



# FINANCIAL INNOVATIONS FOR DISASTER RISK REDUCTION AND MANAGEMENT

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## Abstract

This paper talks about the various Financial Innovations for the Disaster Risk Reduction or Management. Disaster Risk can be predicted, estimated or sometimes not even imagined sometimes. But, the tools for risk management are many to mitigate or manage such predicted risks are many. In this article, among the various Risk Management techniques, only financial instruments which are innovative financial tools are discussed. It is also recommended about some modifications in the existing policies regarding disaster risk management with special reference to reinsurance.

**Keywords:** Disaster Risk Management, Reinsurance, Financial Innovations.

## INTRODUCTION

Financial innovations plays a crucial role in risk reduction and avoiding risk by providing efficient as well as effective solutions in addressing the financial risks related to the disasters. This paper discusses how financial innovations can contribute to disaster reduction and management. These instruments provide financial protection and quick access to funds for recovery and rebuilding efforts after a disaster. This essay examines how global financial innovations have responded to recent mega-catastrophes. With reinsurance as a potent platform, it offers suggestions for regulatory changes to enhance catastrophe management. Disaster management encompasses the four pillars of emergency management: planning and preparedness, mitigation, response, and recovery. (Bly, J., Francescutti, 2020)<sup>1</sup>. Many cutting-edge strategies and resources have been created for catastrophe risk reduction, (Takako Izumi, 2019)<sup>2</sup>

The three main concerns that could aid in removing these obstacles are networking, knowledge coproduction, and a larger role for academia, Izumi (2019). By incorporating disruptive technology into smart cities, the infrastructure required to potentially handle crises is improved, (Hafiz Suliman Munawar, 2022)<sup>3</sup>

## REVIEW OF LITERATURE

Panwar(2022)<sup>4</sup> in his article discusses various challenges to protect from disaster by using such funds like Mitigation Funds, arrangements for credit transfer of risk towards resilience at national and global level. Motlagh<sup>5</sup> in his study suggests some important guidelines in the policies for financing various pre and post disaster. Weltrungerhilfe(2024) <sup>6</sup>in the work “Leveraging Innovative financial strategies for effective Anticipatory Action(AA)”, discusses on various innovative financial tools utilization like DFR (Disaster Financial Risk) instruments through efficient DRM (Disaster Risk Management) approach. The article also talks about other innovative products like Central and Disaster Relief Emergency Funds and suggests that these tools would more support AA in reducing insolvency risk.



Ishiwatari(2019) discusses regarding progress in disaster Science mentioned that due to rapid growth in Urbanization, chance of getting exposed to more such risks due to Climate change in emerging nations. This paper also predicted that there could be more such risks like heat stress, water security, water end Vector borne diseases. This paper suggested DRR integration and long term plans to meet commitment towards future<sup>7</sup>.

Bandari(2022) says that even though disasters are uncontrollable, human cost disasters can be mitigated. The study suggested use of various technologies like Robotics, Drone, IoT, Mobile Technology, AI at three different stages like Pre-disaster, Disaster and Post-Disaster phase. To improve faster transmission of useful and timely information. Some of the latest technologies in predicting include Robo Cup rescue to find out simulated victims. in his article “Use of Technology in Disaster Management”<sup>8</sup>

Botzen(2019) discussed various models on catastrophe in estimating direct impacts and applications to estimate the effected population and potential natural disasters. Assessing a natural disaster's effects can help teach lessons for risk management policies.<sup>9</sup>

Kyne(2020) discussed that preparedness for the unforeseen disasters can make Everyone adjusts to the shocks from the outside world and returns to the disastrous event more quickly. The study proved that individuals encouraged for better preparedness enhance themselves for the valley's resilience to storm disasters<sup>10</sup>

Kunreuther(1999)discussed about the role of Public Private Partnership and explained the important role of insurance for dealing with such losses in the relevant policies who can bring together these people who are concerned with the earthquakes. <sup>11</sup>

Lan(2021), says that the frequency of natural disasters is increased. Annual frequency is between zero and 43 and mean is 1.9. The average fatality rate is 302, with a range of 0 to 0.224 million deaths.<sup>12</sup>

Huong and Joyce(2023) in “Business Resilience and Disaster Risk Management”, discussed that the magnitude of pandemic spreading across all places, public as well as private and civil sector. It disturbs business operations, management policies, supply chain and other operational activities. Additionally, it assesses how resilient the company is to risk from pandemics, one of the disaster types. In order to assist organizations become more flexible and risk-averse, new strategies should be investigated.<sup>13</sup>

Shakeri(2021) examined the effectiveness of the DM systems in both nations in order to pinpoint their advantages and disadvantages and offer suggestions for enhancing the current setup.<sup>14</sup>

Marcillo(2021), aimed to analyse disaster risk reduction strategies with reference to seven Spanish speaking South American countries and found that the region's strengths and weaknesses and serves as a basis to follow up on the 2030 Paris Agreement Agenda.

