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Financing the Disaster That Did Not Happen: Resilience Bonds and Parametric Risk Finance as India's Next Urban Infrastructure Innovation

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ABSTRACT- India's infrastructure finance debate has largely concentrated on mobilizing capital for asset creation through public expenditure, bank lending, public–private partnerships, municipal bonds, green bonds and multilateral finance. This paper advances a balancing argument: infrastructure finance in a climate stressed economy must also finance risk reduction before disasters occur. Urban floods, cyclones, heatwaves, water stress and critical service disruptions impose direct repair costs, fiscal pressure, business interruption, livelihood loss and social distress. However, most public finance continues to operate after the shock through relief, compensation and reconstruction. This paper examines resilience bonds and parametric disaster risk finance as nonconventional instruments for Indian urban infrastructure during 2017–2026. Using a descriptive and policy analytical design based on secondary literature, disaster risk finance documents, regulatory material and international experience, the paper develops a Protect–Price–Pay framework. The framework links three functions: protection through risk reducing infrastructure, pricing through avoided loss estimation, and payment through prearranged insurance, catastrophe risk transfer or resilience linked savings. The paper does not claim that India already has a mature resilience bond market; rather, it argues that Indian cities can initiate with structured pilots in urban flooding, cyclone exposed infrastructure, heat resilience and critical public services. The proposed approach is technically feasible only if India develops reliable city level risk accounts, transparent parametric triggers, actuarial modelling capacity, regulatory clarity on insurance linked securities and legally preapproved social payout plans. Resilience finance cannot replace public investment, municipal finance reform or climate adaptation planning. Its value lies in making avoided losses visible, measurable and partially financeable.

KEYWORDS: Resilience Bonds, Parametric Insurance, Disaster Risk Finance, Urban Resilience, Infrastructure Finance, Climate Adaptation, Catastrophe Bonds, India.

I. INTRODUCTION

India's infrastructure challenge is commonly framed as a problem of capital mobilization. Cities require large and continuing investment in roads, drainage, water supply, sewerage, solid waste management, public transport, housing, power distribution, digital networks and climate resilient urban services. The conventional policy response is therefore to expand the financing base through budgetary support, infrastructure pipelines, development finance, bank credit, public private partnerships, municipal bonds, green bonds and institutional investors.

This financing logic is necessary, but it remains incomplete. It treats infrastructure mainly as an asset to be built, while climate risk requires infrastructure also to be understood as an asset that can fail, disrupt public services and create future fiscal liabilities. Disaster resilient backup systems, or a power network that is vulnerable to cyclone damage is costly. These are emergency repair, relief payments, loss of working days, supply chain disruption, stress on public health and loss of household income.

The problem of analysis is then not the extent to which India constructs infrastructure, but the extent loss that can be avoided by infrastructure in the future. Conventional infrastructure finance generally measures success based on capital raised, project completion and asset delivery. Resilience finance introduces a second measure: the decrease of predicted disaster loss. In simplified terms, the economic value of a resilience project may be represented as:

$$\Delta EAL_{c,h} = EAL^0_{c,h} - EAL^1_{c,h}$$

Where $EAL^0_{c,h}$ is the expected annual loss for city(c) from hazard (h) before the resilience investment, and $EAL^1_{c,h}$ is the expected annual loss after the investment. If $(EAL^0_{c,h}$>0), the project produces an avoided loss benefit. That portion of this avoided loss can be reflected in financing decisions by insurance, resilience linked savings or risk transfer instruments. The focus of this discussion is two tools: resilience bonds and parametric disaster risk finance. A catastrophe bond passes on a defined disaster risk to capital market investors. A parametric insurance contract is paid when a measurable event, like intensity of rainfall, flood. depth, wind speed or heat index, crosses an agreed threshold. A resilience bond is based on these principles through linking disaster risk transfer and investment in risk reducing infrastructure. This paper proposes that India must not blindly imitate the models of catastrophe bonds elsewhere. Indian cities operate with uneven data quality, limited municipal fiscal capacity, fragmented planning systems and high social vulnerability. Therefore, any Indian model must be gradual, regulated, transparent and socially anchored. The central contribution of the paper is the Protect–Price–Pay framework. “Protect” refers to identifying and financing infrastructure that reduces measurable hazard exposure. “Price” refers to estimating the value of avoided losses and possible reduction in insurance or risk transfer cost. “Pay” refers to arranging pre agreed liquidity through parametric insurance, pooled risk funds, catastrophe risk transfer or resilience linked rebates.

