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Sustainable Resilience of Women Batik Makers in the Face of Environmental Degradation

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ABSTRACT

This study examines the impact of environmental degradation caused by urbanization and groundwater exploitation in North Pekalongan, which has triggered flooding, tidal inundation, and permanent waterlogging in 30% of the area. These conditions increase the vulnerability of female batik artisans in social, economic, and environmental aspects, threatening the sustainability of batik production. Using qualitative methods and an exploratory mixed approach, data were collected through in-depth interviews, surveys, and analyses such as overlay, indices, and SWOT. The findings show that: 1) Environmental degradation in Pekalongan City involves wetland conversion, land subsidence from soil deterioration and groundwater overuse, mangrove loss, and limited green spaces, all leading to flooding; 2) Female batik artisans face increased vulnerability and reduced resilience; 3) Stakeholders address these issues through government flood control measures, NGO sanitation projects, climate adaptation groups, and academic data support; 4) Sustainable resilience strategies prioritize offensive approaches, such as home elevation, empowering artisans, and leveraging external opportunities. The recommended sustainable resilience strategy is offensive, optimally leveraging internal strengths and external opportunities.

INTRODUCTION

The era of industrialization has brought development progress in various regions of the world that improves the quality of human life (Suherman et al., 2023). However, behind the benefits, industrialization also causes negative effects in the form of development externalities, such as environmental degradation, climate change, and natural disasters due to excessive exploitation of natural resources and the transfer of ecosystem functions (Ruggerio, 2021; Dwiprigitaningtias, 2024). The consequences of these unsustainable development practices not only impact current generations but also future generations (WCED, 1987; Kahyani, 2020). In response, the concept of sustainable development was introduced to make wise use of natural resources without sacrificing the needs of future generations (Brundtland et al., 2023).

In the last 20 years, the International Disaster Database (EM-DAT) recorded that about 3.9 billion people were affected by climate-related disasters, with 510,837 deaths from 6,681 catastrophic events, such as floods and hurricanes, which dominated 46% of cases between 2000–2019 (CRED, 2020). These adverse impacts exacerbate poverty, inequality, and community welfare. To address these challenges, three global commitments were adopted in 2015: the 2030 Agenda for Sustainable Development (SDGs), the Paris Agreement for climate change control, and the Sendai Framework for disaster risk reduction (Secretariat, 2017). These three commitments are integrated to reduce vulnerability and increase community resilience to environmental degradation, climate change, and disasters with the principle of "No-one Left Behind".

Indonesia, as a country with a geographical location vulnerable to various disasters such as floods, landslides, and tsunamis, is committed to adopting the three agendas. Its implementation is manifested in various policies, such as the

ratification of the Paris Agreement through Law No. 16 of 2016 and Presidential regulations related to the SDGs and the Sendai Framework (Rachmaditya et al., 2022). In Central Java, the province with the highest population growth on the island of Java, the challenges of sustainable development are increasingly real, especially on the north coast which is vulnerable to flooding and environmental degradation due to resource exploitation and urbanization (Saraswati & Abubakar, 2020; Rizalty, 2021).

The city of Pekalongan, one of the centers of the batik industry in Pantura, Central Java, is facing a serious impact from the continuous (Andriani et al., 2020; Saraswati & Abubakar, 2020). This area is recorded to have a large contribution to the local economy through the batik industry which accounts for 23% of the city's GDP (Khairulbahri, 2022). However, the floods that submerged up to 37% of the city area had an impact on the decline in productivity and sustainability of the batik industry, most of which were women (Pekalongan City Government, 2021a). The Putting-Out-System (POS)-based work system, which provides flexibility for women to work from home, actually makes them more vulnerable to the impact of floods because production is carried out in flood-affected neighborhoods (Avisah, 2022; Dewi & Nugroho, 2020).

Women, who make up the majority of workers in the batik industry, have a great contribution to the local economy but are also the most vulnerable group to the impact of disasters (Hedriyanti & Syamsuddin, 2021; Raman et al., 2022; Chisty et al., 2021; Gaisie et al., 2022; Rakib et al., 2017). In general, women face a double burden in disaster situations, namely increasingly difficult domestic and productive roles (Azad & Pritchard, 2023; Jerin et al., 2023; Tanner et al., 2022). This vulnerability can threaten the sustainability of the batik industry in Pekalongan if not handled properly.

Therefore, an integrative strategy is needed to reduce the vulnerability of women batik makers and increase their resilience through gender-sensitive social, economic, and environmental approaches (Kridarso, 2018; Sulthonuddin & Herdiansyah, 2021). This study aims to analyze the vulnerability and resilience of batik women to floods, as well as evaluate the policies implemented by stakeholders in overcoming the problem of environmental degradation in Pekalongan City. The results of the research are expected to provide strategic guidance in creating inclusive sustainable development while protecting cultural heritage in the form of the batik industry, which not only has economic value but also historical and cultural value.

MATERIALS AND METHODS

This study uses a qualitative methodology with an explanatory sequential mixed approach, which starts with quantitative data collection in the first stage and continues with qualitative data collection in the second stage (Creswell & Creswell, 2017). In the initial stage, quantitative data was collected through questionnaires aimed at women batik workers to obtain an overview of the demographics of respondents, their vulnerability to disasters and environmental degradation, and their resilience. Meanwhile, data on environmental degradation were obtained through the analysis of official local government documents, as well as literature studies and satellite imagery using ArcGIS software.

The second stage involves qualitative analysis through in-depth interviews with informants that include stakeholders such as batik entrepreneurs, the government, academics, and NGOs. Quantitative data was analyzed by descriptive methods and SWOT (Strength, Weakness, Opportunity, Threats) analysis, while qualitative data was analyzed with index composites for vulnerability and resilience.

This research was carried out in Padukuhan Kraton and Krapyak Villages, North Pekalongan District, Pekalongan City, with data collection from July to November 2024. The data collected includes information related to environmental degradation, social, economic, and environmental sensitivities, as well as the social, economic, and environmental resilience of women batikers.