Ito(2022), Reinsurance is examined in this paper from the perspective of global risk sharing. 44 economies' cross-border reinsurance payments between 1982 and 2017-a total of 93 countries' disasters are the proposed new data collection. Furthermore, it is noted that in developed nations with limited fiscal room, exposed government catastrophe insurance without international reinsurance may cause expertise risk to turn into financial risk. <sup>15</sup>

Ricard(2016), in his case study on wildfires at Colorado between 2012 and 2013, Haitian earthquake, 2010. The study demonstrated how crowdsourcing is advantageous in today's internationally interconnected society, which includes social media and catastrophe

managers..16

Graveline(2022), research on 25 chosen businesses to comprehend many elements such as response, recuperation, readiness, and prevention.<sup>17</sup>

Dmuchowski(2023), studied to find out whether company's performance related to ESG funding or not.<sup>18</sup>

Gotze(2022)<sup>19</sup>, Insurance businesses employ the two financial tools that are available for risk management in the practice discussed on risk and insurance issues. In an ideal capital market, insurers ought to behave indifferently toward the two products. CAT bonds will process as effectively and due to the insured risk characteristics and market imperfections, as effectively as possible. This instrument is in high layers and has a minimal basis risk.

Enciso(2001), shows how the insurance and reinsurance companies and financial institutions can shift towards new methods to fund extraordinary or disaster risk in the capital markets. This research educates the investors a new measure of reducing portfolio risk through well diversified instruments including using catastrophe models.<sup>20</sup>

### **Objectives:**

- ✓ To find out the new approaches to Disaster Risk Management with specific reference to financial innovative tools.
- ✓ To suggest the corporates how to face the challenge of Emergency Funds.
- ✓ To analyse how to use technology for effective disaster response for each type of disaster
- ✓ To prove how the effective implementation of various innovative financial techniques helped in natural disaster management in many countries, in the global context

### **Need of the Study:**

The world's attention has been drawn to extreme weather catastrophes like the recent hurriicanes in North and South America including the Tsunami occurred in the Indian Ocean. It became evident after Hurricane Katrina that the United States needed to improve its ability to meet the security needs of these areas following significant natural disasters.

The nature of disaster risk is changing, with an increasing number of unpredictable events such as pandemics, climate events, and cyberattacks. These events require new approaches to disaster risk management that are more agile and responsive to emerging risks. In the traditional disaster risk management, there was lack of access to funding which can limit the effectiveness risk management methods. They were slow and bureaucratic, impeding the ability to implement effective and timely solutions. Southeast Asia's catastrophe risk environment has changed due to systemic risks, which have increased the frequency and severity of geological and hydro meteorological disasters, which are expected to rise from about 400 in 2015 to 560 annually by 2030,(Bisri, M. B., & Lutfiananda, F. ,2022)<sup>21</sup>.

These methods include emergency funds, insurance, and contingency planning. While these methods can provide some protection, they are not designed to cope with the magnitude of large-scale, catastrophic disasters. By increasing the frequency and severity of geological and hydro meteorological disasters, which are expected to rise from about 400 in 2015 to 560 annually by 2030, systemic risks have changed the catastrophe risk environment in Southeast Asia, (Edunjobi, T. E. (2024)<sup>22</sup>

**Types of Natural Disasters:**

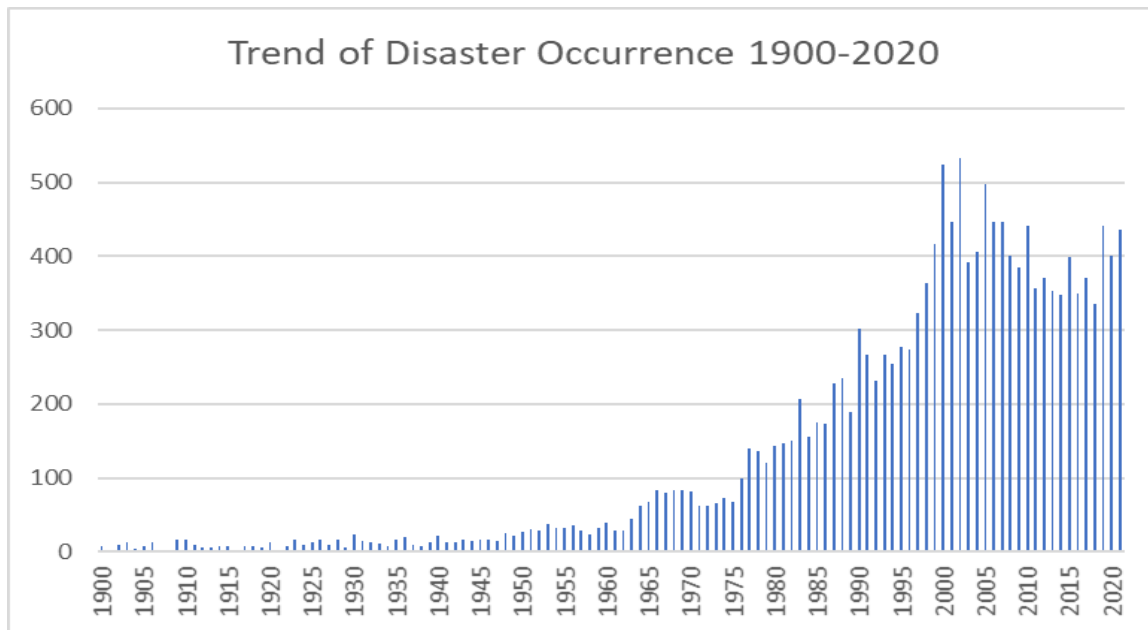
Catastrophic disasters have become more frequent and intense in recent years due to global climate change.