The paper is organized into six sections. After the introduction, Section 2 reviews the conceptual and policy literature. Section 3 explains the data and methodology. Section 4 develops the Protect–Price–Pay framework and discusses the analytical results. Section 5 presents policy design for India. Section 6 concludes with limitations and future research directions.

II. LITERATURE REVIEW AND ANALYTICAL BACKGROUND

The literature relevant to this paper lies at the intersection of infrastructure finance, disaster risk finance, insurance linked securities and climate adaptation. Conventional infrastructure finance focuses on capital formation, long-term debt, public–private partnerships, project viability, institutional investment and fiscal sustainability. In this literature, climate risk is commonly managed as a project risk or external shock, but not as a core financing variable. Disaster risk finance takes a different point of departure. It contends that governments ought to organize financial safeguarding prior to calamities. The operational structure of the World Bank on disaster risk financing focuses on stratified instruments like budget reserves, contingent credit, insurance, reinsurance and catastrophe bonds to improve fiscal preparedness and speed of response [1]. The OECD similarly frames disaster risk financing as a public finance tool for managing contingent liabilities before shocks materialize [2].

Insurance linked securities and catastrophe bonds bring disaster risk financing to the capital markets. According to Cummins and Weiss [3], securitized risk transfer instruments are hybrid linkages between insurance and financial markets. Froot [4] states that catastrophe when the traditional insurance and reinsurance are insufficient, risk markets can offer extra capacity insufficient. Kerjan and Morlaye [5] further discuss how trigger design and investor participation shape the use of insurance linked securities for extreme events.

Parametric insurance differs from indemnity-based insurance because payment depends on a predefined physical or statistical trigger rather than a detailed assessment of actual loss. Its advantage is speed and administrative simplicity. Its limitation is basis risk, which occurs when the parametric payout differs from actual loss [6]. This can be written as:

$$BR_{c,h} = \frac{\left|L_{c,h} - P_{c,h}\right|}{L_{c,h}}, \quad L_{c,h} > 0$$

Where $BR_{c,h}$ denotes basis risk, $L_{c,h}$ is actual loss and $P_{c,h}$ is the payout received by city (c) for hazard (h). A lower value of (BR) indicates that the payout more closely matches the loss. For Indian cities, basis risk is especially important because urban flooding may occur not only because of rainfall intensity but also because of drainage blockage, land use change, encroachment, tidal conditions and infrastructure failure.

Resilience bonds are a more recent concept, utilized as tools that bridge catastrophe risk transfer and investments that mitigate physical risk [7]. The central innovation is the fact that reduced expected loss can be translated into a resilience rebate or insurance saving. Resilience bonds are different in this regard as compared to regular infrastructure bonds. Since they not only finance the creation of assets; but they also appreciate the monetary worth of risk reduction. Climate adaptation finance provides an additional analytical foundation. Many adaptation benefits are public, long-term and difficult to monetize. Mechler [8] notes that risk-based cost–benefit analysis can be useful for disaster risk management, although estimates depend heavily on assumptions, data and hazard modelling. The difficulty is that avoided losses are not always visible in annual budgets. Resilience finance attempts to bring avoided losses into financial decision making.

In India, disaster management and infrastructure finance have generally developed as parallel policy domains. Disaster risk governance is supported by national and state level institutions, guidelines and funds [11], while infrastructure finance is driven by capital expenditure, sectoral schemes, municipal finance, public–private partnerships and development finance. The National Infrastructure Pipeline reflects the scale and policy importance of infrastructure investment [9]. Disaster management funding and Finance Commission allocations provide important public finance support for mitigation and response [10]. However, the use of insurance linked securities, catastrophe bonds and resilience bond structures for Indian urban infrastructure remains limited.

The analytical gap is therefore clear. India has active debates on infrastructure finance, green finance, municipal finance and disaster management. Yet there is limited integrated analysis of how city level risk reduction can be priced and linked to prearranged financial protection. This paper addresses that gap by developing a practical framework for resilience finance in Indian urban infrastructure.

