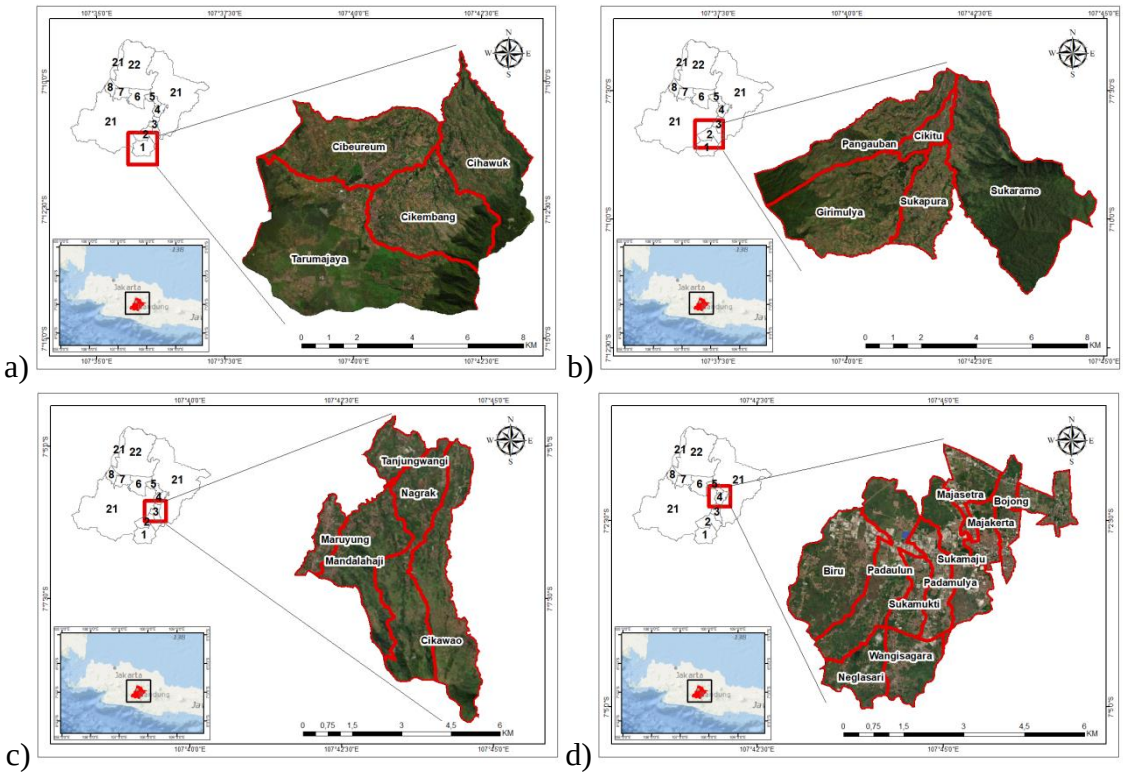

Figure 3. Sector 1 - 4 Location Map

Sector 2 of Citarum Harum is located in the Pacet Subdistrict. The environmental issue in this area is critical land. Pacet Subdistrict is one of the areas with the largest extent of critical land, with erosion reaching more than 480 tons/ha/year (Nurysyifa, 2021). The dominant land use in this area is forests and paddy fields. The local farming community in Pacet Subdistrict still follows traditional practices, resulting in manual waste management. This indicates river pollution as the waste is directly discharged into the river without prior treatment. Testing of Total Dissolved Solids (TDS) values shows that groundwater and river water pollution has occurred in this area. With a gaining stream relationship between groundwater and river water, contaminated groundwater can also pollute the river water.

The environmental issue in Sector 3 or the Maruyung-Cikarau area is the presence of garbage along the river. The dominant source of garbage in this area is from domestic activities. The excessive dumping of garbage into the river in this area leads to flooding when the river overflows. This is because the river is often constrained by large rocks, making it prone to overflow when the trash blocks the flow path. Activities carried out to increase environmental awareness in

this sector include education and socialization on domestic waste management. Additionally, the community is involved in a greening movement through tree planting along the riverbanks.

