



CLIMATE-RELATED FINANCIAL RISK IN INDONESIA: A SYSTEMATIC LITERATURE REVIEW AND POLICY IMPLICATIONS

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ABSTRACT

Climate change has shifted from an environmental concern into a material financial risk capable of disrupting financial-system stability through both physical and transition-risk channels. Indonesia, as an archipelagic nation with high hydrometeorological disaster vulnerability and an economy still dependent on carbon-based commodities, faces dual exposure to both risk channels. This study aims to map the extent to which financial risk and climate change have been examined in Indonesian academic literature, and to assess whether Indonesia's current condition is a matter of concern or remains within a safe zone. A systematic literature review of national and international journal publications from 2017-2026 was conducted, supplemented by secondary-data analysis of per-capita carbon dioxide emissions and official disaster data. The results show that research on this nexus has grown rapidly since 2022 yet remains behind international institutional studies in volume and methodological depth. Data indicate that Indonesia's per-capita CO₂ emissions remain below the world and Asian averages, but the upward trend is steep, compounded by a high frequency of hydrometeorological disasters and structural dependence on fossil energy. The study concludes that Indonesia occupies an 'elevated-but-manageable risk zone' - not yet a systemic crisis, but no longer within a safe zone - requiring accelerated integration of climate-risk management into macroprudential policy, stronger data infrastructure, and a just acceleration of the energy transition.

1. INTRODUCTION

Climate change has evolved from a purely environmental concern into a material financial risk with the potential to undermine the stability of the financial system, operating through two principal transmission channels: physical risk and transition risk (IMF, 2025). Physical risk arises from extreme weather events and long-term climatic shifts, while transition risk stems from policy, technological, and market changes associated with the shift toward a low-carbon economy ("Weathering the Storm," 2025). Both channels transmit into the financial system through higher borrower default probabilities, declining collateral values, abrupt asset repricing (stranded assets), and disruptions to the liquidity and solvency of financial institutions (Zhang et al., 2025).

Indonesia occupies a uniquely exposed position in the global climate-risk landscape. As an archipelagic tropical nation with the world's second-longest coastline, it is highly vulnerable to physical risks such as floods, landslides, droughts, forest and land fires, coastal abrasion, and sea-level rise (IMF, 2025). At the same time, its economy remains structurally dependent on carbon-intensive sectors, including its position as one of the world's largest exporters of coal and liquefied natural gas, exposing it to transition risk as domestic and global decarbonization policies accelerate (IMF, 2025; Climate Action Tracker, 2025). This dual exposure makes the intersection of financial risk and climate change an urgent research and policy agenda for Indonesia.

Recent data reinforce this urgency. Based on data from Global Carbon Budget (2025), Indonesia's per-capita CO₂ emissions rose sharply from the early 2000s, from less than one tonne per capita to approximately 2.9 tonnes per capita in 2024. Although this figure remains below the world average (around 4.7 tonnes) and the Asian average (around 4.9 tonnes), the slope of increase is far steeper than the historical trend of developed economies, indicating a rapid rise in the carbon intensity of the national economy within a relatively short period. On the physical-risk side, BNPB (2025c) recorded a significant shift in the national

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disaster pattern since 2023, with hydrometeorological disasters such as floods and landslides - triggered by climate anomalies and long-term climate change - becoming dominant. Indonesia's Disaster Risk Index data (BNPB, 2025b) show that 483 regencies/cities (93.97 percent) face high risk of forest and land fires, 341 face high drought risk, and 321 face high flood risk.

In response, Indonesia's Financial Services Authority (Otoritas Jasa Keuangan, OJK) has issued a series of policy instruments, including the Sustainable Finance Roadmap Phase II 2021-2025 (OJK, 2025), the Indonesia Sustainable Finance Taxonomy (TKBI) (OJK, 2024c), and the Climate Risk Management and Scenario Analysis (CRMS) and Climate Risk Stress Test (CRST) guidelines (OJK, 2024a, 2024b). However, the extent to which Indonesian academic literature has adequately examined the linkage between financial risk and climate change, and whether the national financial system currently sits in a safe zone or a zone of concern, still requires a comprehensive synthesis. This article is intended to address that gap.