Gender-sensitive development policy analysis is also carried out using the analysis content in government policy documents. The SWOT method is used to develop a sustainable resilience strategy for women batik affected by environmental degradation, to obtain the best strategy in dealing with the threats faced by women batik in Pekalongan City.

RESULTS AND DISCUSSION

Geographical Conditions of Pekalongan City

Pekalongan City is administratively bordered by the Java Sea in the north, Batang Regency in the east and south, and Pekalongan Regency in the south and west. The soil condition in Pekalongan City is somewhat gray with a type of hydromorphic alluvial soil. This type of soil has a clay texture and has slow permeability (water runoff). In addition, this city is one of the cities that geographically has at least 5 rivers, namely the Kupang River, the Meduri River, the Bremi River, the Banger River, and the Gabus River with the main river the largest crossing the city of Pekalongan is the Pekalongan River or another name is the Kupang River. (Pemerintah Kota Pekalongan, 2021a).

For a city, Pekalongan City has an administrative area that is not so large, which is only about 45.25 Km with a fairly small number of sub-districts, namely 4 sub-districts and 27 sub-districts. Specifically, the research area of this case study was taken from North Pekalongan District, the sub-district with the largest area in Pekalongan City, which is 34% of the total area. North Pekalongan District has 7 villages with the area of each complaint.

Table 1. Village Area in North Pekalongan District

No	Neighborhoods	Area (Km^2)
1	Tires	1.73
2	Long Cage	1.50
3	Wetan Length	1.41
4	Degayu	1.19
5	New Length	1.11
6	Krapyak	3.79
7	Padukuhan Kraton	4.15
Total Area		14,88

Source: (BPS Pekalongan City, 2023)

The city of Pekalongan has experienced significant changes in land use over the past 32 years, with the conversion of wetlands (rice fields) to dry land (settlements). Since 1991, the area of wetlands has decreased from 1,778 hectares (39%) to just 717 hectares (16%) in 2023, while drylands are increasing rapidly (Pekalongan City Environmental Agency, 2023). This process has led to a decline in the function of green open spaces (RTH), which now covers only 3% of the city's total area, far from the 20% target. In addition, vegetation cover has also experienced a drastic decline, with mangroves in the north increasingly degraded (Iskandar et al., 2020).

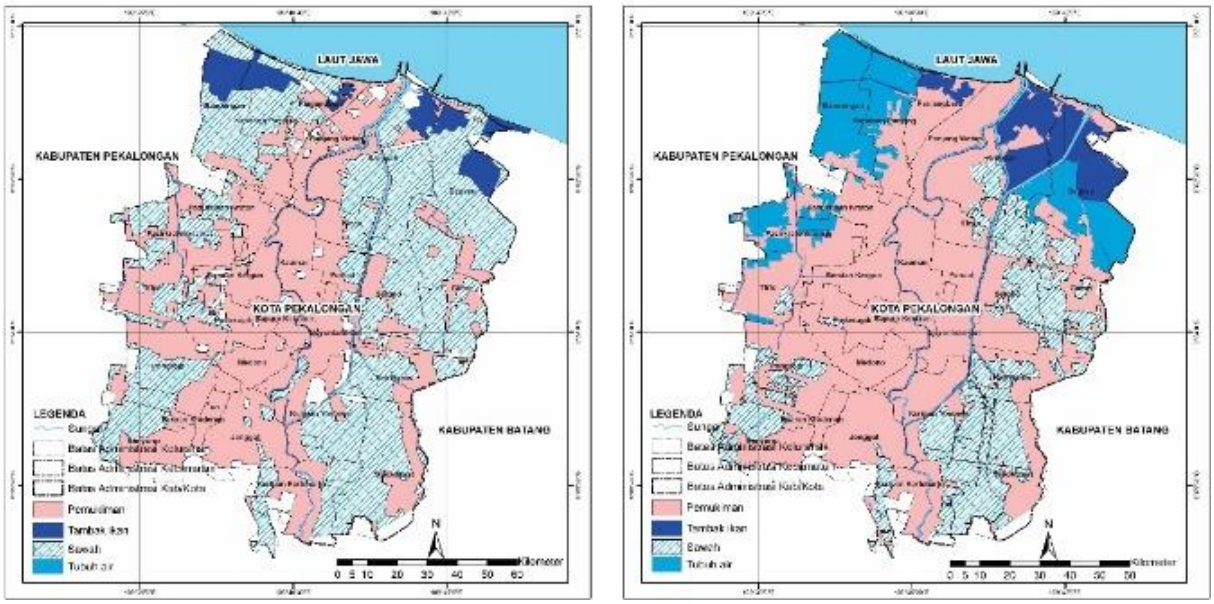


Figure 1. Comparative map of land use in Pekalongan City in 2021 compared to 2022

Source: BPBD Pekalonga City, 2024; Reprocessed by researchers

This land conversion is related to various environmental problems, such as increased run-off, erosion, and flooding. The decline of rice fields and vegetation reduces water capacity and reduces the region's ability to handle flash floods, which are getting worse. The environmental report also shows that the quality of land cover is in the alert category, with a quality index of only 23.5.

The shrinkage of mangrove land, which is important to protect the north coast, and the clearing of residential land and excessive groundwater extraction have also led to subsidence, exacerbating flood risks. High rainfall, poor drainage, and a lack of abrasion barrier vegetation magnify the potential flood hazards in the area.

Rate of Land Subversion

Pekalongan City has a type of land *Alluvial* that is susceptible to subversion due to high humidity, excessive groundwater uptake, structural load on buildings, and geological processes. Based on data from the 2021–2026 Pekalongan City RPJMD, there are three types of alluvial soils in this city, namely hydromorphic alluvial (dominant in the north), dark gray alluvial (east and west), and gray-brown alluvial (south).