In Sector 4 of Citarum Harum, located in the Neglasari-Rancabuana area, the local community faces flood issues due to land conversion and direct disposal of waste into the river. The contaminated river water affects the quality of groundwater, making it unsafe for direct consumption by the community. Physically, Neglasari Village is categorized as low-lying land, making it vulnerable to flood disasters. To anticipate this, the community has implemented the construction of biopore holes. Biopore pipes also serve as rainwater catchments, which can be used as a groundwater reserve.

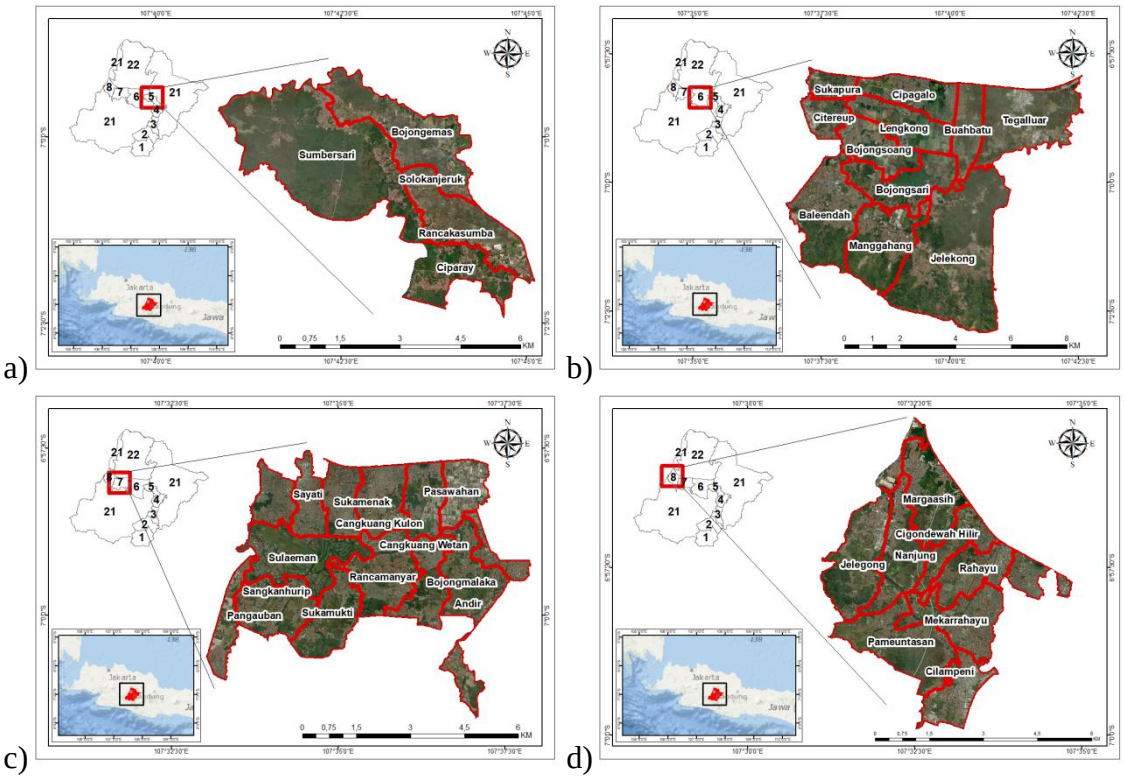

Figure 4. Sector 4 - 8 Location Map

The Rancabuana to Bojongsoang area is predominantly used for residential and industrial purposes. Extensive land conversion in this area results in improperly managed waste and frequent flooding during the rainy season. Environmental degradation in Sector 5 of Citarum Harum is influenced by the socio-economic conditions of the local community. According to Enzler & Diekmann (2019), factors such as education and income levels affect the formation of knowledge and attitudes of the community towards the environmental conditions, in a preliminary study, it was found that the community in this area still lacks adequate knowledge regarding waste management and its impact on the level of damage that has occurred. This can be identified through direct disposal of agricultural and household waste into the river.

