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Climate Risk Management and the Need for a Paradigm Shift in Iran's Insurance Industry

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ABSTRACT

BACKGROUND AND OBJECTIVES: Climate change, recognized as a systemic risk, has posed unprecedented challenges to the foundations of the insurance sector. As the global environment undergoes rapid transformations, the historical predictability of insurable risks is being fundamentally undermined. This study aims to examine the bidirectional impacts of climate change on the insurance sector, with a particular focus on physical and transition risks. The study further investigates how these risks are reflected in the financial statements and operational strategies of insurance firms. Globally, the insurance sector is undergoing a fundamental transformation in response to climate change, with insurers increasingly recognizing it as a material financial and strategic risk. This recognition is driving a shift toward more sophisticated climate risk disclosure and internal stress testing. However, responses remain uneven across jurisdictions, and practical adaptation is often limited to pricing and reinsurance adjustments rather than comprehensive long-term resilience planning. Many markets still struggle to integrate forward-looking climate projections into their core business models. Similar challenges persist in Iran, where regional climate volatility adds another layer of complexity to the domestic financial landscape. On the one hand, the country is highly exposed to a wide range of natural hazards, particularly earthquakes and floods, which frequently result in severe socioeconomic losses due to inadequate insurance coverage. On the other hand, the domestic insurance market continues to rely on traditional insurance products and pricing models without an effective, specialized climate risk management framework. This institutional inertia has widened the insurance protection gap and poses an increasing threat to national economic stability.

METHODS: Using a descriptive–analytical approach, this study examines the physical and transition risks associated with climate change and their implications for the insurance sector. The methodology is based on an in-depth review of the existing literature and industry reports to identify emerging patterns of risk and vulnerability. The analysis also draws on key international frameworks, including the Task Force on Climate-related Financial Disclosures (TCFD) and the Network for Greening the Financial System (NGFS), to evaluate how strategic adaptation and innovation can enhance the resilience and sustainability of the insurance sector. By assessing these global benchmarks, the study establishes a link between international best practices and the specific regulatory environment of Iran. It further employs comparative analysis to demonstrate how global adaptation trends can be contextualized within the Iranian insurance market to mitigate future financial shocks.

FINDINGS: Economic losses from natural catastrophes reached USD 318 billion in 2024, resulting in approximately 14,000 fatalities, while 57% of global losses remained uninsured. This highlights a critical vulnerability in the global financial safety net. These losses increased from USD 303 billion in 2023 and exceeded the 10-year average of USD 254 billion, confirming that climate-induced volatility is becoming the new normal. The findings indicate that the sharp rise in losses from natural disasters has rendered insurers' traditional risk pricing and management models increasingly ineffective. Conventional actuarial methods, which rely heavily on historical loss frequency and severity, are no longer sufficient to capture the non-linear risk dynamics associated with a changing climate. At the same time, climate change presents opportunities for innovation by enabling insurers to expand their portfolios with products such as green insurance and parametric insurance. The findings further suggest that developing innovative solutions, including weather index insurance and renewable energy insurance, can enable insurers to access new markets while supporting environmental objectives. In addition, the analysis demonstrates that investment in digital transformation and catastrophe modeling is essential for maintaining solvency in an increasingly uncertain risk environment.

CONCLUSION: This study examines the physical and transition risks associated with climate change and their implications for insurance, proposing a framework that repositions insurers from passive claims payers to proactive leaders in climate risk management and the sustainable transition. This transformation requires a fundamental rethinking of the insurer–policyholder relationship. Insurance mechanisms should not only compensate losses but also encourage and facilitate preventive action. By incentivizing risk-reduction measures through premium discounts and specialized advisory services, insurers can reduce aggregate losses and strengthen resilience. The study concludes that strategic adaptation and sustained investment in innovation are not only essential for the survival of insurers but also critical to the long-term sustainability of Iran's insurance sector. Without a proactive approach, the domestic market is likely to face severe capacity constraints and heightened capital volatility. Accordingly, the study proposes several strategic measures, including the establishment of a national climate risk database, the promotion of public–private partnerships for catastrophe insurance, and the adoption of Environmental, Social, and Governance (ESG) criteria in insurance investment portfolios. Implementing these measures can strengthen the sector's long-term resilience while enhancing its contribution to national climate resilience.

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INTRODUCTION

Climate change, as one of the most critical challenges of the twenty-first century, is no longer a distant threat but a present-day reality that is impacting the global economy and, by extension, the insurance industry (Lee et al., 2023; Swiss Re Institute, 2024). The escalating severity and frequency of climate-related events are challenging the way insurers traditionally approach risk. The future of insurance will depend on solutions that not only compensate for damage but also actively help reduce exposure to risk (European Commission, 2025). This represents a genuine paradigm shift that the insurance industry is expected to undergo.