Building on this background, the study addresses the following research questions: (1) To what extent has the topic of financial risk and climate change been examined in Indonesian academic literature, both national and international? (2) What are the characteristics of Indonesia's physical- and transition-risk exposure relative to global and regional carbon-emission trends? (3) Is Indonesia's current climate-financial risk condition a matter of genuine concern (elevated risk), or does it remain within a safe zone? (4) What policy recommendations are relevant for regulators and policymakers seeking to strengthen the financial system's resilience to climate risk?

Accordingly, this study aims to: (1) map the development and depth of the literature on financial risk and climate change in Indonesia through a systematic literature review; (2) analyze current emissions and disaster data to assess Indonesia's comparative risk position; and (3) formulate evidence-based policy recommendations for financial authorities, banks, and national energy-fiscal policymakers.

2. Literature Review

International literature conceptualizes climate-related financial risk through two main transmission channels. Physical risk is transmitted into the financial system through damage to productive assets, supply-chain disruption, and reduced borrower income following disasters, while transition risk is transmitted through asset repricing, carbon regulation, and shifting investor preferences away from carbon-intensive assets ("Weathering the Storm," 2025). A study of European banks found that climate-risk exposure significantly increases bank credit risk, raises the cost of risk, and reduces bank financial stability, particularly through the physical-risk channel, which has historically received less attention than transition risk owing to the limited availability of geographically and sectorally granular loan-exposure data ("Weathering the Storm," 2025). At the credit-analysis level, the transmission mechanism operates through higher probability of default (PD) and loss given default (LGD): when extreme climate events damage collateral and disrupt borrower income, collateral value falls just as repayment capacity weakens, so that high environmental credit-risk exposure correlates negatively with the profitability, solvency, and market valuation of financial institutions (Binus Accounting, 2026).

Studies explicitly linking financial risk and climate change in Indonesia have grown rapidly since 2022-2024, mostly focused on the banking sector. Shofia Maulida et al. (2026) conducted a systematic literature review of 25 articles on climate-risk management and sustainable finance in Indonesia's green-banking sector, finding that the main challenges include limited climate-risk data, sub-optimal integration of climate risk into bank risk management, low green-financing profitability, and inconsistent disclosure standards across banks. A qualitative study by IJHESS (2024) on the perspective of Indonesia's banking industry found that OJK is beginning to integrate climate factors into banks' risk-management frameworks, though readiness to adopt the Basel Committee on Banking Supervision (BCBS) principles for the effective management of climate-related financial risk varies considerably, with large banks generally more prepared than mid-sized and small banks.

On the quantitative side, Zhang et al. (2025), working with the Sustainable and Green Finance Institute (SGFIN) at the National University of Singapore, analyzed transition- and physical-risk exposure in Indonesian bank loan portfolios, finding that both pluvial flood risk and decarbonization-related transition risk significantly increase borrowers' probability-of-default shocks across Indonesian regions - one of the most comprehensive quantitative pieces of evidence on the climate-credit risk nexus at the

national banking-system level to date. A separate study by Soleha (2024) tested the effect of climate-related risk on the financial stability of 548 firms listed on the Indonesia Stock Exchange, finding a significant negative effect mediated by firm size, confirming that climate risk is no longer merely a corporate-sustainability issue but a variable with a measurable effect on the real financial performance of Indonesian issuers.

Basmar and Yosepha (2026) conducted a stress test of green-finance resilience against climate-change risk in Indonesia and concluded that the financial and environmental ecosystems are closely interlinked, such that a crisis on one side can propagate through banking-sector performance. Meanwhile, RFI Foundation (2024) mapped financed emissions within Indonesia's financial system and found that financed emissions are concentrated in the energy and natural-resource sectors, with granular-data limitations remaining the principal obstacle to accurate quantification. On the policy side, Nurlatifah et al. (2026) examined the Climate Stress Test as a direction for green economic policy in Indonesia's banking sector using a normative-juridical approach, concluding that the CRMS 2024 and CRST frameworks reflect an effort to build inclusive, phased, learning-based climate-risk management, with a discernible shift from voluntary guidance toward binding obligations for the banking sector.