III. DATA AND METHODOLOGY

This study follows a descriptive, conceptual and policy analytical methodology. A full econometric model is not appropriate at this stage because India does not yet have a sufficient time series or panel dataset of city level resilience bonds, catastrophe bonds or parametric disaster risk finance instruments. The absence of repeated observations across cities and years makes statistical estimation of market performance, pricing behaviour or payout effectiveness infeasible. The paper therefore uses structured secondary analysis and framework development.

The study period is 2017–2026. This period is analytically relevant because climate resilient infrastructure, municipal finance, green finance, insurance linked securities and disaster risk financing have gained greater policy attention during these years. The unit of analysis is not a single bond transaction, but the proposed city–hazard–instrument combination. For example, an urban flood risk pilot in Mumbai, a cyclone risk pilot in a coastal city, or a heat

resilience pilot in an inland city may each be treated as a potential analytical unit.
The paper uses four categories of secondary material: first, academic literature on catastrophe risk, insurance linked securities, resilience bonds and disaster risk financing; second, Indian policy material on infrastructure pipelines, disaster management funds, insurance regulation and resilient infrastructure; third, international institutional reports on catastrophe bonds, sovereign risk protection and urban climate investment; and fourth, conceptual evidence from global experience with parametric and catastrophe risk instruments. The method does not invent new numerical observations. Instead, it strengthens the analytical structure by defining variables, relationships and decision rules that can be used in future empirical research (See table 1).

Table 1: Data Sources and Analytical Use in the Study

Source category	Examples of sources retained in the paper	Main information used	Analytical use in this study
Academic literature	Froot [4]; Cummins and Weiss [3]; Cummins et al. [6]; Kerjan and Morlaye [5]; Mechler [8]; Vaijhala and Rhodes [7]	Catastrophe risk markets, insurance linked securities, resilience bonds, avoided loss logic	Builds the conceptual base for risk transfer, basis risk and resilience rebate
Indian public policy documents	Government of India [9], [10]; NDMA [11]; IRDAI [12]; IFSCA [13]	Infrastructure planning, disaster management finance, insurance regulation, insurance linked securities discussion	Frames Indian feasibility, regulatory constraints and institutional design
International institutional reports	World Bank [1], [16], [17]; OECD [2]; IFC [14]	Disaster risk financing frameworks, country experience, urban climate investment	Supports the layered risk finance approach and city level adaptation logic
Market review material	Artemis [15]	Catastrophe bond and insurance linked securities market developments	Provides market context without using unverifiable transaction level claims

The analytical framework uses five core variables. Let (H) denote the hazard type, such as flood, cyclone, heat or drought. Let (E) denote exposure, measured by the assets, population or services located in the risk zone. Let (V) denote vulnerability, reflecting the susceptibility of those exposed assets or populations to loss. Let (I) denote the resilience investment, such as drainage, flood retention, cool roofs, coastal protection or backup power. Let (P) denote the prearranged payout from a parametric or risk transfer instrument.
The expected loss relationship may be expressed as:

$$EAL_{c,h} = f\left(H_{c,h}, E_{c,h}, V_{c,h}, A_{c,h}\right)$$

Where $A_{c,h}$ represents adaptive capacity. A resilience investment is expected to reduce either exposure, vulnerability or both. Therefore:

$$EAL^{1}_{c,h} = f\left(H_{c,h}, E^{1}_{c,h}, V^{1}_{c,h}, A^{1}_{c,h}\right)$$

A project is financially meaningful from a resilience perspective when:

$$EAL^{1}_{c,h} < EAL^{0}_{c,h}$$

The percentage reduction in expected annual loss may be represented as:

$$RRR_{c,h} = \left(\frac{EAL^{0}_{c,h} - EAL^{1}_{c,h}}{EAL^{0}_{c,h}}\right) \times 100$$

Where (RRR) is the risk reduction ratio. The paper does not estimate (RRR) numerically because city level loss data and hazard modelling are not compiled here. However, the expression shows how future empirical work can measure whether a resilience project produces quantifiable economic value.
For parametric finance, the payout may be represented as:

$$P_{c,h} = min\left[C, \alpha \times max\left(0, Z_{c,h} - \tau_h\right)\right]$$

Where (C) is the coverage cap, $Z_{c,h}$ is the observed hazard index, h is the trigger threshold and α is the payout rate. If $Z_{c,h}$, no payout is made. Then $Z_{c,h} \leq \tau_h$, payout begins, subject to the coverage cap. This term brings out three policy issues: trigger. design, payout adequacy and basis risk. It is not statistical estimation but analytical modelling. It explains how resilience finance can be assessed in India without being a transparent way. Assuming the existence of a full-grown domestic dataset.