Table 2. The Speed of Land Subsidence in Pekalongan City Every Year

No	District	Mean (cm)	Max (cm)	Min (cm)	Std Dev
1	North Pekalongan	-24.13	-27.51	-19.73	1.06
2	West Pekalongan	-22.83	-26.80	-18.93	1.33
3	East Pekalongan	-21.94	-25.64	-18.57	1.13
4	South Pekalongan	-20.40	-24.31	-16.74	1.43

Source: Iskandar et al., 2020

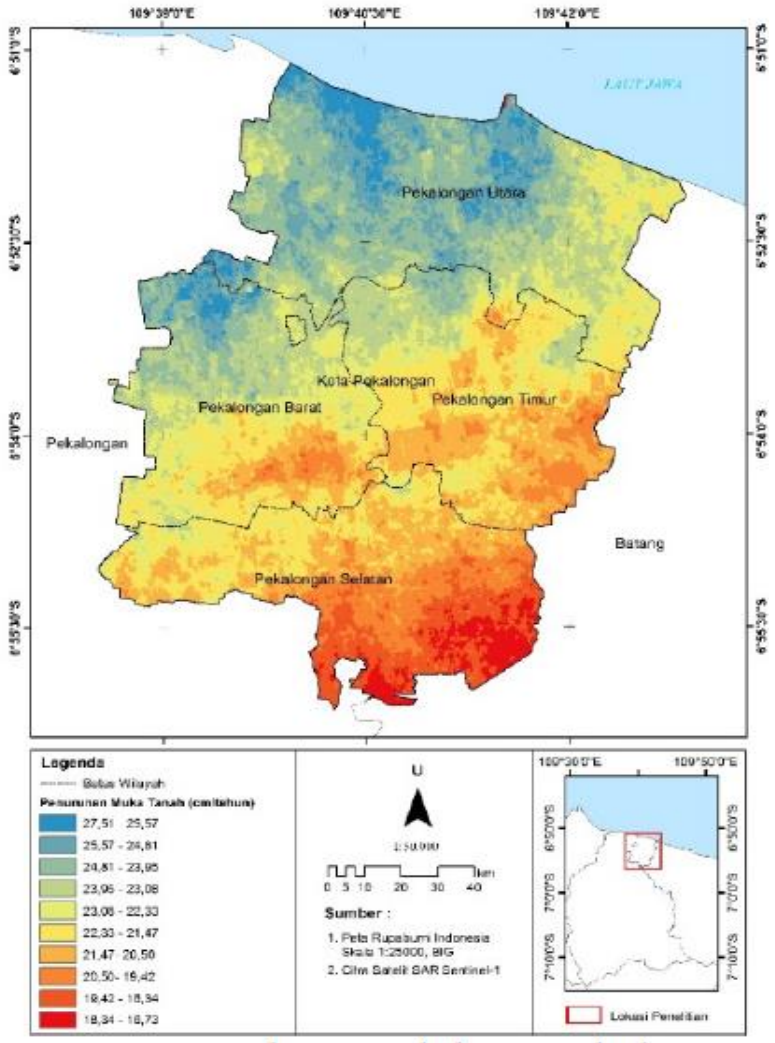


Figure 2. Land Subversion Map of Pekalongan City 2017 – 2019

Source: Iskandar et al., 2020

Land subsidence in Pekalongan varies between 0.4 to 34 cm per year, with the highest rate occurring in northern coastal areas such as Tirto and Beggot Villages. This land subsidence has an impact on wetland degradation, including the difficulty of mangrove growth in the north because sedimentation is not able to cover the rate of land subsidence. In addition, rob and seawater infiltration further worsen the condition of coastal areas, affecting economic activities, including the batik industry. Batik production requires a large amount of clean water, but the water in the rob area is often contaminated, making it unsuitable for use.

Infrastructure development such as ports, fisheries industry, textiles, and batik in the northern region also contributed to land subsidence due to massive groundwater exploitation. Currently, the Nusantara Pekalongan Fisheries Port, located in Panjang Wetan Village, North Pekalongan District, is the center of coastal economic activities that accelerate the extraction of water resources, affecting the stability of the surrounding soil. With a very high rate of land subversion (>24 cm/year), the northern region of Pekalongan faces great challenges in maintaining environmental sustainability and economic activities.

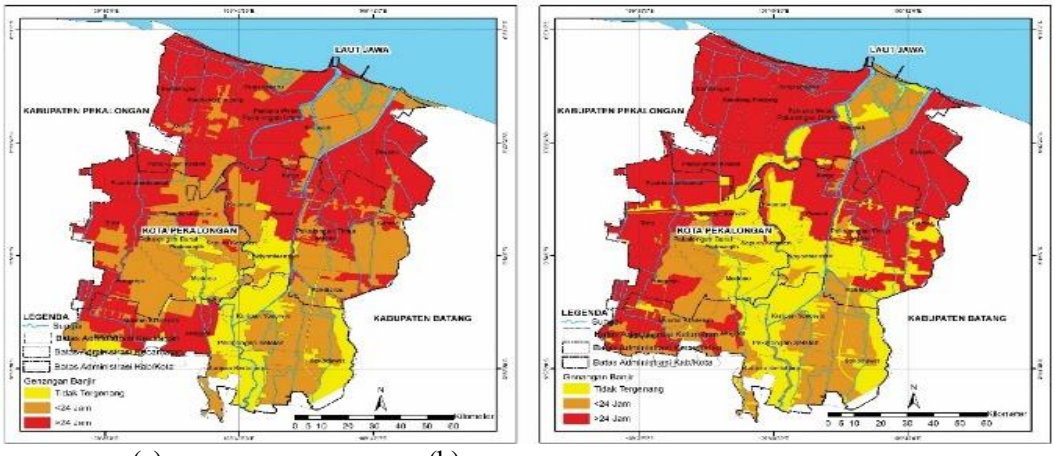
Rate of Increase in Flood Inundation Area

The city of Pekalongan, which is located on the north coast of Java with an elevation of only 1 meter above sea level, has hydromorphic alluvial soil characteristics that make it vulnerable to flash floods, runoff from the upper reaches of Pekalongan Regency, and ineffective urban drainage problems. Based on the 2021–2026 Pekalongan City RPJMD and BPBD 2022–2023 data, the flood inundation area has reached 50% of the total city area, with peaks occurring in 2022 and 2023.