Domestic waste management issues also occur in Sector 6 along the Sapan to Cijagra area. The characteristics of the community in this area still show low knowledge, attitudes, and awareness towards existing environmental damage. Low levels of education and economy contribute to the direct disposal of domestic, agricultural, and livestock waste into the river. The community perceives waste management as time-consuming, labor-intensive, and costly. Furthermore, they are unaware that direct waste disposal has caused environmental damage that is felt by the local community. The rivers in this area are contaminated with heavy metals such as Cadmium (Cd), Chromium (Cr), and Copper (Cu) in the water, sediments, and fish.

Contamination of heavy metals in groundwater and river water also occurs in Sector 7, in the Cijagra to Jembatan Cilampeni area. The presence of iron (Fe) in the water renders it unfit for consumption by the local community (Febrita & Roosmini, 2022). Textile industry activities contribute to the generation of hazardous and toxic chemical waste, which affects the physical, chemical, and biological properties of both groundwater and river water. The highest concentration of waste is found in Pangauban Village, Katapang District. Characteristics identified due to water pollution in this village include turbid and odorous water. In addition to water pollution, the overcrowding of riverbanks by the population has led to uncontrolled accumulation of domestic waste. Several districts in Sector 7, namely Dayeuhkolot, Baleendah, and Bojongsoang, experience flooding 10-15 times a year due to the accumulation of waste and mud.

Another environmental damage along the Citarum River is river sedimentation and erosion. As a result, floods often occur in settlements built along the river. In Sector 8, located in the Jembatan Cilampeni to Curug Jompong area, river sedimentation occurs due to agricultural, livestock, and residential waste. Without proper waste management, most of the livestock waste, agricultural waste, and domestic waste directly enter and accumulate at the riverbed. This sedimentation and organic pollution also decrease the quality of water that should be usable by the local community. Various studies conducted on water quality in this area indicate poor and unsuitable conditions for consumption.

The Handling River Pollution and Damage by Citarum Harum Taskforce

Generally, the handling of pollution and damage in the Citarum River Basin (DAS Citarum) follows three policy directions: prevention of pollution and/or damage to the basin; management of pollution and/or damage to the basin; and restoration of basin functions (Satgas PPK Citarum Harum (Lestari et al, 2022). Based on these policy directions, there are 11 action plans implemented across all sectors, including sectors 1 to 8. These action plans include: 1) critical land management; 2) industrial waste management; 3) livestock waste management; 4) domestic wastewater management; 5) waste management; 6) spatial planning; 7) water resources management; 8) floating net cage arrangement; 9) law enforcement; 10) education; and 11) community relations. The expected target achievements are monitored and evaluated through periodic reports submitted to the daily chairman of the Citarum River Basin Task Force and forwarded to relevant local agencies or the DAS PPK working group.

The activities conducted in Sector 1, from Situ Cisanti to Sector 8, in the area from Jembatan Cilampeni to Curug Jompong, are determined based on the existing pollution and environmental damage conditions. The types of activities carried out include community awareness campaigns about the importance of environmental preservation and disaster prevention due to damage, tree planting, biopore hole construction, riverbank normalization, casting, wastewater channels, surprise inspections, construction of wastewater treatment plants, development of supporting tourism infrastructure, demolition of illegal buildings, and community service activities. As studied by Prayoga (2022), the purpose of these activities is to increase community involvement and raise awareness in environmental conservation. The implementation of these activities is accompanied by regulations regarding strict enforcement against pollution or damage violations along the Citarum River.

In Sector 2 of Citarum Harum, in the Pacet-Maruyung area, the main activity is the cleaning of waste around the riverbanks. Waste is a major problem that leads to river and environmental pollution. Through this activity, community participation is expected to become a habit rather than a temporary action, resulting in a sustainable environment. Physically, Sector 2 has a sloping topography, and the available land is dominated by potato plantations. To anticipate landslides, extensive greening activities are also carried out. Furthermore, the greening efforts aim to enhance the area's infiltration capacity through the establishment of protected forests and springs from Situ Cisanti (Deliarnoor, et al. 2023). One of the water sources utilized by the local community

in this area is Danau Alam Lestari, an artificial lake formed by natural springs in Pangauban Village, Pacet District.