IV. RESULTS AND DISCUSSION: THE PROTECT–PRICE–PAY FRAMEWORK FOR INDIA

The principal analytical result of the paper is the Protect–Price–Pay framework (See table 2). It translates resilience finance as an abstract financial concept into a model that can be applied to Indian cities. The model is based on a basic hypothesis: a city must initially mitigate risk at the physical level, then put a price on that risk reduction, and lastly, organize quick liquidity or savings linked to the risk profile.

A. Protect: Identifying Risk Reducing Infrastructure

The first stage is protection. Cities must identify infrastructure projects that reduce measurable hazard exposure or vulnerability. These may include storm water drainage, flood retention ponds, wetland restoration, permeable surfaces, sea walls, cyclone shelters, cool roofs, public cooling centers, resilient power distribution, hospital backup systems, early warning systems and emergency transport routes.
The project selection criterion should not be visibility alone. A project should qualify for resilience finance only if it is capable of reducing expected loss. This creates a more disciplined appraisal method than ordinary capital

expenditure planning. The relevant question becomes: by how much does the project reduce expected annual loss, service disruption or recovery cost?

For example, an urban drainage project should not be evaluated only by its construction cost or physical coverage. It should also be evaluated by the reduction in expected flood damage, business interruption, and transport closure and public health disruption. Similarly, a heat resilience programme should not be treated only as a welfare measure; it should also be assessed as an economic protection measure if it reduces health costs, productivity loss or mortality risk.

B. Price: Estimating Avoided Loss and Insurance Savings

The second stage is pricing. Resilience finance requires the avoided loss to be estimated with reasonable credibility. The pricing exercise does not require perfect prediction, but it does require transparent assumptions, hazard data and exposure information. In principle, the avoided loss value is:

$$\Delta L_t = L_t^0 - L_t^1$$

Where (L_t^0 is expected loss in period (t) without the project and L_t^1 is expected loss after the project. The net present value of a resilience project may then be expressed as:

$$NPV_R = \sum_{t=1}^{T} \frac{(\Delta L_t + \Delta P_t + \Delta D_t)}{(1+r)^t} - I_0$$

Where L_t is avoided physical and economic loss, P_t is any reduction in insurance premium or risk transfer cost, D_t is the value of avoided downtime, (r) is the discount rate, (T) is the evaluation period and I_0 is the initial resilience investment. This expression shows that the value of resilience is not limited to direct damage reduction; it may also include lower risk transfer cost and improved continuity of services.

Nonetheless, estimation of avoided loss should be conservative. In case models overstate the reduction of risk, insurance savings will be exaggerated and the financial framework can be misleading. Thus, modelling must be reviewed on its own, sensitivity analysis about hazard intensity, exposure to assets, population exposure and climate unpredictability.

C. Pay: Pre-Arranged Liquidity and Resilience Linked Savings

The third step is payment. After the risk has been priced, cities are able to organize pre agreed financial mechanisms. These may include parametric insurance, pooled risk funds, contingent credit, catastrophe bonds or resilience bond structures. For Indian cities, the most practical starting point is likely to be parametric insurance and pooled state level risk facilities rather than immediately issuing complex city level catastrophe bonds.

The advantage of parametric finance is speed. If the trigger is reached, payout can be released without waiting for prolonged loss assessment. This is especially relevant during the first 72 hours after a disaster, when cities require liquidity for evacuation, temporary shelter, emergency health response, restoration of water supply, drainage clearing, public transport recovery and livelihood support.

The central problem is basis risk. A city may experience flooding even when rainfall is below the trigger because of local drainage failure. Alternatively, rainfall may cross the trigger but actual damage may be low. Trigger design must therefore be based on hazard behaviour, infrastructure conditions and actual exposure. For urban flooding, a rainfall trigger alone may be insufficient; rainfall may need to be combined with flood depth sensors, drainage zone mapping or ward level vulnerability indicators (See table 2).