Table 3. Area of Flood Inundation in Pekalongan City in 2015 – 2023

No	Year	Inundation Area (ha)	Percentage to Total City Area
1	2015	1.920	42%
2	2016	1.870	41%
3	2017	1.396	31%
4	2018	1.391	31%
5	2019	1.057	23%
6	2020	1.730	38%
7	2021	1.107	24%
8	2022	2.291	51%
9	2023	2.291	51%

Source: Pekalongan City Government, 2021; BPBD, 2024



(a) (b)

Figure 3. Comparative Map of Flood Inundation in 2021 and 2022 in Pekalongan City: (a) Flood Inundation Map of Pekalongan City in 2021; (b) Pekalongan City Flood Inundation Map in 2022

Source: researcher, 2024

Landscape-wise, Pekalongan City is the downstream part of the Kupang Watershed (DAS), whose headwaters are in Pekalongan Regency with an altitude of 0–1,249 meters above sea level (Mercy Corps Indonesia, 2021). The water catchment area in the highlands of Pekalongan Regency affects the flow downstream, where Pekalongan City only has an elevation of 0–6 meters. This factor exacerbates the environmental conditions of the city, making it prone to permanent inundation. An interview with a batik entrepreneur in North Pekalongan District confirmed that significant flooding has begun to be felt more severely in the last 10-20 years, reflecting increasing environmental and infrastructure pressure on the city's resilience.

Frequency and Intensity of Rainfall

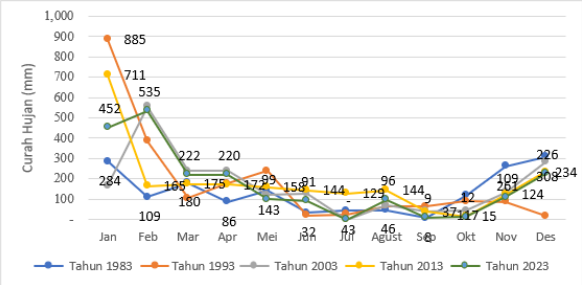


Figure 4. Average Rainfall Graph of Pekalongan City in 1983 – 2023

Source: BPS Pekalongan City, self-processed

In the period of January and February, daily rainfall in Pekalongan City often exceeds the threshold of extreme rainfall (>150 mm/day). Linear regression shows a tendency to increase the number of rainy days and rainfall intensity. This increase in rainfall has the potential to worsen the risk of flooding, which has an impact on people's livelihoods, especially farmers, fishermen, and batik makers in the northern part of the city. The batik industry, which relies on conventional drying of fabrics by drying outside, is severely affected by rain which hampers the production process. The impact of global climate change that increases extreme rainfall, as well as land subsidence with low permeability, loss of vegetation, and suboptimal urban drainage, can exacerbate this condition, affecting the productivity of the batik industry in Pekalongan (Andari et al., 2023).

Vulnerability and Resilience of Batik Women

Table 4. Vulnerability and Resilience Score Results

Neighborhoods	Vulnerability		Resistance
	Exposure	Sensitivity	
Krapyak Village	2,08	2,53	2,14
Padukuhan Kraton Village	1,79	2,28	2,12
Average	2,17		2,13

Source: Researcher, 2024

The results of the vulnerability score calculation show that the smaller the vulnerability value, the more vulnerable it is. Meanwhile, the smaller the durability value, the smaller the resilience ability.

Exposure

Exposure in this study is defined as the exposure of women batik workers in Pekalongan City to the impact of environmental degradation that occurs, especially floods.

Table 5. Flood Exposure Index Score Results

No	Indicator	Score Per Village		Average score
		Krapyak	Padukuhan Kraton	
1	Average flood inundation height experienced in the last 10 years	2,21	2,32	2,26
2	Parts of the house that have always been flooded for the last 10 years	1,09	1,69	1,39
3	Average length of inundation	1,23	1,00	1,12
4	Frequency of floods over the past 10 years	3,02	2,91	2,97
5	Losses experienced over the last 10 years on average	1,74	1,36	1,55
6	Frequency of house flooding in the last 10 years due to floods	3,16	1,43	2,29
	Exposure Average Index	2,08	1,79	1,93

Remarks: the lower the worse the exposure

Source: Researcher, 2024

Pekalongan City has 8,305 batik workers, or 2.61% of the total population, a number that has decreased drastically by 76% compared to 2009 when 43,260 batik workers were recorded (Huraoh, 2012). This decline was influenced by floods that consistently hit batik production center areas, especially in North Pekalongan District. Floods with a duration of more than 24 hours often occur in Padukuhan Kraton and Krapyak Villages, inundating houses, neighborhoods, and batik production sites.

The prolonged duration of the floods, sometimes up to monthly, hampers the productivity of batik workers in this region. In addition, floods with an average height of 50–105 cm submerged houses and caused moss growth on walls and roads. Even so, most respondents rarely evacuated, as long as the water did not reach the mattress or the toilet could still be used.

Batik workers also recognize three types of floods: floods of shipments from upstream, rainwater floods, and tidal floods. This knowledge is an important capital in flood preparedness. The northern region of Pekalongan, which is known for producing fine batik with a long process, faces significant impacts due to flooding, which has caused disruptions in capital turnover and production. This also explains why this area has the least number of batik workers compared to other areas in Pekalongan.

Figure 5. Traces or traces of flooding left on the walls of residents' houses

Source: Researcher, 2024

Vulnerability and Resiliency

The vulnerability and resilience of batik women are measured through three main aspects: social, economic, and environmental (UNISDR, 2017). Social vulnerability is proxied through age, education, health, and gender equality (Lianxiao & Morimoto, 2019). Economic vulnerabilities include income, expenditure, and productivity (Azad & Pritchard, 2023). Environmental vulnerabilities include water availability, sanitation, and waste management conditions (Birkeland et al., 2011; NCDHR, 2015; Patel et al., 2020).