Waste cleaning is a core activity found in all sectors of Citarum Harum. This is because the accumulation of waste, both along the riverbanks and in the water bodies, is a major factor contributing to the current pollution and damage issues (Pamungkas et al, 2021). In Sector 3, the accumulation of waste blocking the flow of the Andir River in Tanjungwangi Village is predominantly domestic waste. This condition indicates that household waste management has not been implemented in this area, leading the community to dispose of their waste directly into the river. The activities carried out by Sector 3 Task Force include regular socialization and education to reduce the habit of dumping waste into the river and raise awareness about the issue. As a result of this pollution, the flow of the Citarum River has narrowed and silted up. Dredging activities with heavy equipment have been conducted as part of the river normalization efforts.

In Sector 4 of Citarum Harum, another activity carried out by the task force in collaboration with the community is the construction of biopore holes. The land conversion that has occurred in this area has disrupted the ecological functions of the land surrounding the river as a rainwater infiltration area. As a consequence, rainwater quickly enters the river, leading to overflow (Nkeki et al, 2022). The construction of biopore holes also serves as groundwater reserves. Additionally, fish stocking activities are conducted along the river. The fish stocking serves as an indicator of improving water quality from heavily polluted to lightly polluted. By cultivating fish in the river, it is expected to change the behavior of the community from waste disposal to river conservation, as there are valuable resources that can be utilized. The fish species stocked along the river in Solokan Jeruk Sub-district include catfish, tilapia, and catfish.

The environmental management carried out by the Citarum Harum Task Force can result in the development of tourist destinations and infrastructure development for the local community. In Sector 5, an Icon Park has been built along the banks of the Citarik River. The purpose of constructing the park is to utilize the land along the riverbank to enhance the beauty and aesthetics of the river environment. The park also features a greenhouse for plant propagation and greening activities. The utilization of land near the riverbank aims to encourage the community to cultivate plants that can support self-sufficiency and food security. Not far from the Icon Park, a Temporary Waste Disposal Site (TPS) has been established in Bojong Emas Village, Majalaya Sub-district. The TPS serves as a temporary solution to address the lack of waste disposal facilities in Sector 5, while plans for the construction of a permanent TPS are being developed.

The role of the military institution as part of the Citarum Harum Task Force is demonstrated through the implementation of "karya bhakti" or voluntary work. One of these activities includes waste cleaning, inspections, and social communication with the community in Sector 6. The objective of these activities is to raise public awareness about the importance of preserving the river. These activities are motivated by the challenging habit of directly disposing of waste into the river, which is difficult to change. However, through various approaches, this habit has gradually decreased, and the pollution conditions have become more manageable. One observable indicator of change in this area is the decrease in floodwater height by up to 30 cm, which recedes within three days (Muin et al, 2015). These activities are carried out as a preventive measure to mitigate the accumulation of large amounts of waste during increased water flow in the rainy season.

Another activity encountered in the Citarum Harum sector is tree planting. In Sector 7, vetiver planting has been implemented to prevent sedimentation in the Citarum River. In 2022, a total of 8,000 vetiver seedlings were planted along the sub-watershed of Citarum, including the riverbanks of Andir, Rancamanyar, Sukamukti, Sangkanhurip, Dayeuhkolot, and Cangkuang. Sedimentation is a common problem in the Citarum River caused by the accumulation of waste or mud originating from local agricultural, livestock, and domestic activities. Vetiver planting is an anticipatory measure carried out in conjunction with regular dredging. As studied by Islam et al (2021), vetiver grass has roots that can reach a depth of 2.5 meters, effectively preventing

sedimentation. Additionally, vegetation on the riverbanks contributes nutrients to the soil, supporting greening efforts in every sector of Citarum Harum.