Given their location and economic size, small island states are particularly affected by the substantial economic effects of natural disasters, (Dayong Zhang, 2020)<sup>23</sup>.

We will examine floods as a disaster in detail and analyze the risks to the business and community. It is essential to identify a problem domain and work toward a real solution for handling the destruction and damage brought on by floods. Along with its limits, the use of technology for disaster response is also examined, (Munawar, 2020)

**Trend of Disaster Occurrence between 1900-2020:**

Indonesia's dedication to accomplishing sustainable and adaptable catastrophe management objectives in accordance with internationally accepted frameworks (Indira Rachel, 2024)<sup>24</sup>. The trend is clearly showing the rise in the occurrence of disasters and therefore, there is a need to face the challenges.

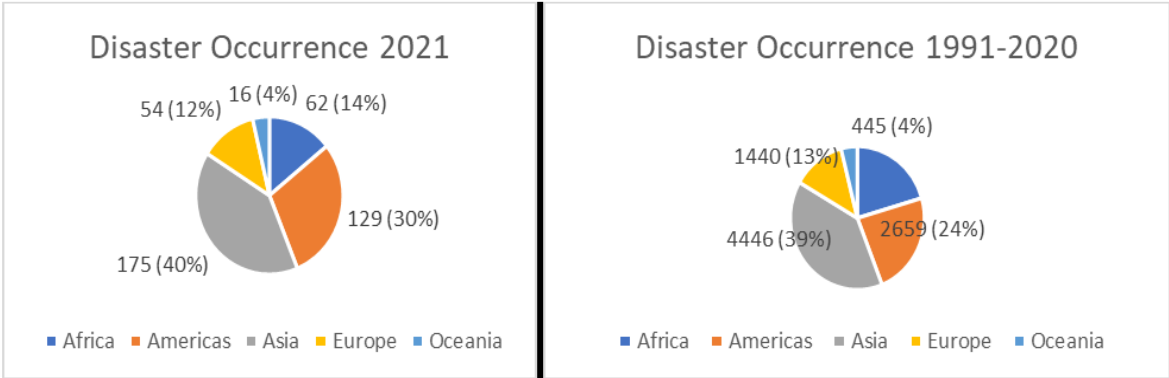


Source: [www.emdat.be](http://www.emdat.be)

**The global and Asian worst disasters in 2021: 2023**

According to research, the number of climate-related disasters has increased over the past 30 years, and their effects are become more severe. Extreme heat waves (like those in Canada in July) and cold waves (like those in France in April) were observed in several regions of the world in 2021 alone. According to research, the number of climate-related disasters has increased over the past 30 years, and their effects are become more severe. Extreme heat waves (like those in Canada in July) and cold waves (like those in France in April) were observed in several regions of the world in 2021 alone.

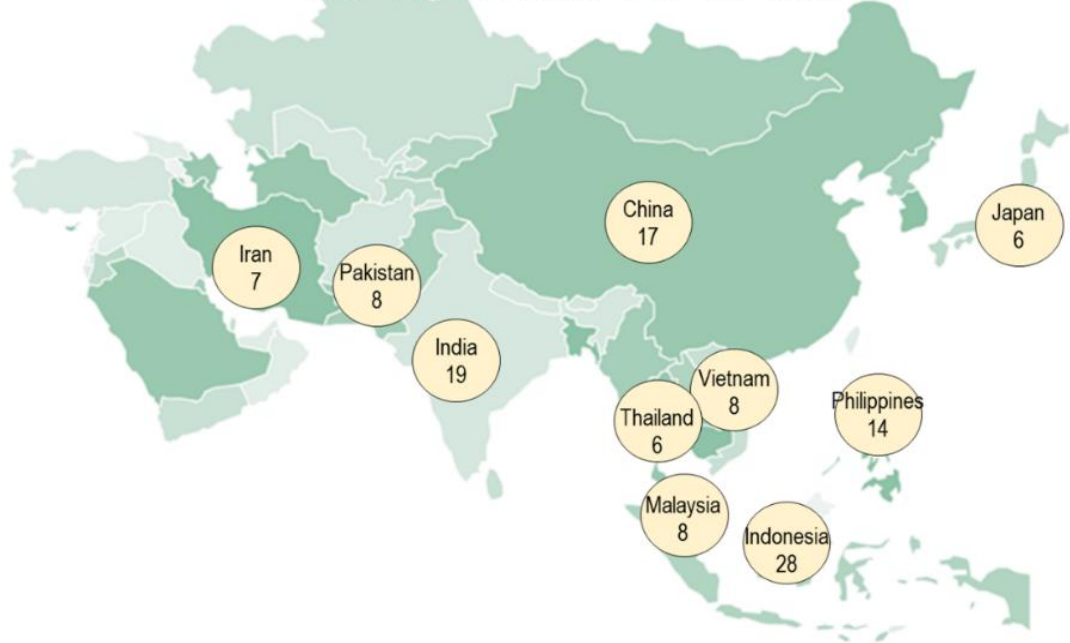
In 2021, the greatest number of persons impacted and the greatest financial losses are caused by climate-related disasters, especially floods, storms, and droughts.



Source: [www.emdat.be](http://www.emdat.be)

At 40% of all disasters worldwide in 2021, the Asian area had the highest number of disaster events. Given that 39% of all disasters occurred in Asia during the last 30 years (1991–2020), this statistic shows that the region continues to be the most disaster-prone in the globe.