Table 6. Vulnerability Score Per Village

No	Vulnerability Indicators	Score Per Village		Average score
		Krapyak	Padukuhan Kraton	
1	Socio-Cultural Sensitivity	2,28	2,43	2,36
2	Economic Sensitivity	1,91	1,78	1,84
3	Environmental Sensitivity	3,39	2,64	3,01
	Average vulnerability score	2,53	2,28	2,40

Source: Researcher, 2024

The resilience of women batik is also analyzed through socio-cultural aspects (access to preparedness training, social cohesiveness, and public services), economy (savings, assets, and alternative sources of livelihood), and environment (knowledge of greening, recycling, and environmentally friendly batik).

Table 7. Resilience Score Per Village

No	Vulnerability Indicators	Score Per Village		Average score
		Krapyak	Padukuhan Kraton	
1	Socio-Cultural Resilience	2,27	2,25	2,26
2	Economic Resilience	1,90	1,97	1,94
3	Environmental Resilience	2,03	2,02	2,03
	Average resilience score	2,07	2,08	2,08

Source: Researcher, 2024

Overall, the vulnerability and resilience index of batik women was on a low scale, namely 2.40 for vulnerability and 2.08 for durability (from a scale of 5). A low score on vulnerability reflects a high level of vulnerability, while a low score on resilience indicates a weak resilience capability. Details of the index results on the sub-indicators are available in the appendix.

Social Sensitivity

In Pekalongan City, batik workers are dominated by men (69%), while women are only 31%. This decline in the role of women in the batik industry is due to the transformation of production from finer written batik to faster and more economical stamped batik.

To better understand the conditions of women batik workers, a survey was conducted focusing on their vulnerabilities and resilience to floods, particularly in North Pekalongan District. This district was chosen due to its frequent and prolonged flooding lasting more than 24 hours and significant land subsidence. The survey specifically targeted Krapyak and Padukuhan Kraton villages, which fall under the areas designated by Perwal 17A of 2015 for Technopolitan Batik.

Table 1 below combines key data on the gender distribution of batik workers, the types of professions of female batik workers, the impact of floods on their health, and the domestic division of tasks during floods.

Table 8. Summary of Social Sensitivity in Pekalongan City by Gender

Indicator	Percentage/Total
Gender distribution of batik workers	Men: 69%, Women: 31%
Female batik workers' average age	51 years
Female batik workers with no education	30%
Common diseases during floods	Itchy skin (26.65%), flu (23.51%), cough (15.99%)
Domestic task sharing during floods	Providing meals: Mostly women (59%)

Source: Researcher, 2024

The survey data reveals that most female batik workers are elderly, with low educational attainment—30% have never attended school. Prolonged floods in North Pekalongan exacerbate their vulnerability, causing health issues such as itchy skin (26.65%), flu (23.51%), and stress (9.72%). Despite these challenges, the culture of mutual cooperation in Pekalongan helps distribute domestic responsibilities. For example, providing meals is still largely carried out by women (59%), while tasks like fetching clean water (81%) and cleaning the house (79%) are shared among family members. This combined analysis highlights the interplay between social vulnerability, health impacts, and cultural resilience in Pekalongan City, emphasizing the need for targeted interventions to support female batik workers.

Economic Sensitivity

The economic sensitivity of batik women in Pekalongan City shows high vulnerability with an index of 1.84 out of a scale of 5. The main factors include low income, the high cost of repairing houses due to floods, and uncertain income due to the informal work system.

Table 9. Results of the Economic Sensitivity Index

Krapyak District	Kel. Padukuhan Kraton	Average
1,91	1,78	1,84

Source: Researcher, 2024

The majority of female batik makers earn only Rp. 400,000–800,000 per month under normal conditions and drop drastically to Rp. 0–400,000 during floods, far below the UMR of Pekalongan City (Rp. 2,389,801). Repeated floods have forced many batik growers to spend large amounts of money to raise their houses more than three times in the last 10 years, with losses reaching more than Rp. 10 million. In addition, batik production and distribution activities were disrupted, especially in floods with a duration of more than 24 hours.

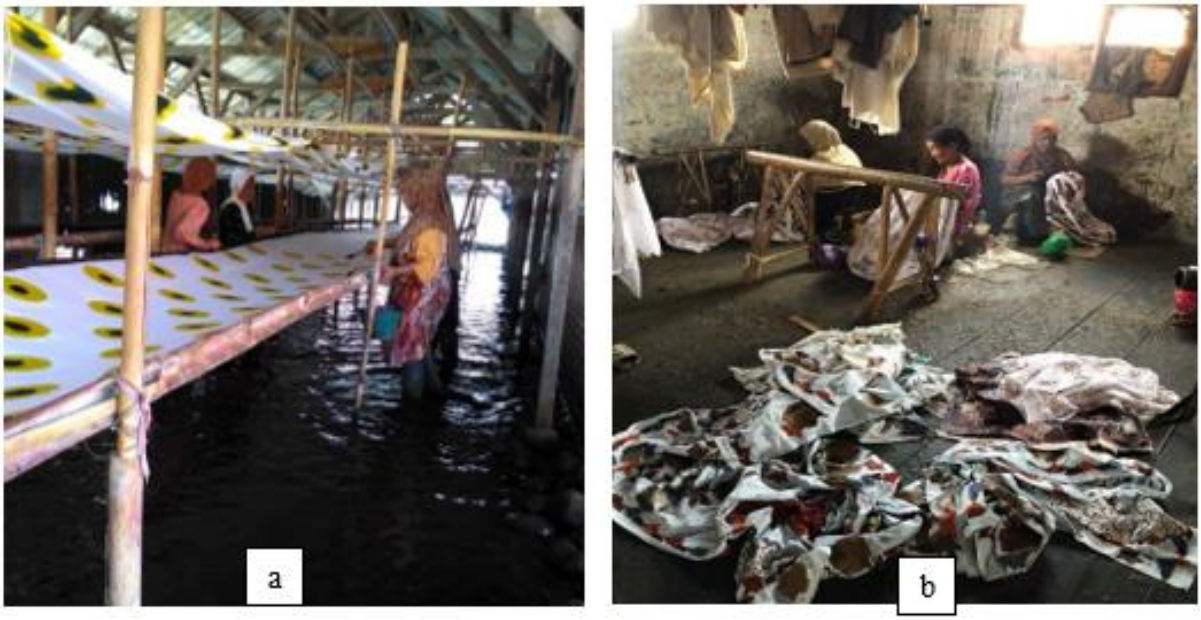


Figure 6. Situation of Female Batik Workers: (a) The Situation of Female Workers Who Continue to Work During the 2018 Flood and (b) Batik Makers Who Need a Large and Dry Place to Make Batik