Secondary data and information from reliable and credible sources indicate that global economic losses exceeded USD 318 billion, with more than 14,000 fatalities in 2024. Insured losses from these catastrophes reached USD 137 billion, corresponding to 43% coverage, leaving a 57% protection gap. Among a multitude of perils, the disasters contributing most to the accumulation of losses were Hurricanes Helene and Milton, severe convective storms in the United States, large-scale urban floods worldwide, and the highest ever recorded natural catastrophe insured losses in Canada (Swiss Re Institute, 2025). Recent catastrophic events, such as Hurricane Melissa in 2025, have also underscored the vulnerability of insurance systems to climate risks. Hurricane Melissa, one of the strongest Atlantic storms on record, caused widespread damage in the Caribbean and highlighted the limits of traditional insurance and the need for forward-looking climate risk assessments and adaptive strategies. For countries such as Iran, Melissa underscores the importance of shifting from reactive disaster response to proactive climate risk management (World Bank Group, 2025).

The insurance mechanism is expected to play a vital role in managing climate-related risks by providing not only financial protection but also incentives for risk mitigation. By transferring risk from individuals and businesses to insurers, it reduces the financial impact of these risks and encourages preventive actions. Furthermore, national and regional climate risk pools can play a leading role in diversifying climate impacts at national, regional, and global levels.

It is projected that by 2040, climate change-related primary and secondary (also referred to as acute and chronic) losses in developed countries will increase by 35% to 120%, while insurance premiums are expected to rise by up to 60%. Without collective action among insurers, policyholders, governments, and industry partners, the climate crisis could destabilize and potentially undermine the functioning of the insurance system from within. The establishment of a shared climate risk framework is therefore identified as a crucial step toward building a more resilient and sustainable future (Fantini et al., 2023).

The impact of climate risks on the insurance business is now a certainty. The insurance industry, which has traditionally served as a financial shock absorber against natural disasters, is now directly exposed to both the immediate (acute) and indirect (chronic) consequences of climate variability (Swiss Re Institute, 2024). Insurers are now required to incorporate an additional risk factor into their calculations: climate-related exposures. The consequences of this new situation are substantial and bidirectional, giving rise to both physical and transition risks. Physical risk materializes in the form of financial losses or increased costs resulting from chronic and acute physical events. Transition risk arises from the costly adjustment toward a low-carbon economy and is typically driven by changes in climate and environmental policy, technological advances, and shifts in business and consumer preferences (Bua et al., 2022).

Addressing both physical and transition risks requires a structured governance framework that operates across all organizational levels of the insurance industry. Decision-making on climate issues should begin at the board level, where climate strategies are reviewed and integrated into corporate objectives. Dedicated committees, such as risk, Environmental, Social, and Governance (ESG), and audit committees, play a critical role in assessing exposures, ensuring transparency, and overseeing disclosure and compliance processes. At the operational level, risk management and sustainability teams are responsible for implementing adaptation strategies, monitoring climate-related indicators, and coordinating communication with external stakeholders. This multilayered governance framework can enable Iranian insurers to systematically manage climate challenges and transition from reactive responses to proactive climate risk management across the industry (Bruneau, 2025).

Fig. 1 illustrates how various lines of insurance business are affected by the physical consequences of climate risks (Swiss Re Institute, 2025). Property, commercial, and reinsurance lines are identified as the most vulnerable segments impacted by climate risk-related losses.

According to the International Association of Insurance Supervisors (IAIS) Global Insurance Market Report 2023, between 29% and 42% of insurers' investment portfolios are exposed to sectors potentially affected by climate transition risks, with a global average of around 37% (IAIS, 2023). For simplicity, this can be interpreted as roughly one-quarter to one-third of total portfolios being at risk. According to the European Insurance and Occupational Pensions Authority (EIOPA) Financial Stability Report (December 2023), stress test scenarios indicate that a disorderly or delayed transition to a low-carbon economy could reduce

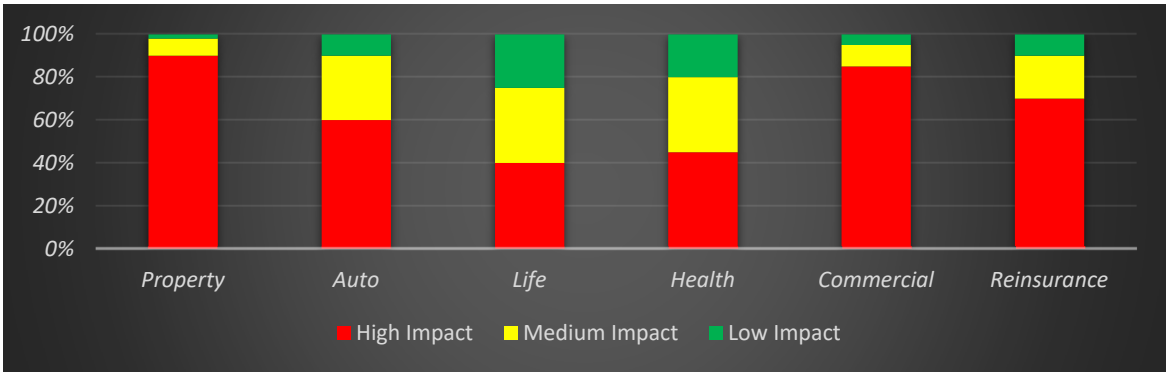


Fig. 1. Climate change impact on various lines of insurance business

insurers' investment returns by approximately 5% to 15%, mainly due to valuation losses in carbon-intensive sectors. Insurers should assess the impact of physical and transition risks on their investment portfolios as well as on their asset–liability management. A forward-looking perspective, including the use of scenario analysis, may help achieve a better understanding of these risks (EIOPA, 2023).