Table 2: Operational Logic of the Protect–Price–Pay Framework

Stage	Core question	Technical expression	Indian policy requirement
Protect	Which infrastructure reduces measurable risk?	$EAL^1 < EAL^0$	City level hazard mapping, asset registers and resilience project appraisal
Price	What is the value of avoided loss?	$\Delta EAL = EAL^0 - EAL^1$	Actuarial modelling, engineering validation and independent review
Pay	How will liquidity be released when risk materializes?	$P = \min[C, \alpha \max(0, Z - \tau)]$	Transparent triggers, regulated contracts and preapproved payout plans
Verify	Did the instrument reduce fiscal and social stress?	$BR = \frac{\lvert L-P \rvert}{L}, \quad L > 0$	Post event audit, social disclosure and model recalibration

This framework shows that resilience finance is not a substitute for public investment. It is a method for linking public investment with risk based financial protection. The financial structure is useful only when the underlying infrastructure genuinely reduces risk and when payouts are designed to reach public services and vulnerable populations.

V. POLICY ARCHITECTURE FOR INDIAN URBAN RESILIENCE FINANCE

India should introduce resilience finance gradually through a practical institutional architecture rather than isolated financial experimentation. A useful starting point would be a City Resilience Finance Facility at the national or state level. Such a facility could provide shared technical capacity to cities that do not individually possess actuarial, legal, modelling or capital market expertise.

The facility may include six functional units. A risk data unit would compile rainfall, flood, cyclone, heat, drought, asset exposure and service disruption information. A project preparation unit would help cities identify bankable resilience projects. A modelling unit would estimate expected annual loss and avoided loss. A finance unit would structure parametric insurance, pooled risk funds, contingent credit or resilience bond models. A social protection unit would define how payouts will support vulnerable communities. A disclosure unit would publish simplified information on triggers, coverage, payout use and outcomes (See table 3).

Table 3: Proposed City Resilience Finance Facility for India

Component	Function	Expected contribution
Risk data unit	Collects hazard, exposure and vulnerability data	Builds the evidence base for pricing and trigger design
Project preparation unit	Converts resilience needs into financeable projects	Improves project quality and reduces preparation gaps
Modelling unit	Estimates expected loss, avoided loss and basis risk	Supports actuarial discipline and independent verification
Finance unit	Structures insurance, contingent credit or resilience bond models	Links risk reduction with liquidity and capital market access
Social protection unit	Defines beneficiary use of payouts	Ensures that finance protects people, not only assets
Disclosure unit	Publishes trigger, coverage and payout information	Strengthens transparency and public accountability

This facility-based model is better suited to India than expecting every municipality to independently design catastrophe risk instruments. Many Indian cities have limited technical capacity and uneven fiscal autonomy. Shared capacity would also permit risk pooling, reduce transaction costs and improve standardisation.

Four pilot areas appear most suitable. The first is urban flooding, where Indian cities repeatedly face monsoon related disruption. A pilot could combine drainage improvement, retention infrastructure, wetlands and rainfall or flood depth based parametric cover. The second is cyclone exposed coastal infrastructure, including ports, coastal roads, power systems, shelters and communication networks. The third is heat resilience, where triggers may be based on heat index or temperature thresholds, although modelling is more complex than for cyclones. The fourth is critical public services, including hospitals, water supply, sanitation, power backup and emergency transport (See table 4).

Table 4: Possible Pilot Design for Indian Cities

Risk area	Possible resilience project	Indicative trigger type	Main expected outcome
Urban flooding	Drainage improvement, retention ponds, wetland restoration	Rainfall intensity, flood depth or combined local index	Faster liquidity and reduced flood damage
Cyclone risk	Coastal protection, resilient power systems, shelters	Wind speed, storm track or cyclone intensity	Protection of critical infrastructure and quicker recovery
Extreme heat	Cool roofs, cooling centers, heat shelters, worker safety systems	Heat index or temperature threshold	Reduced health risk and productivity disruption
Water stress	Storage, reuse, leakage control and drought preparedness	Rainfall deficit or reservoir level index	Improved preparedness during rainfall failure
Critical services	Hospital backup systems, water and power continuity plans	Hazard specific service disruption trigger	Continuity of essential public services