Source: Researcher, 2018

Table 10. Comparison of Women Batik Makers'Income During Flood Season and Normal Conditions

No	Wages per week (000 rupiah)	Total Women Batik Makers Krapyak		Total Women Batik Makers Padukuhan Kraton	
		Flood	Normal	Flood	Normal
1	Rp. 0-100	4	40	28	1
2	Rp. 101-200	3	30	9	19
3	Rp. 201-300	0	6	3	11
4	Rp. 301-400	0	1	1	5
5	Rp. 401-500	0	0	1	1
6	Rp. 501-600	0	0	0	1
7	Rp. 601-750	0	0	1	2
8	Rp. 751-1.000	0	0	1	4
9	Other amounts	0	2	3	3

Source: Researcher, 2024

Although expenses during floods tend to be smaller due to limited activities, most batik makers choose not to go into debt and live modestly. The low wages of women batik makers, coupled with the high cost of living during floods, present significant economic challenges. However, the firmness and religious values of the residents helped them survive in the face of these conditions.

Environmental Sensitivity

The environmental sensitivity of batik women in Pekalongan is influenced by the availability of clean water, sanitation, and waste management. The well water in Krapyak and Padukuhan Kraton Villages is no longer suitable for use because it is contaminated by seawater intrusion, so residents turn to PDAM or PAMSIMAS. However, subscription fees are an additional burden, especially for batik makers with low incomes.

Sanitation is also a challenge, especially in Padukuhan Kraton, where 40% of respondents do not have a proper toilet, compared to Krapyak, the majority of whom already have a toilet. This condition increases health risks, especially during floods. In addition, household waste management is not optimal because not all residents subscribe to cleaning services, so most burn garbage or dispose of it themselves.

Figure 7. Residents walk in a red flood puddle because it is contaminated with batik waste in Pekalongan, Central Java, 2021

Source: VOA Indonesia, 2021

Batik waste is also a serious issue because many batik makers dispose of waste directly into sewers or rivers without treatment. This worsened the water quality during the floods, which happened in 2021 with flood water turning red due to contamination of batik dye. The carcinogenic impact of this waste is not yet clear, but it increases health risks, not only for batik makers but also for their families.

Resistance

As a form of vulnerability represented in 3 aspects of development, the resilience of women batik is projected from its social, economic, and environmental aspects.

Table 11. Social, Economic, and Environmental Resilience

No	Vulnerability Indicators	Score Per Village		Average score
		Krapyak	Padukuhan Kraton	
1	Socio-Cultural Resilience	2,27	2,25	2,26
2	Economic Resilience	1,90	1,97	1,94
3	Environmental Resilience	2,03	2,02	2,03
Average resilience score		2,07	2,08	2,08

Source: Researcher, 2024

Social Resilience

The social resilience of batik women in Pekalongan has a low average score, which is 2.26 out of a scale of 5. This resilience is measured through access to disaster services, health, social cohesiveness, and participation in decision-making. The early warning system and disaster preparedness training are not optimal, with only 21% of respondents in Krapyak Village and 13% in Padukuhan Kraton accessing it. Although access to free healthcare is available and quite satisfactory for most respondents, there are still complaints related to bad experiences that reduce their desire to access services.

Social cohesion, such as help from family or relatives, is limited because relatives are often also affected by floods. In addition, women have a significant role in decision-making, especially in disaster situations, with 65% of respondents reporting decisions being discussed together. This shows the influence of women in increasing family resilience (Kusumasari, 2015; Tickamyer & Kusujiarti, 2020).

Economic Resilience

Most of the women batik makers who work as batik makers, potters, mopots, or fishermen in Pekalongan do not have savings or assets that can be used in emergencies, such as during floods. The only major asset they own is the house they occupy. Only babar workers are more likely to have savings or assets, often in the form of inheritances or batik fabrics that can be pawned even if the value is not commensurate. The absence of a formal employment contract makes them vulnerable to losing their jobs and not having old age security. In addition, 100% of respondents admitted that they did not have formal savings.

Table 12. Savings and Asset Adequacy

No	Sufficiency	Savings	Asset
1	There isn't any	66%	59%
2	Tends not to be enough	23%	29%
3	Tends to be sufficient	4%	5%
4	Enough	6%	6%
5	Very Enough	1%	1%

Source: Researcher, 2024

To increase economic resilience, some women do side jobs such as trading, opening stalls, laundry workers, or other odd jobs. Independence, creativity, and egalitarian culture are important capital for women batik makers to survive and face environmental degradation.

Environmental Resilience

Environmental resilience in Pekalongan City is affected by people's understanding and behavior in preserving the environment, which unfortunately is still minimal, especially among batik workers. Most residents, particularly in Krapyak and Padukuhan Kraton Villages, do not have enough yard land for reforestation, with 56% in Krapyak and 62% in Padukuhan Kraton reporting limited space for planting. Frequent floods also damage soil quality, making it difficult for plants to grow.

The survey reveals significant gaps in environmental awareness and action, as summarized in Table 1 below. This table consolidates respondents' understanding of greening, participation in environmental cleaning, and awareness of mangrove preservation and eco-friendly batik processes.

Table 13. Summary of Environmental Awareness and Behavior in Krapyak and Padukuhan Kraton

Indicator	Krapyak	Padukuhan Kraton
Don't understand and don't do greening	37%	30%
Understand greening but can't do it	35%	28%
Active in environmental cleaning ("Very inactive")	47%	11%
Don't understand mangroves and don't do it	77%	40%
Eco-friendly batik process: Natural dyes ("Don't understand and don't do it")	63%	83%
Eco-friendly batik process: Waste disposal ("Don't understand and don't do it")	81%	91%
Eco-friendly batik process: Recycling ("Don't understand and don't do it")	53%	83%

Source: Researcher, 2024

The data highlights limited knowledge and application of reforestation and mangrove preservation efforts. For instance, 77% of respondents in Krapyak and 40% in Padukuhan Kraton do not understand mangroves or take action to preserve them. Similarly, eco-friendly batik processes are minimally practiced due to high costs and lack of demand, with the majority of respondents unaware of practices like using natural dyes, waste disposal via IPAL systems, or recycling batik waste.