In the case of Iran, insurers are also increasingly exposed to both physical and transition risks, yet their current risk management practices remain predominantly reactive rather than preventive and proactive (Hamzeh et al., 2024). The Iranian insurance market faces significant physical risks, particularly earthquakes and floods, while the use of advanced catastrophe risk modelling and preventive risk assessment remains limited (Ghafory-Ashtiany & Motamed, 2024). Furthermore, macro-economic factors such as persistent double-digit inflation over recent decades, low economic growth, high unemployment, and international sanctions have impeded the development of the insurance market. This is reflected in the relatively low insurance penetration rate, which constrains the sector's ability to absorb major losses. At the same time, the industry has yet to develop comprehensive products addressing climate-related transition risks, even though awareness and demand for such products are growing (Hamzeh et al., 2022).

According to the Global Climate Risk Index (CRI) (2021), Iran ranks among the more vulnerable countries to climate-related risks, with a CRI score of 90.00. The CRI does not provide an all-encompassing analysis of the risks of anthropogenic climate change, but rather represents one analytical lens that helps explain countries' exposure and vulnerability to climate-related risks based on the most reliable quantified data available. The CRI (2021) report is based on loss figures for 180 countries during the period 2000–2019 and ranks the most affected countries (Eckstein et al., 2021).

Recent policy reforms—such as the reduction of compulsory reinsurance cession rates by the Central Insurance of Iran (Bimeh Markazi)—reflect attempts to strengthen market resilience and encourage more proactive risk management (Jackson, 2022).

Previous national studies indicate that Iranian insurers are still in the early stages of integrating climate considerations into underwriting and governance structures (Hamzeh et al., 2024). These considerations encompass a range of measures, including but not limited to: advanced risk modelling using big data and artificial intelligence; reviewing current pricing models and terms and conditions; providing advisory services to help insurers' clients adapt to climate impacts and vulnerabilities; incentivizing preventive measures; and other related initiatives.

The main issue is that traditional risk assessment and pricing models, which are based on historical data and linear trends, are unable to predict new and nonlinear climate patterns. This limitation has contributed to a sharp increase in insured losses and the expansion of the protection gap, whereby significant economic damages remain uninsured, ultimately threatening the financial sustainability of many insurance companies (Xu et al., 2025). Conversely, the shift toward a low-carbon economy (energy transition) also introduces new risks, known as transition risks, which encompass new policies, technological changes, and market developments.

By examining both physical and transition risks, this study seeks to answer the following questions:

- How can Iran's insurance industry evolve from a passive role as a claims payer to an active, leading role in climate risk management, facilitating the transition toward a sustainable economy?
- How can Iran's insurance industry facilitate and incentivize preventive actions?

Accordingly, this paper aims to identify the impacts of climate risks on Iran's insurance sector and to propose a strategic conceptual framework and pathways for adaptation. The paper is structured

as follows: Section 2 reviews the literature; Section 3 presents the theoretical framework; Section 4 outlines the methodology; Section 5 discusses the results; and Section 6 concludes with recommendations.

LITERATURE REVIEW

Research on the intersection of climate change and insurance began in the early 1990s and intensified following catastrophic events such as Hurricane Katrina in 2005, which exposed the insurance sector's vulnerability to climate-related extreme events. In response, leading international insurance organizations and professional associations began publishing comprehensive reports on climate-related risks, while the concepts of green and sustainable insurance gradually gained prominence. As a result, climate change evolved from a peripheral environmental concern into a central consideration in risk management, pricing, and strategic decision-making within the insurance sector (Munich Re, 2025).

Table 1 summarizes the principal international studies and frameworks on climate risk and insurance that underpin the conceptual foundation of this study.