Taken together, the literature reveals four consistent patterns. First, research on the financial risk-climate change nexus in Indonesia has grown rapidly over the past two to three years (2022-2026), yet remains considerably smaller in volume than comparable research on European and other advanced financial systems ("Weathering the Storm," 2025). Second, most Indonesian studies remain descriptive-qualitative or literature-review in nature, while quantitative research using micro-level (loan-level or firm-level) data remains limited - much of it conducted by international research institutions such as SGFIN NUS (Zhang et al., 2025) rather than domestic institutions. Third, nearly every study consistently identifies the scarcity of granular climate-risk data as the principal structural constraint, for both supervisory and academic purposes (Shofia Maulida et al., 2026; RFI Foundation, 2024; IMF, 2025). Fourth, existing research remains concentrated on the banking sector, while studies of the insurance sector, capital markets, and non-bank financial institutions remain comparatively scarce.

2. METHODS

This study employs a systematic literature review (SLR) with narrative-thematic synthesis, drawing on the general principles of the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) framework for the identification, screening, eligibility-assessment, and inclusion stages - an approach consistent with the method used by Shofia Maulida et al. (2026) in reviewing Indonesia's green-banking literature. This approach was chosen because the study's objective is exploratory-descriptive: to map the breadth and depth of available literature rather than to test a single quantitative hypothesis.

Literature was retrieved from academic databases including Scopus, Google Scholar, DOAJ (Directory of Open Access Journals), Indonesian Sinta/Garuda-indexed journal portals, and institutional repositories. Beyond academic journals, this study also reviewed official reports and credible research institutions, including OJK, Bank Indonesia, BNPB, the International Monetary Fund, the World Bank, the Institute for Essential Services Reform, SGFIN at the National University of Singapore, and the RFI Foundation. Search terms combined 'financial risk', 'climate risk', 'climate change', 'sustainable finance', and 'Indonesia'.

Inclusion criteria were: (i) publications from 2017-2026, to capture developments since the Paris Agreement began broad implementation through to the present; (ii) a thematic focus on the linkage between financial risk (credit, stability, portfolio) and climate change (physical and/or transition) in the Indonesian context, or global conceptual frameworks relevant to that context; (iii) indexed journal articles, official reports from authoritative institutions, or working papers from credible research institutions, with publications lacking a clear methodology excluded from the synthesis; and (iv) priority given to studies containing empirical data or official secondary data (BNPB, OJK, Global Carbon Budget) to strengthen analytical validity.

The retrieved material was analyzed through two complementary approaches. First, a qualitative-thematic analysis of the academic and policy literature identified patterns, areas of consensus, and research gaps, as presented in the Results and Discussions section. Second, a descriptive-comparative analysis of

quantitative secondary data - specifically per-capita CO2 emissions data from Global Carbon Budget (2025) and disaster frequency and economic-loss data from BNPB (2025a, 2025b) - provided current empirical context on Indonesia's risk position. Both analytical strands were then synthesized to answer the research question concerning the degree of concern warranted by Indonesia's climate-financial risk position

3. RESULTS AND DISCUSSIONS

3.1 Overview of Reviewed Studies

Table 1 summarizes the key studies underpinning the thematic synthesis presented above, illustrating the rapid but still uneven growth of Indonesia-focused literature on the financial risk-climate change nexus.