The low awareness about environmental management exacerbates environmental degradation in the region. Batik waste is often dumped directly into rivers or sewers, causing water pollution and fostering the growth of water hyacinths due to urea-containing waste. The figures below illustrate the environmental impact:

Figure 8. (a) the right home batik industry next to the river; (b) batik washing place directly to the riverside; (c) The Kupang River is fully covered by hyacinth plants.

Source: Researcher, 2024

Overall, the low awareness about environmental management and batik waste increases its vulnerability to environmental degradation, as well as worsening the water and soil quality in the region.

Stakeholder Efforts

Environmental degradation that hinders sustainable development is a global concern, including in the context of the SDGs (Sustainable Development Goals). Sustainable development in Pekalongan City, especially related to the control of environmental degradation that affects the resilience of batik women, is in line with several SDGs, including:

1. SDG No. 5: Gender equality and women's empowerment in accessing environmental resources.
2. SDG No. 15: Sustainable management of terrestrial ecosystems and resource conservation.
3. SDG No. 13: Climate change action and managing its impacts.
4. SDG No. 6: Availability of clean water and sanitation.
5. SDG No. 11: Sustainable urban and settlement development.

Environmental degradation control is related to the resilience of women batik, which also includes various stakeholder sectors such as the government, the private sector, and the community.

Sustainable Resilience Strategy

Women batik makers in Pekalongan City have an important role in the local economy, especially in the batik industry sector. However, the sustainability of their profession is threatened by environmental degradation, especially frequent floods. To maintain survival, strategies that reduce vulnerability and increase resilience are needed. One of the analysis methods used is SWOT analysis (Strengths, Weaknesses, Opportunities, Threats) which maps internal and external factors (Tohidimoghadam et al., 2023).

The main strengths of women batik makers include their ability to manage households in an egalitarian manner, understand flood seasons, have environmental awareness, and have access to decision-making within the family. These factors form a crucial foundation in building their resilience to external threats. In the SWOT analysis, these strengths have a total score of 2.74, reflecting a significant level of internal factors supporting their resilience. On the other hand, external opportunities supporting their resilience include family support, access to free healthcare services through BPJS, and increasingly effective flood control policies. Additionally, the availability of clean water for daily consumption also contributes positively. The total score for external opportunities is 3.43, indicating that these opportunities are considerable in supporting their resilience.

However, women batik makers in Pekalongan also face significant external threats, such as rising floodwater levels, the impact of floods on their income, and limited access to aid during flooding events. These factors, with a total score of 1.60, indicate the magnitude of threats they must address and require serious attention in resilience strategy planning. Furthermore, internal weaknesses include dependence on informal employment, lack of understanding of environmental sustainability, and limited savings or assets to cope with flood impacts. These internal weaknesses have a total score of 1.82, suggesting that addressing these weaknesses should be a focus in resilience strategies.

Table 14. Internal-External Factors of Sustainable Resilience of Batik Women in Pekalongan City

Internal Factors		External Factors	
Power (S)	Weakness (W)	Chance (O)	Threat (T)
2,74	1,82	3,43	1,60
Combination of Factors			
SO	WHERE	ST	WT
Offensive strategy	Adaptive strategy	Conservative strategy	Defensive strategy
6,17	5,25	4,34	3,42

Source: Researcher, 2024

The SWOT matrix results in four strategies:

1. SO (Offensive Strategy): Maximizing external strengths and opportunities to increase resistance.
2. WO (Adaptive Strategy): Reducing internal weaknesses by optimizing external opportunities.
3. ST (Conservative Strategy): Reducing the impact of external threats by leveraging internal forces.

4. WT (Defensive Strategy): Mitigating internal weaknesses and avoiding external threats, especially related to environmental degradation.

Overall, the best strategy to improve the sustainable resilience of women batik is to combine internal strengths with external opportunities, as well as reduce the impact of threats from the environment and dependence on informal work. Environmental degradation in Pekalongan City is caused by two main factors: local triggers and global triggers. Local triggers include the conversion of wetlands to drylands and groundwater extraction that causes land subsidence. This land conversion process has occurred since the Dutch colonial period, which focused on port development. Along with urbanization and increased water requirements for industries, such as fisheries and batik, the alluvial soil structure in Pekalongan is becoming vulnerable to decline (Andreas et al., 2019).

Land subsidence in Pekalongan City is faster than in Jakarta and Semarang, at a rate of up to 34 cm per year, which increases the risk of flooding and environmental damage (Mercy Corps Indonesia, 2021; Pekalongan City Government, 2021). Degradation also causes damage to coastal vegetation, especially mangroves, which serve as a shield from abrasion. In addition, the construction of dense settlements and infrastructure leads to the loss of green open space and exacerbates the city's drainage problems.

Flash floods, triggered by global climate change and land subsidence, are further exacerbating conditions. The decline in environmental quality in Pekalongan City is reflected in a low environmental quality index, with a significant impact on the economy and quality of life of residents. Most residents, especially women batik makers, suffer economic losses due to the floods, which reduces their income. Knowledge about climate change and the impacts of floods is limited, although there are efforts to transfer knowledge between generations.

Exposure to flooding in the Krapyak and Padukuhan Kraton areas is quite high, with the frequency of flooding 3-4 times a year and the duration of waterlogging varies. In response, people are adapting by raising their homes, even though this comes at a huge cost. Economic vulnerability is the main factor that determines the vulnerability of women batik makers, with low economic sensitivity scores in both villages, namely 1.78 and 1.91 on a scale of 5.