As summarized in Table 1, although the international literature underscores the urgency of integrating climate risk management within the insurance sector, the Iranian context reveals substantial implementation and governance gaps. International initiatives, including the International Association of Insurance Supervisors (IAIS) Climate Framework, the European Union Sustainable Finance Action Plan, and the International Financial Reporting Standards (IFRS) S2, have embedded climate risk disclosure and scenario analysis within supervisory practice. However, However, these principles have yet to be systematically operationalized within Iran's regulatory and corporate insurance frameworks. Domestic studies (Ghafory-Ashtiany & Motamed, 2024) identify three persistent deficiencies: shortcomings: the predominance of reactive risk management, the limited application of climate risk modelling, and weak coordination among insurers, regulators, and environmental agencies. These deficiencies are particularly significant given Iran's high exposure to floods, droughts, and earthquakes. Moreover, macroeconomic challenges—including persistent inflation, international sanctions, and limited investment capacity—have further constrained innovation and market resilience (Jackson, 2022). Consequently, insurance penetration remains among the lowest in the region, while adaptive instruments such as parametric insurance and microinsurance remain underdeveloped (AON, 2025).

Nevertheless, recent regulatory reforms and the growing policy dialogue surrounding sustainable finance suggest the emergence of a gradual systemic transition. Iran's insurance sector has reached a critical inflection point, requiring a shift from post-disaster compensation toward proactive, innovation-driven climate risk management.

Building on these observations, this study proposes strategic recommendations for enhancing climate resilience within Iran's insurance sector, with particular emphasis on governance reform, product innovation, and regional cooperation. By contextualizing international best practices within Iran's socioeconomic and institutional environment and proposing a conceptual framework (Fig. 2), the study seeks to facilitate the transition from a reactive insurance model to a resilient and adaptive climate risk management paradigm.

THEORETICAL FRAMEWORK

This study draws on the climate risk governance frameworks established by the Task Force on Climate-related Financial Disclosures (TCFD) and the Network for Greening the Financial System (NGFS), which articulate four core pillars: governance, strategy, risk management, and metrics and targets. These frameworks assist insurers in integrating climate-related risks into financial decision-making, enabling forward-looking scenario analysis (e.g., 1.5°C versus 2.0°C warming pathways) and the disclosure of material risk exposures (TCFD, 2020; NGFS, 2025). In Iran, alignment with TCFD and NGFS principles remains nascent, with limited operational adoption in underwriting practices and solvency assessments. Regulatory benchmarks—such as EU Sustainable Finance Taxonomy and EIOPA Solvency II guidelines—demonstrate how Iranian regulators could enhance institutional resilience through standardized disclosures and stress testing. Beyond regulatory compliance, the theoretical framework positions insurance as a pivotal instrument for climate change adaptation and mitigation (OECD, 2021). Indeed, insurance transcends conventional risk transfer by incentivizing behavioral change and supporting macroeconomic stability through four primary mechanisms:

- **Risk Transfer and Sharing:** By pooling premiums, insurers alleviate post-disaster fiscal burdens on governments and households, as demonstrated by regional catastrophe risk pools (World Bank Group, 2017).
- **Incentivizing Adaptation and Mitigation:** Risk-based pricing and underwriting exclusions encourage policyholders to invest in climate-resilient infrastructure—such as flood-proofing and seismic retrofitting—thereby reducing long-term physical exposure (O'Neill et al., 2022)
- **Enhancing Recovery and Liquidity:** Parametric insurance products provide rapid liquidity based on

Table 1. Summary of Key Literature on Climate Risk and Insurance

Category	Source/Title	Title	Key contribution/ Relevance
1. Standards, Frameworks and Disclosure	(IAIS, 2018)	Issues Paper on Climate Change Risks to the Insurance Sector	Provides regulatory guidance for insurance supervision and supports climate-related regulatory reforms.
	(Net-Zero Insurance Alliance, 2021)	Response to CMA Call for Inputs on Environmental Sustainability	Brings together major global insurers committed to achieving net-zero insurance portfolios by 2050.
	(NGFS, 2022)	Climate Scenarios for Central Banks and Supervisors	Provides global climate stress-testing scenarios applicable to insurers' risk assessment.
	(AON, 2025)	Global Insurance Market Insights Reports	Demonstrates insurers' use of artificial intelligence and big data in risk modeling, dynamic pricing, and innovation aligned with TCFD/NGFS frameworks.
2. Physical Risk and Insurance Modeling	(Swiss Re Institute, 2021)	The Economics of Climate Change: No Action Is Not an Option	Quantifies climate-related insured and economic losses, highlighting the significance of physical risks.
	(BaFin, 2022)	Annual report: Federal Financial Supervisory Authority	Demonstrates the application of advanced climate risk and investment models under BaFin's risk management framework.
	(Lee et al., 2023)	AR6 Synthesis Report	Highlights the limitations of traditional insurance models and advocates integrated climate risk frameworks.
	(Sakamoto, 2023)	Typhoon Damage and Countermeasures Against Storm Surge Inundation in Japan	Presents innovative flood and earthquake insurance models that enhance risk quantification and offer insights applicable to Iran.
3. Transition Risk and Strategic Response	(Bernstein et al., 2018)	Disaster on the Horizon: The Price Effect of Sea Level Rise	Demonstrates that physical and transition risks influence asset values, creating financial implications for insurers.
	(Golnaraghi, 2021)	Climate Change Risk Assessment for the Insurance Industry	Explains how insurers address physical and transition risks through underwriting, investment strategies, and policy engagement.
	(AXA Group, 2023)	AXA's Climate and Sustainability Strategy: Transitioning to a Net-Zero Insurance and Investment Portfolio	Illustrates strategies for reducing transition risk through fossil fuel divestment, renewable energy insurance and sustainable investments.
4. Innovation Of Products and Technologies	(ADB, 2025)	How Innovative Insurance Products Can Bridge the Climate Insurance Gap	Highlights the role of parametric insurance, green bonds, and digital risk assessment in narrowing the global protection gap, with implications for developing markets such as Iran.