Table 1. Summary of Selected Studies on Financial Risk and Climate Change in Indonesia

Author(s) (Year)	Focus	Method	Key Findings
IMF (2025)	Assessment of Indonesia's financial-system climate risk (FSAP)	Macroprudential risk analysis & stress testing	Indonesia is exposed to both physical and transition risk simultaneously; regulators' analytical capacity and climate-risk data remain limited.
Shofia Maulida et al. (2026)	Climate risk management and sustainable finance in Indonesia's green banking sector	Systematic literature review of 25 articles (2017-2024)	Climate-risk data remain scarce; integration of climate risk into bank risk management is sub-optimal; green-financing profitability is low; disclosure standards are inconsistent.
IJHESS (2024)	Indonesian banking-industry perspective on climate change as a business risk	Qualitative, semi-structured interviews with regulators & bank executives	Banks are beginning to adopt the BCBS framework, but readiness varies widely; OJK and Bank Indonesia are pushing climate-risk integration into macroprudential supervision.
Soleha (2024)	Effect of climate-related risk on the financial stability of IDX-listed firms	Quantitative, 548 firm sample from the Indonesia Stock Exchange	Climate-related risk significantly and negatively affects financial stability; firm size mediates the relationship.
Zhang et al. (2025)	Transition and physical risk exposure in Indonesian bank loan portfolios	Quantitative probability-of-default analysis against flood & decarbonization risk	Physical risk (pluvial flooding) and transition risk both significantly raise borrowers' probability of default across Indonesian regions.
Basmar & Yosepha (2026)	Stress-testing green finance resilience against climate risk in Indonesia	Banking-sector stress test	The financial and environmental ecosystems are closely interlinked; a green-finance crisis could threaten banking-sector performance if mitigation is inadequate.
RFI Foundation (2024)	Mapping financed emissions in Indonesia's financial system	Financed-emissions exposure estimation	Financed emissions are concentrated in the energy and natural-resource sectors; granular data remain a key constraint.
Nurlatifah et al. (2026)	Climate stress test as a direction for green economic policy in banking	Normative-juridical, qualitative	The CRMS 2024 and CRST frameworks build inclusive, phased climate-risk management; banks are positioned as engines of the green-economy transition.

3.2 CO2 Emission Trends and Indonesia's Global Position

Data from Global Carbon Budget (2025), visualized through per-capita CO2 emission trends, provide an informative picture of Indonesia's position relative to the world, the Asian region, and the group of upper-middle-income countries. As summarized in Table 2, Indonesia's per-capita emissions were historically far below the world average throughout 1750-1990. However, since the early 2000s, Indonesia's trend line has shown a markedly steeper slope than in earlier periods, consistent with accelerating industrialization, the expansion of coal-based mining and energy sectors and rising domestic energy consumption.

Three key findings emerge from the chart. First, in 2024 Indonesia's per-capita emissions (± 2.9 t) remained significantly below the world average (± 4.7 t), the Asian average (± 4.9 t), and well below the upper-middle-income country group (± 6.0 t), which includes China and several other BRICS economies (Global Carbon Budget, 2025). In this respect, Indonesia is not yet a major contributor to global per-capita emissions and retains a degree of statistical 'carbon headroom' relative to comparator countries. Second, the Asia line overtook the world line around 2005-2010 (Global Carbon Budget, 2025), indicating that the Asian region - where Indonesia is located - has become the new center of gravity for global emissions, creating greater regional pressure for decarbonization policy that will, in turn, shape the direction of Indonesia's own energy-transition policy. Third, the rate of increase in Indonesia's emissions from 2000 to 2024 has been proportionally far faster than in 1750-2000; although the absolute level remains comparatively low, this rate of change is itself an early warning signal for future transition-risk exposure, given that domestic and international carbon policy - including the potential effects of border carbon-adjustment mechanisms - is likely to tighten further (Handayani et al., 2022; CERAH, 2025).