**2021 DISASTER OCCURRENCE  
TOP 10 COUNTRIES IN ASIA**

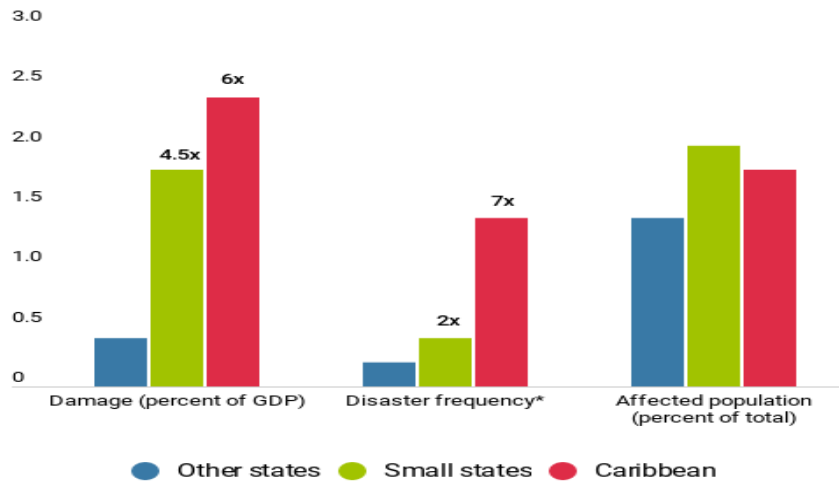


**Caribbean countries Disasters:**

Since 2010, more than 80% of the land is below the ocean, and most of the disasters are predicted more or less appropriate. The loss in the coastal areas is generally between US\$950 million to \$1.18 billion in almost the largest coastal cities in most parts of America and Caribbean cities.

**Highly vulnerable**  
**Caribbean countries experience frequent natural disasters with high human and economic costs.**

(frequency and effects of natural disasters, 1990-2014)



Source: IMF staff calculations.



**Financial Innovations:**

The study provides case studies of four nations: El Salvador, Colombia, the Dominican Republic, and Bolivia—to illustrate the many policy alternatives because natural catastrophes can leave governments with significant budget gaps when it comes to funding rehabilitation. Other ex ante funding sources are noted, such as insurance, contingent credit, and reserve cash, (Warner Koko, 2003)<sup>25</sup>

The field of natural disaster management is changing globally as a result of the successful use of numerous cutting-edge strategies.

Moinak Maiti(2024)also explained how it is possible in exploring innovative techniques for damage control during natural disasters.

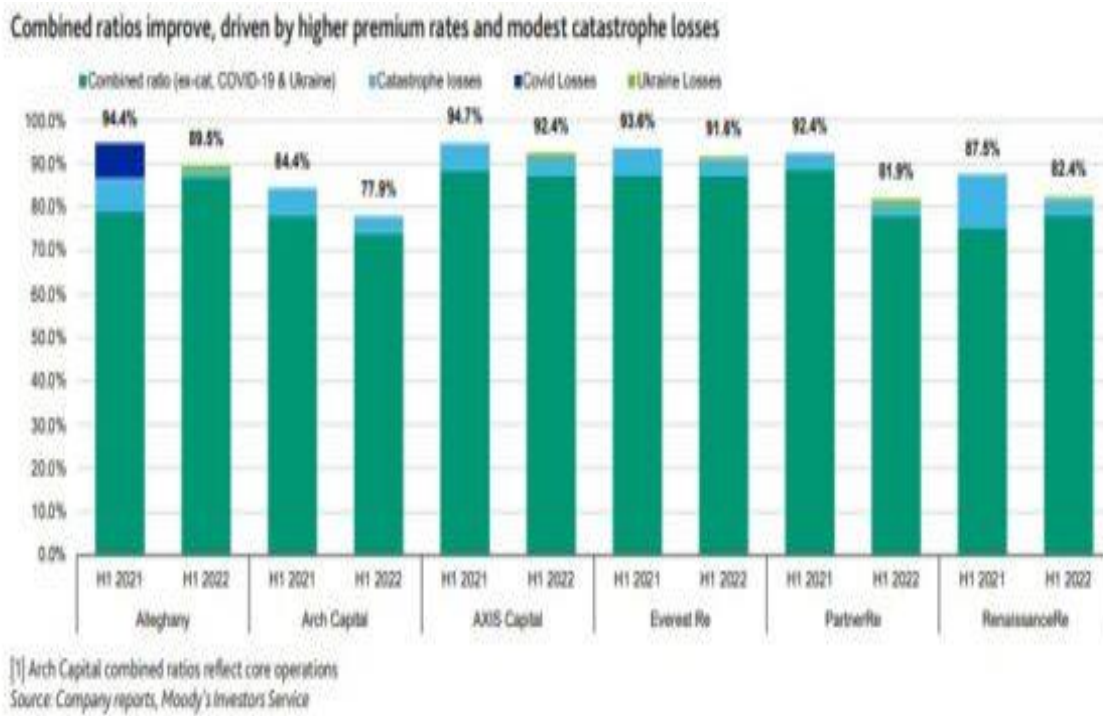
**Reinsurance:**

This identifies the root cause of risk associated with market failure and implies that public reinsurance is an economical way to restore insurance markets for catastrophic climate risks, , (Solomon, A., 2024)<sup>26</sup>

To start with Reinsurance as the most powerful tool of Disaster Management, the role has been significantly increasing. Reinsurance allows insurance companies to transfer some risks to reinsurers. When a disaster occurs, such as a major hurricane, earthquake, or flood, the insurance company's losses can be substantial. Reinsurance helps mitigate these losses by spreading the risk across multiple reinsurers. This allows insurance companies to pay claims and support the recovery process without suffering severe financial strain. Reinsurance provides additional capacity to cover these large-scale losses.