Continued Table 1. Summary of Key Literature on Climate Risk and Insurance

Category	Source/Title	Title	Key contribution/ Relevance
	(IKI, 2026)	Innovative Insurance Products for Climate Change Adaptation (Ghana Project)	Demonstrates the practical implementation of innovative insurance solutions through public-private partnerships, offering lessons for agricultural and regional insurance in Iran.
5. The Paradigm Shift and Climate Risks in Iran	(Talha et al., 2025)	Soft Computing Paradigm for Climate Change Adaptation and Mitigation in Iran, Pakistan, and Türkiye: A Systematic Review	Introduces data-driven and artificial intelligence-based frameworks for regional adaptation, representing a paradigm shift toward predictive climate risk management.
	(Franco & Garcia 2025)	The Paradigm Shift in Scientific Interest on Flood Risk: From Hydraulic Analysis to Integrated Land Use Planning Approaches	Demonstrates the transition from engineering-based to systems-based flood risk management, providing a conceptual benchmark for Iran's evolving disaster governance.
	(Hamze et al., 2022)	An Investigation into the Status of Iran's Insurance Industry in the Underwriting of Climate Change	Examines the preparedness of Iran's insurance sector for climate-related underwriting and identifies structural gaps requiring proactive adaptation.
	(Hamzeh et al., 2023)	The Role of the Insurance Industry in the Perception of Climate Change in Iran	Evaluates Iranian insurers' awareness of climate change and highlights the early-stage integration of climate considerations into insurance products.

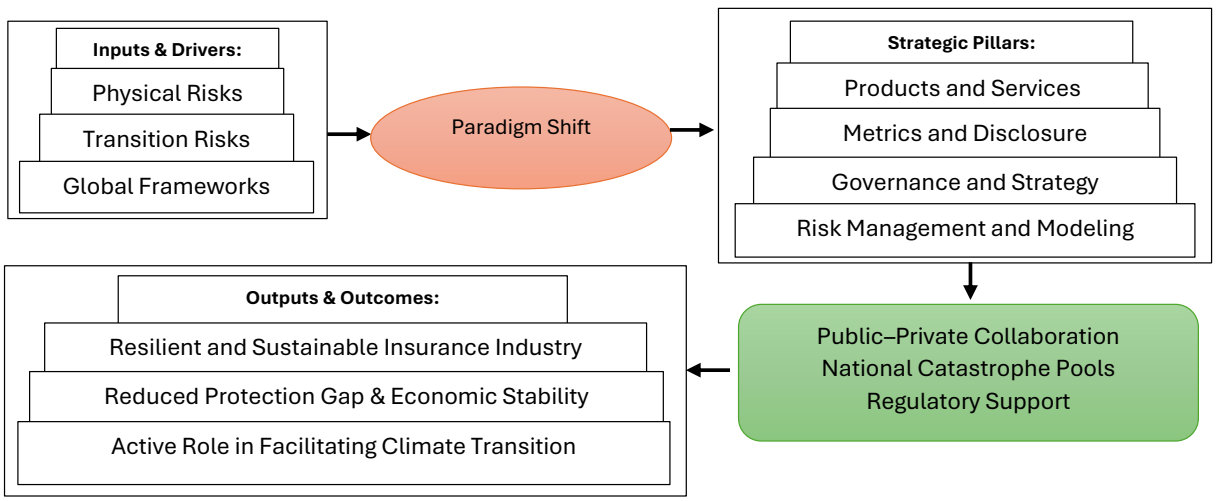


Fig. 2. Conceptual Framework for Climate Risk Impacts and Strategic Transformation in Iran's Insurance Industry

predefined index triggers (e.g., specific rainfall or wind-speed thresholds), thereby minimizing administrative delays and facilitating prompt post-disaster reconstruction (Goyal, 2021).

- **Data-Driven Risk Awareness:** Insurers generate comprehensive, high-resolution risk data, which informs evidence-based public policymaking and heightens risk awareness across civil society (EIOPA, 2022; GIZ, 2020).