Table 2. Estimated Per-Capita CO2 Emissions (tonnes), read from the Our World in Data chart based on Global Carbon Budget (2025)

Year	World	Asia	Indonesia	Upper-middle-income countries
1950	≈ 1.0 t	≈ 0.2 t	≈ 0.1 t	≈ 0.2 t
1990	≈ 4.1 t	≈ 1.8 t	≈ 0.7 t	≈ 1.9 t
2010	≈ 4.7 t	≈ 3.7 t	≈ 1.7 t	≈ 4.2 t
2024	≈ 4.7 t	≈ 4.9 t	≈ 2.9 t	≈ 6.0 t

3.3 Physical Risk Exposure: Disaster Frequency and Economic Losses

On the physical-risk side, BNPB data (BNPB, 2025c) reveal a trend that warrants continued vigilance. Although the total number of recorded disaster events nationally fell from 5,400 in 2023 to 2,107 in 2024, BNPB (2025c) recorded a significant shift in disaster composition since 2023, with a sharp rise in hydrometeorological disasters - particularly floods and landslides - driven by the La Niña phenomenon and climate change. Throughout 2024, disasters caused 540 deaths, 63 people missing, 11,531 injuries, and more than 8.1 million people affected or displaced, with damage to over 80,000 housing units, 612 educational facilities, and 445 bridges (BNPB, 2025a).

Indonesia's Disaster Risk Index (BNPB, 2025b) reinforces this picture, showing that the three disaster types with the largest high-risk coverage are forest and land fires (483 regencies/cities, or 93.97 percent of the total), drought (341 regencies/cities, or 66.34 percent), and flooding (321 regencies/cities, or 62.45 percent). In terms of direct economic impact, the early-2025 Jabodetabek floods caused losses and damage of nearly IDR 1.7 trillion, with Bekasi Regency recording the highest damage value at IDR 659.1 billion (BNPB, 2025d). The scale of loss from a single regional event of this kind points to a far larger potential aggregate risk once accumulated nationally and annually.

The implications for the financial sector are direct: property and infrastructure damage reduces the value of loan collateral, disrupted economic activity depresses the income of micro, small, and medium enterprises (MSMEs) in affected areas, and the insurance sector faces mounting claims pressure. Consistent with the finding of Zhang et al. (2025) that pluvial flood risk significantly raises the probability of borrower default, recent disaster-loss data (BNPB, 2025d) reinforce the empirical basis for this concern in the current Indonesian context.

3.4 Transition Risk Exposure: Fossil-Energy Dependence and Policy Contradictions

On the transition-risk side, Indonesia faces structural challenges arising from its heavy reliance on fossil energy, particularly coal, which continues to dominate the national power-generation mix (GovInsider Asia, 2025). The government has updated its Nationally Determined Contribution (NDC), raising the unconditional 2030 emissions-reduction target from 29 percent to 31.89 percent and the conditional (internationally supported) target from 41 percent to 43.20 percent, alongside a commitment to achieve net-zero emissions (NZE) by 2060 or sooner, as set out in the Enhanced NDC and the Long-Term Strategy for Low Carbon and Climate Resilience (GovInsider Asia, 2025; Climate Action Tracker, 2025).

However, several studies identify a contradiction between policy ambition and implementation reality. PT PLN's 2025-2034 Electricity Supply Business Plan (RUPTL) reportedly allocates substantial additional capacity from fossil-based power plants, including gas, despite the government's international commitments to phase out fossil power generation by 2040 (CERAH, 2025). Such policy contradictions create regulatory uncertainty that magnifies, rather than reduces, transition risk for investors and financial institutions financing the energy sector (CERAH, 2025).

Stranded-asset risk is also a serious concern. The planned early retirement of 32 coal-fired power-plant units, with a combined capacity of approximately 17 gigawatts, being prepared by the government together with PT PLN - while positive for the NZE target - could generate stranded-asset risk in the credit portfolios of banks that have historically financed coal-based generation (DEN, 2025). Insufficient investment, technology transfer, and workforce transition remain additional constraints requiring public-private collaboration (DEN, 2025).