The figure shows the participation in catastrophe losses. In order to adequately prepare for and manage the effects of disasters in a changing climate, the International Panel on Climate Change (IPCC) has urged for striking a new balance between lowering the risks associated with

climatic extremes and transferring them (for instance, through insurance, (Joanne Linnerooth,2014)<sup>27</sup>



### Crowd funding:

Online platforms that facilitate crowd funding and peer-to-peer lending can be valuable tools for disaster response and recovery. They allow individuals, organizations, and communities affected by disasters to raise funds directly from a large number of people, bypassing traditional financial intermediaries.

This can enable faster and more targeted financial assistance, particularly in the early stages of a disaster. In recent years, crowd funding has emerged as an alternative method of financing entrepreneurial projects, community initiatives, and social causes. It democratizes the way funding is done and provides a platform for people to support creative ideas that they believe in.

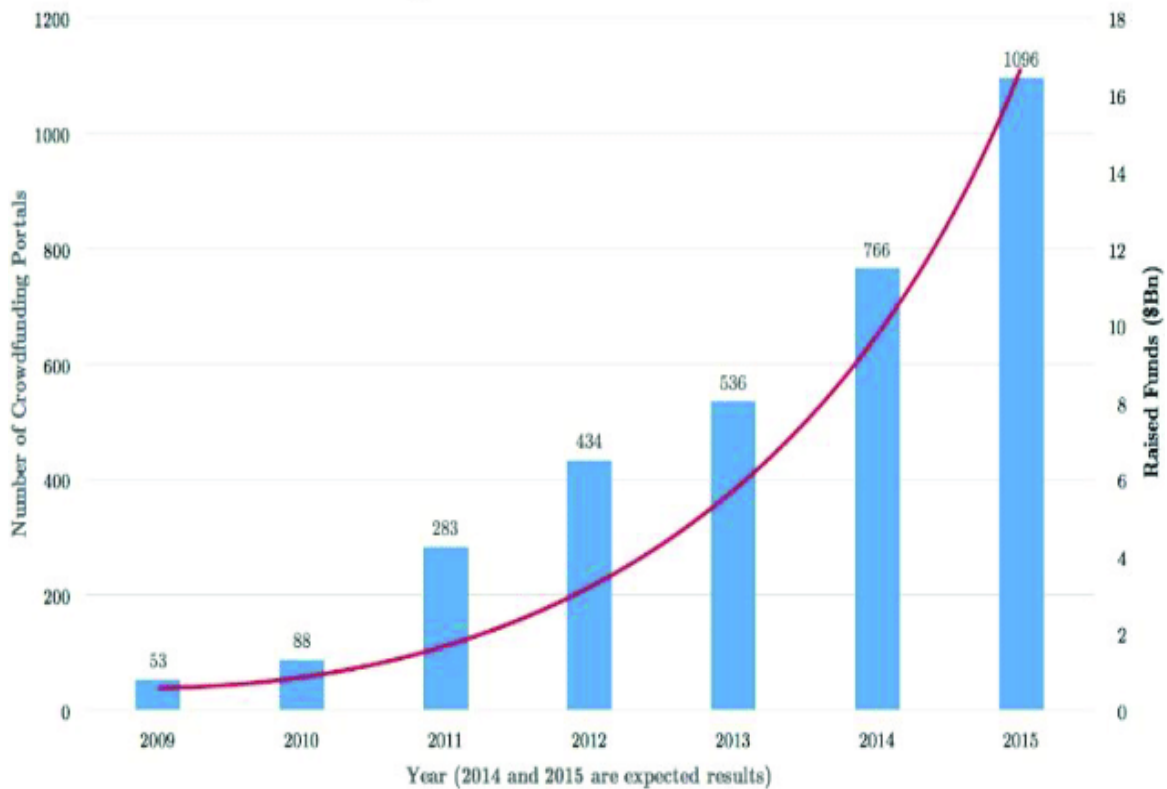
Crowd funding is a collaborative fundraising strategy that, usually through internet platforms, allows people or organizations to generate money by collecting modest donations from a large number of people. It may take the shape of equity crowd funding, in which investors swap shares in a business.

for their investment contributing towards the industrial development or Donation-Based Crowd funding in which donors give money without expectation of receiving anything in return except the satisfaction of contributing to a cause they believe in.

### The Growth of Crowd Funding

Crowd funding has become a powerful tool for raising funds, with tremendous growth over the past few years. The global crowd funding market is expected to grow to \$300 billion by 2025. According to Crowd fund Insider, the average success rate for crowd funding campaigns is 22.4%. Kickstarter, Indiegogo, GoFundMe are the biggest platforms for crowd funding.