This dual mandate—acting as a reactive shock absorber while serving as a proactive enabler of sustainability—requires structured public–private collaboration. Public entities establish regulatory oversight and provide sovereign backstop reinsurance, whereas private insurers contribute underwriting innovation, risk capital, and market discipline (OECD, 2021; Schinko et al., 2019). In emerging and transitional economies such as Iran, public–private partnerships (PPPs) are essential for narrowing the protection gap by adapting global standards to localized, compounding hazards, including droughts, floods, and seismic risks (GIZ, 2020). By integrating these institutional mechanisms, the proposed theoretical framework directly addresses the study's central research questions: facilitating the evolution of Iranian insurers from passive claims-settling institutions into active stewards of climate resilience, and driving proactive risk reduction through product design and risk-advisory services.

Synthesizing these theoretical foundations—specifically the climate governance principles of the TCFD and NGFS, advanced risk-modelling literature, and Iran's specific institutional context—this study constructs a comprehensive conceptual framework (Figure 2). The framework operationalizes the structural transformation of the insurance sector by systematically integrating physical and transition risk drivers, international supervisory expectations, core internal transformation pillars, and the enabling role of public–private collaboration. In doing so, it delineates the strategic pathways through which Iranian insurers can transition from traditional, reactive loss-compensation mechanisms toward a proactive, climate-resilient paradigm centered on governance, risk management, and product innovation.

As illustrated in Fig. 2, the conceptual framework begins with the principal inputs and drivers, including physical risks—both acute and chronic—transition risks arising from policy, technological, and market factors, and global regulatory frameworks such as TCFD, NGFS, and IFRS S2). Collectively, these drivers necessitate a fundamental paradigm shift in the role of Iran's insurance industry: from a passive payer of claims to a proactive enabler of climate change adaptation and the transition toward a low-carbon economy.

This transformation is operationalized through four strategic pillars:

1) Products and Services: Developing parametric, green, and advisory insurance solutions to support climate change adaptation and mitigation.

2) Metrics and Disclosure: Implementing standardized climate-related disclosures aligned with TCFD and emerging Environmental, Social, and Governance (ESG) reporting standards.

3) Governance and Strategy: Strengthening board-level oversight and integrating climate considerations into strategic planning.

4) Risk Management and Modeling: Adopting forward-looking climate scenarios and artificial intelligence-based catastrophe models.

The framework also underscores the importance of public–private participation, particularly through the formation of national catastrophe pools and the strengthening of regulatory support. Effective public–private collaboration is essential because the insurance industry cannot address climate-related risks in isolation, particularly within Iran's institutional and economic context. Through these mechanisms, the framework anticipates three principal outcomes:

(1) a resilient and sustainable insurance industry; (2) a reduced protection gap and improved economic stability; and (3) an active contribution by the insurance sector to Iran's national climate transition.

METHODOLOGY

This study adopts a descriptive-analytical approach to examine the bidirectional impacts of climate risk on Iran's insurance sector and to propose a conceptual framework for a paradigm shift and its adaptation strategies. The methodology integrates qualitative and quantitative elements to ensure comprehensive coverage of the theoretical, empirical, and contextual dimensions of the subject, directly addressing the research questions concerning the evolving role of insurers and their capacity to incentivize prevention.

Data Collection: Secondary data were drawn from authoritative global and national reports selected on the basis of relevance, recency (primarily 2018–2025), and credibility. Key sources include Aon, the Intergovernmental Panel on Climate Change (IPCC), Munich Re, NGFS, the Swiss Re Institute (sigma series), TCFD, and Iranian studies. The data encompassed economic loss statistics, regulatory texts, case studies of insurer innovation, and Iran-specific vulnerability indices. The inclusion criteria prioritized peer-reviewed or institutional publications providing verifiable metrics on physical and transition risks. In total, approximately 50 documents were reviewed, yielding around 150 data points on losses, premiums, and adaptation measures.

Data Analysis: A mixed-methods content analysis

was employed, combining qualitative thematic coding with quantitative summarization. MAXQDA software was used to organize, analyze, and visualize the qualitative data, supporting thematic extraction from regulatory frameworks and strategy documents, as well as the identification of patterns in governance integration (e.g., TCFD pillar alignment) and scenario-based risk assessment (e.g., NGFS pathways). Themes were coded both deductively, based on TCFD and NGFS pillars, and inductively, to capture emerging Iran-specific barriers such as sanctions. For the quantitative component, Microsoft Excel was used to aggregate and visualize trends, including insured loss trajectories (Fig. 3) and protection gaps (Table 4), using descriptive statistics such as means and growth rates. Reliability and validity were strengthened through inter-coder checks (kappa score > 0.80) and triangulation across sources. Global loss data from Swiss Re were triangulated with national vulnerability indices, such as the Climate Risk Index, and findings from Iranian academic studies (e.g., Hamzeh et al., 2024) to ensure a comprehensive perspective.

Limitations: This approach enables the identification of patterns in risk exposure, such as the vulnerability of property lines, and in adaptive capacity, such as the uptake of parametric products, while grounding the study's recommendations in empirical evidence. However, the methodology remains limited by its reliance on secondary data, which may overlook real-time firm-level insights. Future research could address this limitation through primary surveys or interviews with industry stakeholders.