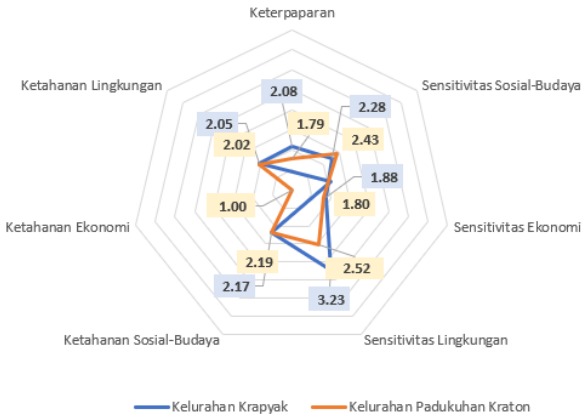


Figure 9. Results of Exposure, Vulnerability (Sensitivity) and Resilience Score

Source: Researcher, 2024

Environmental degradation in Pekalongan City is caused by two main factors: local triggers, such as wetland conversion to dryland and groundwater extraction that cause land subsidence, as well as global triggers such as climate change and sea level rise. Land conversion has occurred since colonial times for port development, which encouraged urbanization and population growth. This causes environmental damage, with the rate of land subsidence in Pekalongan being faster than in Jakarta and Semarang.

Rapid land subsidence causes damage to mangrove ecosystems, loss of green space, and increased flood risk, both from sea tides and heavy rains. Poor drainage worsens flood conditions. In addition, batik waste dumped directly into the river worsens water quality, triggers the growth of water hyacinths, and increases the risk of flooding.

The floods have had a major impact on the economy of women batik makers, who lose up to 50% of their income during the flood season. In addition, they face debt problems and additional costs for basic needs such as toilets, electricity, and water. The informal work system and the uncertainty of batik production further worsened their economic conditions.

Low social sensitivity among female batik makers, is caused by age and low education. Low education, especially among women aged 50 and over, limits access to information related to disasters and climate change. However, there is also

an egalitarian culture in the city of Pekalongan, where domestic work is divided more evenly between men and women (Aka et al., 2008).

The environmental sensitivity of female batik makers tends to be better than economic and social sensitivity. The availability of clean water through PDAM and PAMSIMAS is a solution, even though there is limited access for the underprivileged. Sanitation and garbage are also an issue, with some batik having to use public toilets or dispose of their garbage.

The resilience of women batik makers is very low, mainly due to dependence on vulnerable work and production uncertainty due to environmental degradation. To address this, the government has built flood control infrastructure, including sea embankments and water pumps, to reduce the impact of flooding in vulnerable areas. However, there is still much that needs to be done to support the social, economic, and environmental resilience of women batik makers (Gaisie et al., 2022).

The city of Pekalongan faces major challenges in recovering from floods, especially related to sanitation and environmental degradation control. The MCK Communal program has been launched to address sanitation problems disrupted by floods, which lead to dependence on public facilities and the risk of indiscriminate defecation. The program is spread across the region, not just in the north.

However, policies to overcome land subsidence are still lacking focus in the RPJMD document, because the authority to supervise groundwater extraction is at the provincial level. Although the Pekalongan City Government has implemented a moratorium on groundwater extraction, further enforcement depends on provincial policies, which make the response slower.

Efforts to restore mangrove ecosystems also face obstacles due to land subsidence that is faster than the growth rate of mangroves. Meanwhile, public knowledge about the benefits of mangroves is still very limited. Policies to improve the welfare of batik workers, especially women batikers, have not received specific attention in government documents, which reduces support for reducing vulnerability in batik production centers. The results of the SWOT analysis show that offensive strategies (leveraging internal strengths such as independence, work ethic, and egalitarian culture, as well as external opportunities from health policies, flood control, and stopping groundwater extraction) are best for developing sustainable resilience for women batik makers in Pekalongan City.

CONCLUSION

The environmental degradation that occurs in Pekalongan City is caused by the structure of the alluvial soil of the judiciary cannot support the large flow of urbanization and the increase in the population of Pekalongan City. The addition of building structures and the extraction of groundwater for industries, settlements, and lands that are massive in using water cause land subsidence. Land subsidence is the dominant environmental degradation compared to extreme rainfall and rising sea levels as the cause of flooding. The cause of the flooding is also the relatively high rate of conversion of wetlands (coastal wetlands) into dry land. The lack of coastal protection measures that can reduce the rate of abrasion and the entry of seawater to the mainland also contribute to degradation.

The women batik makers in Pekalongan City, especially in two sub-districts that are the location of batik production centers based on Perwal No.17A of 2015 concerning Technopolitan Batik, are in a condition of exposure to environmental degradation that tends to be high. This high exposure has an impact on high vulnerability from both social, economic, and environmental aspects with an index scale of 2 out of 5. The condition of the resilience of women batik makers in Pekalongan City also tends to be low due to the economic aspect that relies on the informal work system so it is sensitive to termination of employment, the absence of assets, and old age savings. Understanding the reforestation movement, mangrove planting, and environmentally friendly batik processes is also a shortcoming of batik whose average age has entered the twilight stage with a low level of education. The sustainable resilience index scale also only reaches 2 out of 5.

Many efforts and commitments of stakeholders in Pekalongan City have been carried out, in the government sector starting from the central government, provincial governments, and local governments will continue to be pursued and continued by building flood control infrastructure starting from giant embankments, raising

embankments along the watershed, cleaning water hyacinths to repairing slums and drainage. Meanwhile, the NGO/NGO sector also takes an important role in the perspective of climate change adaptation so that in addition to participating in building flood control infrastructure, it also prioritizes the institutionalization of adaptation actions. However, policies and programs related to reducing and even stopping the use of groundwater are still a challenge for the government.

The sustainable resilience strategy of batik women can be carried out by optimizing their internal strengths, namely in the form of independence, work ethic, and egalitarian culture combined with utilizing available external support. However, this external support still has to be optimized in the form of excellent health service support, the development of optimal flood control infrastructure, the cessation of groundwater withdrawal, and the increase in welfare guarantees for batik workers to reduce vulnerability, especially economic vulnerability.

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