### The Global Crowdfunding Market: Raised Funds and Number of Portals



Source: www. Statista

#### Resilience Investments:

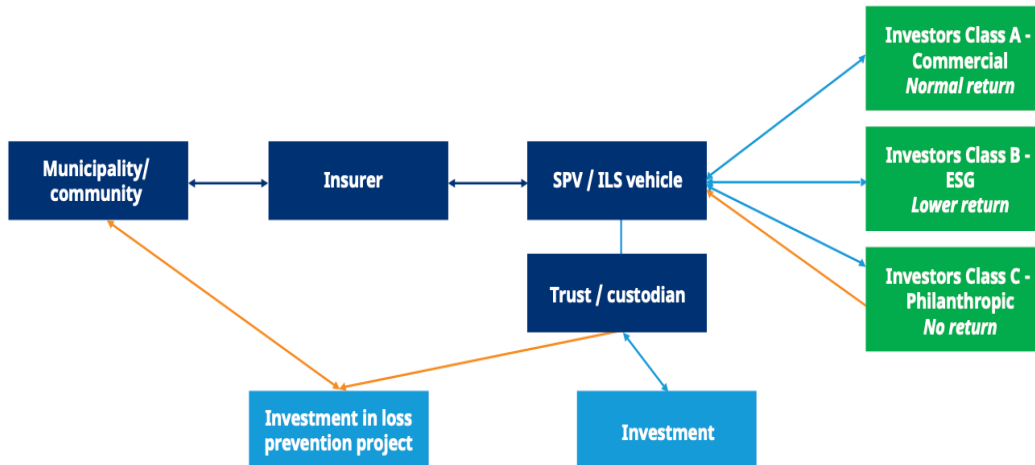
Resilience and disaster management are related concepts that focus on preparing for, responding to, recovering from, and adapting to disasters and their impacts. This investment avenue is going to become another path reaching \$ 5 trillion by 2025. In 2022, Three objectives are outlined in Climate Bonds for the Global Resilience Programme to find reliable, science-based investment opportunities that increase resilience; · to raise funds for reliable resilience measures; and · to quicken the pace and expansion of resilience investments by creating a supportive regulatory and policy environment.

Resilience critical elements are risk assessment, preparedness, response, recovery and adaptation. As of 2021, countries such as Norway, Denmark, and Switzerland ranked highly in overall resilience. We can name them as Global Resilience, Urban Resilience, and Private Sector resilience.

A new financial framework has been developed that uses an insurance-linked security (ILS) design to incorporate resilience, advanced finance for loss-prevention and mitigation, and local area-based insurance on climate risk or transferring the risk to get protection investing in the financial securities.



CRD Bond—Structure

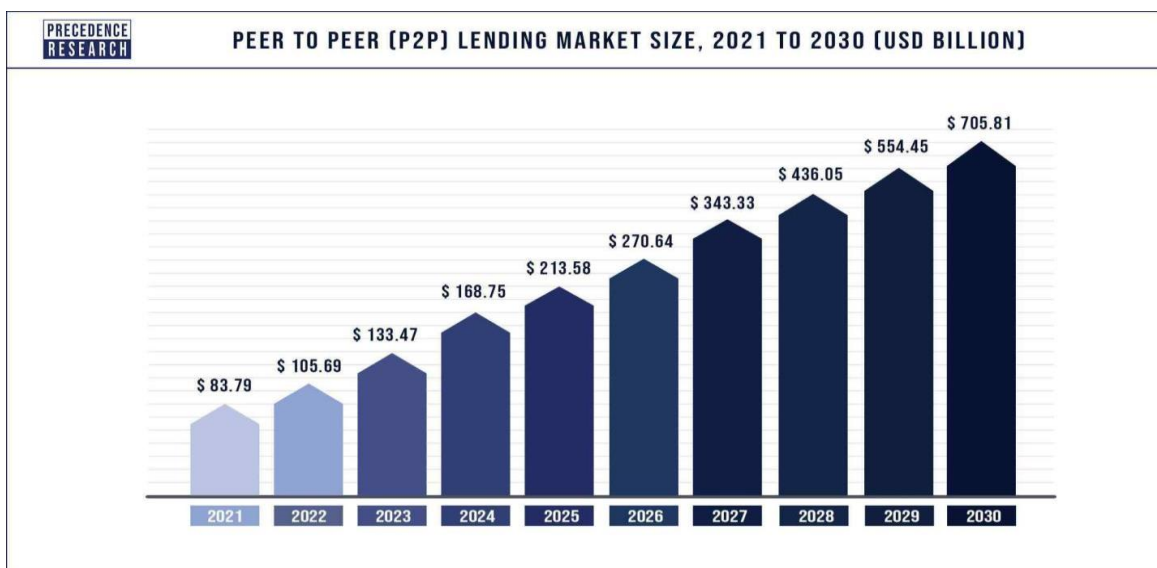


Source: Guy Carpenter

**Peer-to-Peer Lending:**

Without the assistance of conventional financial institutions like banks, peer-to-peer (P2P) lending links borrowers and lenders directly. Online platforms that pair borrowers and lenders according to their requirements and preferences make it possible. P2P lending eliminates middlemen, giving lenders the chance to increase profits on their investments relative to traditional savings accounts and giving borrowers access to funds at lower interest rates than traditional sources.