Pollution and damage in the Citarum River are closely related to the numerous industries located along its banks. The high concentration of toxic and hazardous waste has made the Citarum River one of the most polluted rivers in the world (Belinawati et al., 2018). Stringent measures to address direct waste disposal are being taken, including the inspection of wastewater treatment plants (IPAL) in Sector 8 of Citarum Harum. The task force in several sectors has carried out socialization and IPAL construction efforts to ensure that the wastewater discharged into the river is not polluting and meets applicable standards. Inspections are conducted to monitor IPAL conditions. The indicators for these inspections include the treated condition of the wastewater, absence of heavy metal contamination, and lack of odor. Based on reports from the task force team in Sector 8, the waste discharged by several companies in this area is not hazardous. The surveillance and inspection of IPAL align with the impact indicators in the Citarum Harum PPK Action Plan to ensure that effluents from industries meet the quality standards.

The Relationship Between The Citarum Harum Project and Ecological Literacy

The testing of the relationship between Citarum handling sectorization and the formation of eco-literacy statistically begins in Phase I. The Citarum handling sectorization variable consists of: physical characteristics, social community, and environmental (CH1), the problems in each sector of the Citarum River (CH2), and the handling of the occurring problems (CH3). Then, the community's eco-literacy variable consists of four indicators, namely: environmental knowledge (ECO1), environmental attitude (ECO2), cognitive abilities (ECO3), and participation (ECO4).

The initial stage of testing is conducted using the Smart-PLS program to determine the relationship between variables. In this testing, the strength of the relationship for each indicator can be determined. The calculation is done by comparing the calculated r-value with the critical r-value. If there are constructs or variables with a calculated r-value lower than the critical r-value, indicators may be removed, and further testing is conducted until achieving a satisfactory level of reliability (Zhou et al., 2023). The critical r-value used is 0.196. The initial model used is the result of calculating a hypothetical model that has undergone modifications.

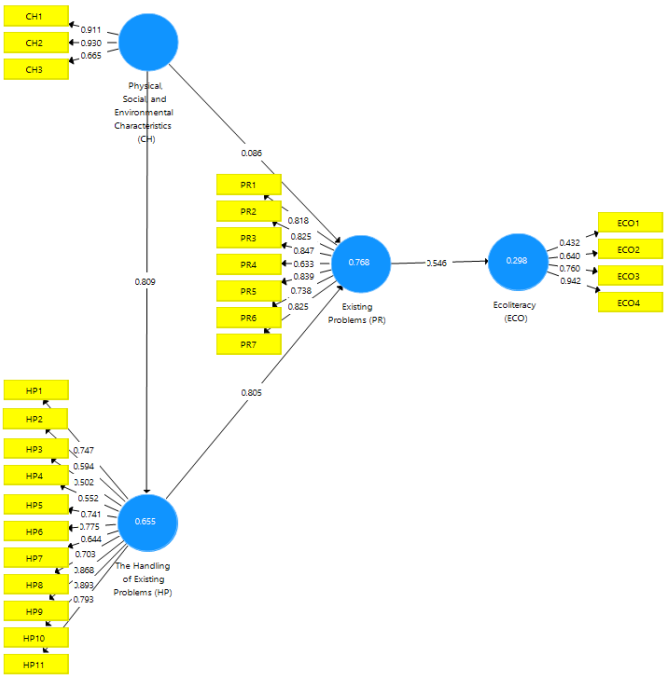

Figure 5. Structural Model of Citarum Harum Project in Upper Citarum and Ecoliteracy

The results of the initial stage of testing indicate that there are still indicators with calculated r-values lower than the critical r-value. In the subsequent testing stage, path improvements are made through retesting, whereby indicators that have not reached reliability are eliminated. After model improvement, statistical calculations are conducted again to assess the strength of the relationships between indicators for both variable X and variable Y. In the initial model, indicators that did not meet the statistical requirements were found in indicator HP, specifically industrial waste management (HP2), livestock waste management (HP3), and domestic wastewater management (HP4). Additionally, for variable ECO, one indicator, environmental attitude, had a calculated r-value lower than the critical r-value. After streamlining, a fixed model is obtained with changes in the r-values for each indicator. The magnitude of the r-value indicates the relationships formed between indicators and between constructs/variables. A positive r-value indicates a positive relationship, while a negative value indicates a negative relationship.