RESULTS AND DISCUSSION

The findings classify climate risks into two principal categories: physical and transition risks (Lee et al., 2023). Physical risks are further delineated into acute, event-driven hazards and chronic, long-term trends. Empirical evidence indicates that these risks exert a direct and intensifying impact across diverse insurance lines (Swiss Re Institute, 2024).

Table 2 illustrates the impact of physical risks across different insurance sectors.

Fig. 3 illustrates an upward trajectory in the impact of physical risks, which escalated from approximately USD 60 billion in 2014 to exceed USD 95 billion in 2023, based on approximate data from (Aon, 2025; Swiss Re Institute, 2024).

In 2023, economic losses from natural disasters reached USD 280 billion, with only USD 95 billion insured, representing a 66% protection gap (Swiss Re Institute, 2024). Secondary perils—such as localized floods, landslides, and wildfires—now account for 70% of total losses (Howard, 2024), while a 1.5°C increase in global temperatures correlates with a 15% rise in the frequency of extreme weather events (WMO, 2024).

This issue is particularly salient for Iran, which is identified as highly vulnerable to flooding in the Global Climate Risk Index 2021 (Eckstein et al., 2021). For instance, the 2022 Khuzestan floods inflicted damage exceeding IRR 2,670 billion on road infrastructure alone, yet insured losses remained negligible. This discrepancy highlights a severe protection gap and

Table 2. Impact of physical climate risks across different insurance sectors

Insurance line	Impact Type	Examples
Property Insurance	Significant increase in losses	Losses caused by flood, storm, wildfire
Agricultural Insurance	Crop losses	Drought, flood, unexpected frost
Motor/Vehicle Insurance	Increase in accidents and damages	Driving under adverse weather conditions, hail
Health Insurance	Increase in illnesses	Heat and air pollution related illnesses

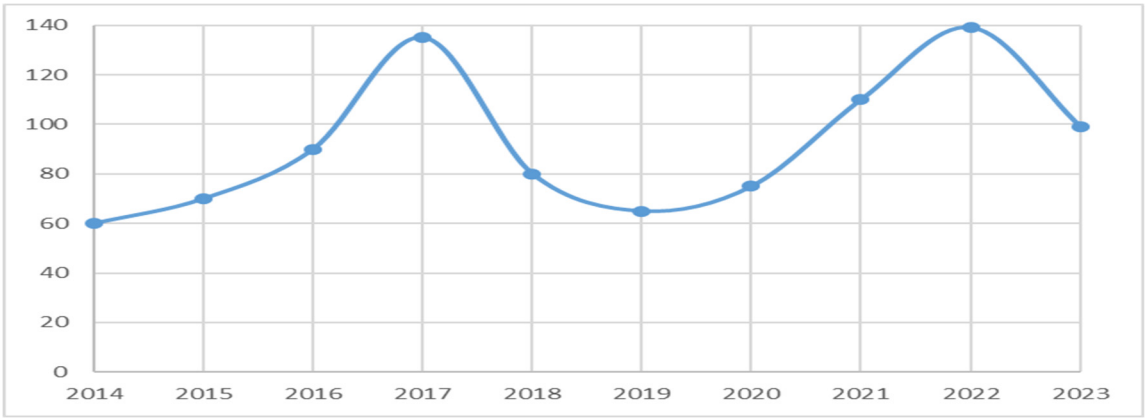


Fig. 3. Upward impact of physical risks on various insurance lines of business

Table 3. Current approaches in Iran versus required paradigm shifts for managing physical climate risks

Aspect	Current State in Iran (Based on Lit Review)	Required Paradigm Shift	Link to Research Question
Risk Modeling	Relies on historical data; limited use of catastrophe models.	Forward-looking, climate-adjusted models using AI/big data needs to be adapted.	Evolves role from passive to active.
Products	Traditional (e.g., fire, motor); no parametric or green products.	Develop parametric triggers for droughts/floods; insure solar/wind projects.	Creates new business and incentivizes prevention.
Governance	Climate risk not integrated at board level; no TCFD disclosures.	Establish board-level climate committees; mandate TCFD-aligned reporting.	Embeds proactive management into strategy.
Public-Private Partnership	Weak coordination between insurers, government, and regulators.	Create national catastrophe pools; co-design resilience standards with the government.	Facilitates transition and shares risk.

underscores the limitations of traditional risk models regarding Iran's specific hydro-climatic hazards (Tinn News, 2022).

Table 3 shows a summary of approaches and paradigms which are currently applied to the physical risks in Iran.

Transition risks emerge from policy shifts, technological advancements, and evolving market expectations, which are intensified by the global transition toward a low-carbon economy (Vano & Vali, 2022; World Bank Group, 2023).