P2P lending platforms are subject to regulations in different jurisdictions. Regulatory frameworks vary across countries, and some markets have implemented specific rules to protect investors and borrowers. This method of lending plays a vital role in disaster mitigation management by providing the required access to various types of financial securities for affected individuals and businesses. P2P lending platforms can help bridge this gap by enabling lenders to fund recovery efforts directly, potentially speeding up the process of rebuilding and recovery. The future of P2P lending looks promising, with several potential developments on the horizon. Abdikerimova, S., & Feng, R. (2022). discussed much about the P2P lending and multiple and complex risks coverage insurance and mutual aid.<sup>28</sup>



**Impact Investing:**

In addition to financial gains, impact investors aim to produce positive social and environmental effects. By funding companies and initiatives that emphasize resilience-building strategies including early warning systems, infrastructure development, and disaster preparedness, they can contribute to disaster reduction.

These investments can help communities mitigate the impact of disasters and recover more quickly. The direction towards Impact investing can be observed through sustainable investing.

**Investment moving from Traditional Investing to Impact Investing:**

Source: [www.emdat.be](http://www.emdat.be)

**Resilience Bonds:**

More funding is needed for disaster mitigation and climate change adaptation since some hazard events are becoming quite common and repeated occurrences due to climate change. Numerous financial instruments are being developed to support initiatives that lessen the effects of hazards on local populations.

Resilience bonds are mentioned in the titles of several of these tools, and one of them is called Resilience Bonds, (Farinaz Motlagh,2024)<sup>29</sup>

**Cat Bonds:**

The market for catastrophe bonds, or "cat bonds," is expanding for both insurers and investors. Climate-related calamities have been on the rise globally, according to data. An example of an insurance-linked instrument is a cat bond, which shifts insurance risk from insurers to investors.

The bonds are triggered by pre-defined catastrophic events such as hurricanes, earthquakes, and other natural disasters.

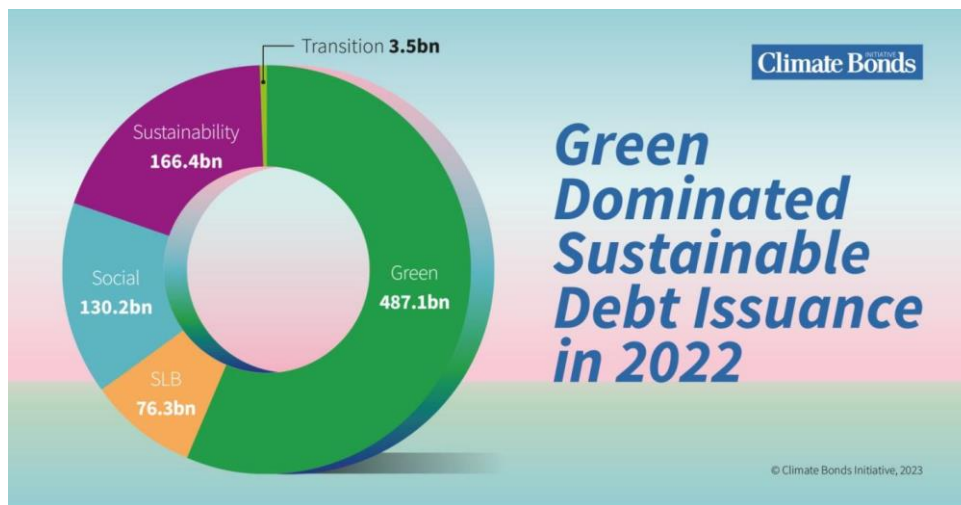
Cat bonds offer several benefits for both insurers and investors, including higher returns than traditional investments, diversifying portfolios, and allowing insurers to access alternative sources of capital and has grown consistently over the past few years, with over \$11 billion in issuances in 2020. Because of these bonds' low correlation to other asset classes and appealing risk-adjusted returns, investors' interest in them has grown. Similar to cat bonds, forward and swap contracts can be connected to catastrophic type of losses. By moving CAT bonds to the capital market, investors are now able to assume these risks and split them at a fair price for the risk associated, (Grabova, P,2024)<sup>30</sup>. Exchanges have connected cat-event futures and options contracts to aggregated measures of cat losses in order to standardize the process.

### Statistics of Cat Bonds Growth

Year	Issuance Amount (in billions USD)
2016	6.8
2017	10.5
2018	9.6
2019	11.5
2020	11.7

### Green Bonds

Insurance-linked securities can fund climate-resilient infrastructure policies and support to move towards a climate change protected economy, creating a new market for green bonds.



Source: Climate funds report-2022

The second consideration with cat bonds is that they may have the unintended but surprisingly pervasive benefit of improving the overall clarity of corporate bond ratings and analysis. Swaps and forward contracts can be linked to kitty losses, much like bonds. To standardize the process, exchanges have linked options contracts and cat-event futures to aggregated measures of catastrophic losses.

### Capital Markets in Catastrophe Undertaking:

Contingent Debt/Equity: An alternative to contingent debt is, of course, contingent equity. In the International Journal of Emergency Management, 1(1), 61-69, Torre-Enciso, I. M., and Laye, J. E. (2001) [Torre-Enciso, I. M., & Laye, J. E. (2001). Financing catastrophic risk in the financial markets.] introduced about the role of Capital Markets in Catastrophe Undertaking and explains about the underwriting of the catastrophe in the western countries during floods and earthquakes.