The social design of payouts is equally important. A parametric payout that remains within an agency account without reaching affected communities would weaken the legitimacy of the instrument. Each contract should therefore include a preapproved payout plan. This plan should specify the share of funds for emergency shelters, temporary livelihood support, public health facilities, water and sanitation restoration, school shelters, transport clearance and small business recovery. The aim is to make resilience finance minimize the fiscal stress and social vulnerability. There is also the need to have regulatory coordination in between catastrophe bonds and resilience bonds capital markets and insurance [12], [13]. This means that insurance regulators in India should coordinate securities market regulators, financial sector regulators, state governments and city local bodies. Nevertheless, introduction of resilience finance cannot be made without explicit rules on disclosure, protection of investors, public liability, trigger verification, post event and use of payout audit. An Indian model can be implemented in four phases. Stage one must develop city climate risk accounts. These reports must recognize risks, assets at risk, potential victims, historical losses, gaps in services and data. Pilot parametric covers should be supported by stage two, when the data quality is reasonable in selected risks. Stage three ought to bridge risk reducing infrastructure that is insured or contingently liquid. Stage four can take into account resilience bond structures of bigger cities or combined state level after pilot testing. Financial innovation should not be the aim of the policy in itself. A resilience bond is useful only when it improves risk reduction, reduces future fiscal pressure, accelerates recovery and protects vulnerable groups. If it becomes a complex instrument without social accountability, it may increase transaction costs without improving resilience.

VI. CONCLUSION AND LIMITATIONS

India's infrastructure finance debate must move beyond the narrow question of how to build more assets. It must also ask how to reduce future losses from assets, services and communities exposed to climate shocks. Urban floods, cyclones, heatwaves, water stress and critical service failures are not only environmental events; they are fiscal, economic and social shocks. The present system continues to rely heavily on post disaster relief, repair and reconstruction. This is necessary, but it is not sufficient for a climate stressed urban economy.

This paper proposed resilience bonds and parametric disaster risk finance as complementary tools for India's next phase of infrastructure finance. The paper developed a Protect–Price–Pay framework in which cities first invest in risk reducing infrastructure, then estimate avoided losses, and finally arrange pre agreed liquidity or resilience linked savings. The framework helps convert avoided disaster loss into a visible financial variable.

The central argument is not that India should immediately launch complex catastrophe bonds for every city. That would be premature. The more practical approach is to begin with city level or state level pilots supported by a City Resilience Finance Facility. Urban flooding, cyclone exposed infrastructure, heat resilience and critical public services provide suitable starting points. Parametric insurance and pooled risk finance may be more feasible initial instruments, while resilience bonds can be considered once data, modelling, regulatory and institutional capacity improve.

The paper has significant shortcomings. It is based on secondary sources and policy analysis rather than primary interviews or transaction level financial data. India is not yet a mature resilience bond market, which makes the paper necessarily conceptual and exploratory. It does not estimate lost profits to any particular city, nor does it make premiums, coupons, investor amounts of returns or payouts. These omissions are deliberate since such figures would demand exposure data, hazard models, and actuarial pricing and city specific loss records. The paper thus does not make quantitative assertions that are unprovable. Future studies ought to create urban case studies with ward level hazard information, city asset registers, rainfall and heat records, service disruption information and fiscal loss estimates. Empirical studies can then approximate the anticipated loss per year prior to resilience investment and after resilience investment calculate risk reduction ratios, compare parametric payout adequacy and evaluate basis risk. Such research would assist in establishing whether resilience finance can transition out of conceptual potential and into practical urban policy. The bigger picture is that India must fund not only the infrastructure that it develops, but also the calamities it averts. When a flood is less damaging due to the drainage being better, when a cyclone has not closed down a hospital due to backup systems, or when heat stress is less lessened by cooling infrastructure, the loss avoided is actual economic worth. The challenge is to quantify it well, price it openly and make it create safer and more inclusive cities. When structured in a disciplined and accountable manner, resilience finance can be a significant next generation tool of climate ready urban development in India.