Global transition risks manifest in three primary dimensions (Dwortzan, 2022; UKSIF, 2025). First, policy enforcement, such as carbon pricing and stringent emission standards, can lead to asset stranding, with approximately USD 2.3 trillion in fossil-fuel-related assets currently exposed. Second, technological shifts, including the rapid proliferation of green technologies like electric vehicles and renewable energy, are actively disrupting traditional business models. Third, evolving market expectations require companies to adhere to ESG criteria; firms failing to demonstrate strong performance in these areas face increased reputational risk.

The management of transition risks present profound challenges for Iran. With the potential easing of sanctions, Iran's oil and gas assets may face significant stranding risks, necessitating an assessment of how insurers are exposed to these sectors through their investment portfolios. Furthermore, Iranian entities pursuing international trade may encounter de facto ESG standards imposed by trade partners, creating a demand for new advisory and insurance services that currently do not exist. Consequently, transition risks for Iran are twofold: internal policy shifts toward a low-carbon economy could strand state-invested oil and gas assets, impacting insurers' portfolios, while external export dependencies generate a pressing need for ESG-compliant advisory and insurance solutions.

At the same time, climate change creates significant business opportunities. Table 4 illustrates the emerging market opportunities in the insurance industry (Sumant, 2025).

Regulators worldwide, including TCFD and NGFS, are increasingly reinforcing transparency and climate risk disclosure obligations, with such mandates now established in over 45 countries (NGFS, 2020; TCFD, 2020).

CONCLUSION AND RECOMMENDATIONS

The findings of this study clearly show that climate change represents a transformational risk for the insurance industry and can no longer be managed within traditional frameworks (Swiss Re Institute, 2024). Rising losses, the reduced effectiveness of geographical diversification, and increasing regulatory pressures have cast doubt on the viability of insurers that continue to rely on conventional models. Traditional management approaches based solely on historical data are insufficient for addressing non-linear and systemic climate risks (Munich RE, 2025).

On the other hand, this crisis also represents one of the greatest opportunities for innovation and for redefining the insurance industry's role. Leading companies, by investing in advanced risk modeling, developing parametric and green insurance products, and providing advisory solutions, are not only strengthening their resilience but also facilitating the transition toward a climate-resilient economy by channeling capital into sustainable projects and helping clients adapt to climate change.

To ensure resilience and long-term sustainability, insurers must adopt strategic innovation and align themselves with international regulatory frameworks. The following strategic recommendations are proposed for the Iranian insurance industry:

- Integration of climate risk assessment into strategic planning: Climate risks should be fully embedded in risk management, investment, and product pricing processes (Aon, 2025).

Table 4. Emerging market opportunities in the insurance industry driven by climate and sustainability trends

Market Opportunities	Description	Growth Potential
Green Insurance	Coverage for green projects, sustainable buildings, and renewable energy	25% annual growth
Parametric Insurance	Payouts based on predefined metrics such as the severity of an earthquake or the amount of rainfall	40% market growth by 2030
Advisory Services	Support to clients in evaluating climate risks and adapting to them	35% revenue growth

- Investment in innovation and data: Developing advanced modeling capabilities through artificial intelligence and big data analytics is essential for more accurate risk prediction (Swiss Re Institute, 2024).
- Development of new products: Focus on high-growth markets such as parametric insurance, green insurance, and microinsurance to reduce the protection gap and gain market share.
- International and cross-sector collaboration: Closing the protection gap can only be achieved through close cooperation among governments, the private sector, and research institutions (NGFS, 2020).
- Transparency and disclosure: Adhering to regulatory frameworks such as TCFD is vital not only for compliance but also for building investor and customer trust (EIOPA, 2023; TCFD, 2020).

Echoing the recommendations of Hamzeh et al. (2024), the establishment of dedicated climate risk teams and the integration of parametric insurance solutions are crucial steps for Iran's insurance market to enhance resilience and close the protection gap. The insurance industry stands at a critical crossroads. The choice between resisting change and embracing it proactively will determine the industry's future in the decades to come. Consistent with Yang et al. (2025) and Hamzeh et al. (2024), the results underline that awareness alone is insufficient; both global and national insurance markets must operationalize climate strategies through innovation, parametric insurance solutions, and transparent risk disclosure frameworks.

CONTRIBUTION OF EACH AUTHOR

Mahmoud Asad Samani: Conceived and designed the study, developed the research methodology, supervised all stages of the research, provided scientific guidance throughout the study, critically revised the manuscript for important intellectual content, and approved the final version. Sahar Haghnazari: Collected and analyzed the data, implemented the research methodology, prepared the initial draft of the manuscript, incorporated revisions based on the supervisor's comments, contributed to the interpretation of the findings, and approved the final version.

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CONFLICT OF INTEREST

The author(s) declares that there is no conflict of interest regarding the publication of the registered research. Furthermore, ethical considerations including plagiarism, informed consent, misconduct, fabrication and/or falsification of data, duplicate publication, and also Journal Policy on Artificial Intelligence Use have been fully observed by the authors.

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