LIBOR plus a spread was used to pay dividends on the preferred shares. Direct investments in disaster underwriting are made by capital markets. In most Western countries, perils like earthquakes and floods, as well as infrastructure risks, are either underfunded or not covered at all. Underinsurance is the main problem in many parts of Africa, Latin America, and Central and East Asia, as well as outside of Japan. Hedging catastrophic risk requires disaster risk modeling. Boehmer, H. J., Doswald, N., Emerton, L., Friess, D. A., Arce-Mojica, T., Sudmeier-Rieux, K., & Walz, Y. (2021). In his paper, he described ecosystem-based disaster risk reduction and natural sustainability. [Sudmeier -Rieux, K., Arce-Mojica, T., Boehmer, H. J., Doswald, N., Emerton, L., Friess, D. A., ... & Walz, Y. (2021). Scientific evidence for ecosystem-based



disaster risk reduction. Nature Sustainability, 4(9), 803-810.]

It is important to note that hedging strategies for catastrophic risk should be tailored to specific circumstances and risk profiles. Consulting with experts in risk management, insurance, and finance can provide valuable insights and guidance in developing an effective hedging strategy.

## ARA net combined ratio

Six year average 100.3% (2017-2022)



Source: Aon / company reports

### Suggestions:

- ✓ Disaster effect reduction and recovery can be greatly aided by financial advances in disaster management. The following are some ideas for possible future financial advances and recommendations for putting them into practice: There is a great chance to meet this demand by increasing funding flows for resilience projects.

Investing in research and development can help identify and develop innovative solutions to mitigate catastrophic risks. This includes advancements in early warning systems, predictive modeling, medical treatments, and disaster response technologies. Societies can improve their ability to react to and recover from severe calamities. By being at the forefront of scientific and technical advancements. The existing realm of green investment can be extended to encompass resilience-building investments by giving the market precise definitions and sets of regulations. Investments that address the fundamental susceptibility of ecosystems and people to climate change will be part of this growth.

- ✓ , going beyond those that lessen the direct physical effects of extreme weather.
- ✓ The cat bond market provides a global investment opportunity, with issuances from various regions, including the US, Europe, Asia, and Latin America.
- ✓ AI-powered Crowd funding will allow for more targeted and personalized crowd funding campaigns, ensuring higher engagement and better outcomes.
- ✓ The number and severity of natural disasters continue to rise, increasing the exposure of governments, businesses, and individuals should be educated for the increase of exposure to face the challenge of financial risk.

- ✓ Financial Collaboration across organizations among different sectors should be increased, enabling more coordinated and comprehensive responses to disasters.
- ✓ More governments and businesses can adopt financial emerging technologies to enhance disaster risk management strategies to meet short term disasters.
- ✓ Reinsurers should employ sophisticated catastrophe modeling and risk assessment tools to evaluate the potential impact of disasters. By understanding and pricing risks accurately, reinsurers can provide appropriate coverage and help insurance companies prepare for potential disasters. They bring expertise in claims processing, risk assessment, and loss estimation.
- ✓ Reinsurers should invest in research and innovation to improve disaster management. They should collaborate with scientific and academic institutions to better understand and assess emerging risks.

### Findings:

The four pillars of emergency management—preparation and planning, mitigation, response, and recovery—are all included in disaster management.

- ✓ It is proved that the required modifications in the existing policies regarding disaster risk management with special reference to reinsurance helped in facing the challenges of disaster with financial preparedness.
- ✓ It is observed that by analysing the data of the frequency and severity of geological and hydro meteorological disasters, which are expected to rise from about 400 in 2015 to 560 annually by 2030, systemic risks will be minimizing the catastrophe risk environment in Southeast Asia.
- ✓ The various modern approaches mentioned should replace the traditional ones to make the Government and business prepared and face the challenges of the Disaster.
- ✓ It has been discovered that financial innovations in disaster management are very important to minimise the impact and occurrence of disasters and speeding up recovery. By increasing capital flows toward resilience investments, there is a great chance to meet this demand.
- ✓ It is found in many articles that investing in research and development can help identify and develop innovative solutions to mitigate catastrophic risks.
- ✓ In order to lessen the effects of disasters and speed up recovery, financial innovations in disaster management are shown to be extremely important. By increasing capital flows toward resilience investments, there is a great chance to meet this demand.
- ✓ The cat bond market provides a global investment opportunity, with issuances from various regions, including the US, Europe, Asia, and Latin America.
- ✓ AI-powered Crowd funding observed to allow for more targeted facing the disaster risks.
- ✓ It is very clear that there is still lack of awareness among the public for the increase of exposure to face the challenge of financial risk.
- ✓ Financial Collaboration across organizations among different sectors and among different countries would probably help in mitigating risk and better disaster risk management.
- ✓ When the governments and businesses can adopt financial emerging technologies to enhance disaster risk management strategies caan meet short term disasters.
- ✓ The active role of the Reinsurers is observed to find out the potential impact of disasters.



## CONCLUSION

The financial innovations can significantly enhance the financial resilience and response capabilities of individuals, businesses, and governments in the face of disasters. Using effectively, the Block chain technology, to enhance transparency, accountability, and efficiency in disaster management to track and distribute aid and donations, ensuring they reach the intended beneficiaries. The efforts of Data Analysts in designing the Predictive Modeling, can help assess and quantify disaster risks more accurately. By analyzing historical data, geospatial information, and other relevant factors, financial institutions and governments can better understand and minimize the potential economic impact of disasters.

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