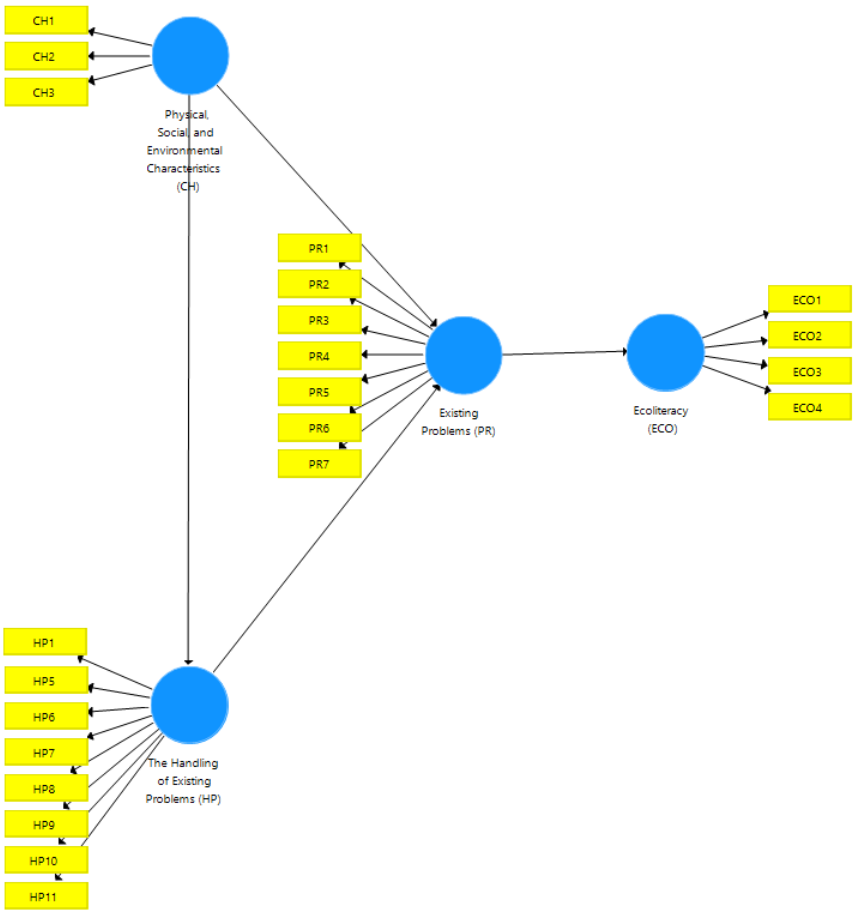

Figure 6. Structural Model after Trimming

In the model improvement, variable X, which is deemed valid and reliable, consists of 18 indicators out of a total of 21 indicators. The determination of validity refers to the comparison of the calculated r-values of each indicator with the critical r-value of 0.600. The model, after improvement, can explain the interconnection between Citarum handling sectorization and the formation of community eco-literacy. It can be stated that there is a positive relationship between the physical, social, and environmental characteristics with the handling of issues and the occurrence of problems. There is also a positive relationship between the occurrence of problems and the handling of those problems. The relationship between variable X and Y depicts a positive connection between the handling of issues and the formation of eco-literacy.

These findings indicate that the physical, social, and environmental characteristics of a region cannot accurately depict the eco-literacy of the community. This observation is evident from the empirical conditions that even though the Upper Citarum region has significant or severe physical, social, and environmental vulnerabilities, the local community does not exhibit a high level of eco-literacy. This is similarly stated in the research conducted by Rahma et al. (2022), where they found that environmental issues alone do not guarantee the formation of eco-literacy. The local community possesses sufficient knowledge, positive environmental attitudes, and cognitive skills to observe the occurring damage, but their impact on environmental restoration is still limited. Therefore, the role of the task force (*satgas*) in conditioning the community remains highly dominant in developing the community's capacity related to the restoration of pollution and damage in the Upper Citarum.