3.5 Institutional Readiness and the Financial-Sector Regulatory Framework

Amid this dual risk exposure, institutional developments on the financial-regulation side have been relatively progressive. OJK (2024c) has issued the Indonesia Sustainable Finance Taxonomy (TKBI), a successor to the Indonesia Green Taxonomy (THI) Edition 1.0, providing a standard classification of environmentally sound economic activities to guide capital allocation and sustainable financing toward the 2060 NZE target. In 2024, OJK, together with seven major national banks - Bank Mandiri, BNI, BRI, BCA, CIMB Niaga, Bank Syariah Indonesia, and Bank Jabar Banten - launched the Climate Risk Management and Scenario Analysis (CRMS) guidelines, the first framework for banks to implement climate-risk governance in line with global standards such as the Task Force on Climate-related Financial Disclosures (TCFD) and the International Sustainability Standards Board (ISSB) (OJK, 2024a, 2024b).

OJK has further developed the Climate Risk Stress Test (CRST), requiring participating banks in the piloting phase to submit reports and executive summaries following a provided working-paper format, reflecting a shift from voluntary guidance toward more binding obligations (Nurlatifah et al., 2026). Nevertheless, the systematic review above shows that field implementation still faces significant constraints, particularly limited granular climate-risk data, uneven human-resource capacity, and inconsistent disclosure standards across banks (Shofia Maulida et al., 2026) - especially among mid-sized and small banks that lack the analytical capacity of large banks (IJHESS, 2024).

3.6 Synthesis: Is Indonesia in a Safe Zone or a Zone of Concern?

Synthesizing the evidence above yields a two-sided picture, such that a single answer of 'safe' or 'concerning' risks being misleading without further qualification.

Arguments that Indonesia is not yet in a critical condition (short term)

a) Indonesia's per-capita CO₂ emissions remain significantly below the world, Asian, and upper-middle-income country averages, providing policy space that is, in theory, still available for a more managed transition than in countries with already very high per-capita emissions (Global Carbon Budget, 2025).

b) The financial-sector regulatory framework has developed relatively progressively over the past three years, with the taxonomy, CRMS, and CRST placing Indonesia not far behind regional best practice in terms of formal policy architecture (OJK, 2024a, 2024b, 2024c).

c) The commitment of seven major national banks, which together hold a significant share of banking-sector assets, demonstrates initial readiness in the systemically most important segment of the banking industry (OJK, 2024b).

Arguments that Indonesia's condition is sufficiently concerning (medium-to-long term)

- a. The rate of increase in Indonesia's per-capita emissions since 2000 has been far steeper than in earlier periods (Global Carbon Budget, 2025), indicating a trajectory that, if unmanaged, could approach the level of upper-middle-income countries within one to two decades - coinciding with an increasingly stringent global carbon regime among major trading partners.
- b. Physical-risk exposure has already materialized visibly and repeatedly, reflected in the dominance of hydrometeorological disasters, the extensive coverage of high-risk regions (BNPB, 2025b, 2025c), and single-event economic losses reaching the trillions of rupiah (BNPB, 2025d).
- c. A genuine contradiction exists between NZE policy commitments and energy-planning reality (RUPTL 2025-2034) (CERAH, 2025), which magnifies rather than reduces regulatory uncertainty and stranded-asset risk for bank credit portfolios exposed to the fossil-energy sector (DEN, 2025).
- d. Independent quantitative evidence from SGFIN NUS empirically confirms that both physical and transition risk already significantly raise borrowers' probability of default across Indonesian regions - not merely a future potential risk, but one already materialized in credit data (Zhang et al., 2025).
- e. Climate-risk data and analytical capacity remain a structural constraint consistently identified across nearly all studies (Shofia Maulida et al., 2026; RFI Foundation, 2024; IMF, 2025), meaning that a sound regulatory framework does not guarantee adequate implementation and early-detection capability, particularly among mid-sized and small banks and non-bank financial institutions.

Weighing both sides of the evidence, this study concludes that Indonesia is most accurately described as occupying an 'elevated-but-manageable risk zone': not yet in a state of systemic crisis as reflected in current macro-financial stability indicators, but no longer within a safe zone, given that physical risk has already materialized visibly and repeatedly (BNPB, 2025a, 2025d), while transition risk could rise sharply owing to energy-policy contradictions (CERAH, 2025) and an accelerating global carbon regime. The policy window for managed mitigation before these risks accumulate into a systemic threat is narrowing, warranting firmer and better-integrated policy action over the next five to ten years (IMF, 2025).