REFERENCES

[1] World Bank, *Financial Protection against Natural Disasters: An Operational Framework for Disaster Risk Financing and Insurance*. Washington, DC, USA: World Bank, 2014. Available from: https://openknowledge.worldbank.org/server/api/core/bitstreams/93356548-5419-5cb9-9417-2921498227de/content

[2] Organisation for Economic Co-operation and Development, *Disaster Risk Financing: A Global Survey of Practices and Challenges*. Paris, France: OECD Publishing, 2015. Available from: https://www.taylorfrancis.com/chapters/edit/10.4324/9781003179900-102/organisation-economic-co-operation-development%E2%80%94oecd-helen-canton

[3] J. D. Cummins and M. A. Weiss, "Convergence of insurance and financial markets: Hybrid and securitized risk-transfer solutions," *Journal of Risk and Insurance*, vol. 76, no. 3, pp. 493–545, 2009. Available from: https://doi.org/10.1111/j.1539-6975.2009.01311.x

[4] K. A. Froot, "The market for catastrophe risk: A clinical examination," *Journal of Financial Economics*, vol. 60, no. 2–3, pp. 529–571, 2001. Available from: https://doi.org/10.1016/S0304-405X(01)00052-6

[5] Michel-Kerjan and F. Morlaye, "Extreme events, global warming, and insurance-linked securities: How to trigger the 'tipping point'," *The Geneva Papers on Risk and Insurance: Issues and Practice*, vol. 33, no. 1, pp. 153–176, 2008. Available from: https://link.springer.com/article/10.1057/palgrave.gpp.2510159

[6] J. D. Cummins, D. Lalonde, and R. D. Phillips, "The basis risk of index-linked catastrophic loss securities," *Journal of Financial Economics*, vol. 71, no. 1, pp. 77–111, 2004. Available from: https://doi.org/10.1016/S0304-405X(03)00172-7

[7] S. Vaijhala and J. Rhodes, "Resilience bonds: A business model for resilient infrastructure," *Field Actions Science Reports*, Special Issue 18, pp. 58–63, 2018. Available from: https://journals.openedition.org/factsreports/4910

[8] R. Mechler, "Reviewing estimates of the economic efficiency of disaster risk management: Opportunities and limitations of using risk-based cost–benefit analysis," *Natural Hazards*, vol. 81, pp. 2121–2147, 2016. Available from: https://link.springer.com/article/10.1007/s11069-016-2170-y

[9] Government of India, *Report of the Task Force on National Infrastructure Pipeline for 2019–2025*. New Delhi, India: Department of Economic Affairs, Ministry of Finance, 2020. Available from: https://doi.org/10.1093/oso/9780198884934.001.0001

[10] Ministry of Home Affairs, *Increased Allocation of Funds under NDRF/SDRF*. New Delhi, India: Government of India, 2023.

[11] National Disaster Management Authority, *National Disaster Management Plan*. New Delhi, India: Government of India, 2019. Available from: https://tinyurl.com/3k2h8r7c

[12] Insurance Regulatory and Development Authority of India, *Annual Report 2023–24*. Hyderabad, India: IRDAI, 2024. Available from: https://tinyurl.com/yh3wuats

[13] International Financial Services Centres Authority, *Report of the Working Group to Study Alternative Risk Transfer Arrangements, including Insurance-Linked Securities and Catastrophe Bonds*. Gandhinagar, India: IFSCA, 2025.

[14] International Finance Corporation, *Climate Investment Opportunities in Cities: An IFC Analysis*. Washington, DC, USA: IFC, 2018. Available from: https://cyberleninka.ru/article/n/international-financial-centers-as-channels-for-foreign-investment-inflow-to-european-cities

[15] Artemis, *Insurance Linked Securities and Catastrophe Bond Market Review*, 2025. Available from: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=5250219

[16] World Bank, *Towards Resilient and Prosperous Cities in India*. Washington, DC, USA: World Bank, 2025. Available from: https://www.sidalc.net/search/Record/dig-okr-1098643183/Description

[17] World Bank Treasury, *Capital at Risk Notes and Catastrophe Bonds for Disaster Risk Protection*. Washington, DC, USA: World Bank, 2026. Available from: https://dergipark.org.tr/en/pub/makuiibf/article/1793035

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