The formation of environmental attitudes cannot be achieved in a short period. Environmental conservation socialization is not something new for the community of Upper Citarum. To cultivate a caring attitude towards the environment, certain components need to be considered, such as supporting facilities and infrastructure, policy harmonization among different levels, and cooperation between the community and the Citarum Harum task force (Wang et al., 2023). Up until now, the commitment of the community in efforts to restore pollution and damage remains a challenge. This is evident in the low participation during environmental program implementation. Increasing commitment requires a continuous approach, thus necessitating strong cooperation between the government, task force, and community leaders.

The research results indicate that the community already possesses knowledge about the current environmental damage, but they have not fully comprehended the impact of pollution on river degradation. This also influences their attitude towards pollution, which is still evident in the study area. Due to the lack of knowledge and formed environmental attitudes, the community is not able to link various aspects of their lives to environmental conservation efforts (Debrah et al., 2021). Discharging waste into the river is considered a norm and lacks a proportional solution. The community is unaware that there are environmentally friendly farming and livestock techniques that can yield similar results to existing practices. With the current knowledge and attitudes of the community, the riverbanks are still perceived as potential areas for construction or even as solid waste disposal sites.

The implementation of the Citarum Harum program, in general, has received positive responses in the form of community participation (Kesa, 2020). Regular activities, such as garbage cleaning and waste removal, installation and monitoring of wastewater treatment facilities (IPAL), waste management, and tree planting, are attended by a considerable number of people. However, the execution of these activities still relies on the coordination of the task force or mobilization team at the district and sub-district levels. The community has not yet demonstrated a strong sense of self-reliance in carrying out environmental programs. Field findings indicate that several environmental programs that were initiated have been abandoned due to a lack of coordination. Collective attitudes towards environmental preservation should be supported by internalization within each individual in the community. The emergence of awareness at the household level can significantly contribute to achieving the goals of Citarum Harum, namely, restoring pollution and damage in the river basin.

Based on the results of the statistical analysis, it is found that 8 indicators have an influence on the formation of community eco-literacy, including: critical land management, waste management, regulation of floating net cages, control of Citarum's spatial utilization, law enforcement, water quality monitoring, water resource management, and education. The formed eco-literacy consists of 5 sub-indicators for environmental knowledge, 3 sub-indicators for cognitive skills, and 4 sub-indicators for participation. It can be concluded that the formation of eco-literacy in the components of environmental knowledge, cognitive skills, and community participation among residents living in the Citarum River Basin, from sector 1 in Situ Cisanti to

sector 8 in the Cilampeni Bridge - Curug Jompong area, is influenced by the handling activities carried out by the task force in collaboration with the community.

CONCLUSION

The Citarum River Basin was once declared the most polluted river in the world. The high level of pollution and damage in the Citarum River is attributed to the concentration of population and unsustainable human activities. The problems in the Upper Citarum Sub-Basin can be assessed based on different river segments. In the upper segment, such as the Situ Cisanti area, the problems encountered include erosion and sedimentation due to agricultural and livestock waste. As we move downstream to the middle and lower segments of the river, pollution is mainly caused by domestic and industrial waste. Since 2018, river management has been carried out through the Citarum Harum Program. In this program, the river basin is divided into sectors to address the problems based on their sources. Surveys conducted among the communities in the Upper Citarum have shown that pollution and damage mitigation efforts are still primarily carried out by the task force. In some locations, the level of awareness and community participation is still low. Enhancing eco-literacy among the communities is crucial, especially to improve their capacity in preserving the river ecosystem after the completion of the Citarum Harum Program in 2025.

ACKNOWLEDGMENTS

The author extends sincere thanks to all parties who have assisted and contributed to this research.

DECLARATIONS

Conflict of Interest

The authors declared that they had no known competing interests.

Ethical Approval

The research has been approved by the Research Committee of Universitas Pendidikan Indonesia. All research was carried out in accordance with Universitas Pendidikan Indonesia research ethics guidelines applicable when human participants are involved.

Informed Consent

Before conducting the study, we had obtained the consent of all the research subjects involved in the study. To maintain the confidentiality of the data, the research subjects were coded or anonymous.

DATA AVAILABILITY

Data used to support the findings of this study are available from the corresponding author upon request.

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