4. CONCLUSION

This systematic literature review shows that the topic of financial risk and climate change in Indonesia has received rapidly growing academic and policy attention since 2022, reflected in an increasing number of studies from both domestic universities and international research institutions focused on Indonesia (Shofia Maulida et al., 2026; Zhang et al., 2025; Nurlatifah et al., 2026). However, in terms of volume and methodological depth - particularly quantitative research using micro-level data - Indonesian literature remains behind studies of financial systems in advanced economies ("Weathering the Storm," 2025). Analysis of current emissions and disaster data confirms that Indonesia occupies a transitional risk position: current per-capita emission levels remain comparatively low by global standards (Global Carbon Budget, 2025), yet the upward trend is steep, while physical risk has already materialized concretely and repeatedly with significant economic losses (BNPB, 2025a, 2025d). This combination places Indonesia not in a safe zone, but in a zone of rising - though still manageable - risk, provided that policy action is strengthened consistently and in a timely manner.

Policy Recommendations for Regulators (OJK, Bank Indonesia, and the Government)

- a. Accelerate the transition of the Climate Risk Stress Test (CRST) from a voluntary pilot toward a mandatory annual exercise for all systemically important banks, with phased expansion to mid-sized banks and non-bank financial institutions, including insurers and pension funds (Nurlatifah et al., 2026).
- b. Build an integrated climate-financial risk data platform linking BNPB/BMKG spatial disaster data with bank credit-exposure data at the regency/city and sectoral level, to address the granular-data constraint consistently identified across the literature (Shofia Maulida et al., 2026; RFI Foundation, 2024).
- c. Align electricity-sector planning (RUPTL) consistently with NDC commitments and the 2060 NZE target (CERAH, 2025), reducing the regulatory uncertainty that currently magnifies transition risk for investors and creditors.

- d. Accelerate implementation of the Indonesia Sustainable Finance Taxonomy (TKBI) (OJK, 2024c) as a mandatory reference for credit analysis in high-carbon sectors, supported by prudential incentives such as lower risk weightings for taxonomy-aligned financing.
- e. Develop a comprehensive just-transition framework for the early retirement of coal-fired power plants (DEN, 2025), including stranded-asset risk-mitigation mechanisms for creditor banks and protections for affected workers.

Recommendations for the Banking and Financial Services Industry

- a. Systematically integrate climate-risk analysis into credit underwriting, extending beyond large corporate segments to MSME borrowers in high disaster-risk regions (Zhang et al., 2025).
- b. Strengthen human-resource capacity and internal data infrastructure for climate scenario analysis, particularly at mid-sized and small banks that continue to lag behind larger institutions (IJHESS, 2024).
- c. Improve the quality and consistency of climate-risk disclosure in line with international standards such as TCFD/IFRS S2 (OJK, 2024a), to enhance market transparency and investor confidence.
- d. Develop more inclusive insurance and disaster risk-mitigation products for borrowers in high physical-risk regions, as a complement to credit risk management (BNPB, 2025b).

This study has several limitations. First, as a systematic literature review employing narrative-thematic synthesis, it does not conduct primary statistical testing of micro-level data; its findings therefore synthesize existing research rather than provide new empirical evidence. Second, the emissions figures read from the visualized chart (Global Carbon Budget, 2025) are approximate rather than exact, owing to limited access to precise underlying values. Third, although the literature search was reasonably broad, it cannot claim to be fully exhaustive given how rapidly this field is developing. Future research should pursue quantitative models based on individual loan-level data across Indonesia's banking system more broadly and longitudinally, following the direction pioneered by Zhang et al. (2025), comparative climate-financial risk studies across ASEAN countries (Handayani et al., 2022), and evaluations of how CRST implementation affects bank lending behavior in carbon-intensive sectors in the coming years.

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