

**Group Report on Optimizing EU Property
Insurance Pricing Through Disaster Data
Integration & Visualization**

**Big Data Analytics for Business
– EBUS633**

Submitted By: 19/03/25

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Student Declaration:

I confirm that I have read and understood the University's Academic Integrity Policy. I confirm that I have acted honestly, ethically and professionally in conduct leading to assessment for the programme of study. I confirm that the work I am submitting is my own. I have not commissioned production of the work from a third party or used artificial intelligence software in an unacceptable manner to generate the work*. I have not copied material from another person or source, nor committed plagiarism, nor fabricated, falsified or embellished data when completing the attached piece of work. I have not colluded with any other student in the preparation and/ or production of this work.

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1. Motivation

The insurance sector in the European Union (EU) has been increasingly relying on data-driven techniques for the decision-making process along the lines of assessing and pricing risks relating to natural hazards such as floods, wildfires, and earthquakes. (Srivastava, Malhotra, & Mukherjee, 2024). Traditional risk management methods struggle to accurately predict financial impacts, which can lead to low premiums, resulting in financial losses or overpriced premiums, making them less competitive (OECD, 2020). Given that the sector relies on accurate risk assessment, insurers need to adopt advanced analytical tools to comply with evolving regulatory frameworks and remain actionable. (European Commission, 2023).

Companies operating in the property insurance segment have vast in-house data related to insured assets and claim histories. Merging this with EU disaster data, while adopting visualization with prescriptive analysis the insurers can better understand dynamically set premiums based on current risk assessments, identify high-risk zones, more accurately estimate potential damages hence enabling fair and responsive premium modifications (World Bank, 2020).

Interactive risk maps can help identify flood-prone areas for effective policies (European Environment Agency, 2023). This makes the operation more accurate and profitable while allowing for proactive risk management to ensure compliance and, thus, enhancing market competitiveness.

2. Literature Review

Insurance companies face major challenges in using natural disaster data to develop policies. Climate change has led to increased natural disasters, making the insurance industry unstable. As a result, insurers must navigate increasingly uncertain risks, so pricing is often based on market conditions rather than actual risk (Tesselaar, Botzen, & Aerts, 2020).

Traditional models fail to manage extreme disasters, leading to underpriced policies or forcing companies to pull out of high-risk areas. The more significant problem is the utilization of historical disaster experience which doesn't consider the growing strength of weather events, causing sudden increases in insurance premiums (Asimit et al., 2021).

Inaccurate or outdated information will create misleading visualisations, and therefore decision-making will be flawed (Minano, Thistlethwaite, & Henstra, 2024). Furthermore, the nature of natural disaster information like meteorological patterns, geography, and socio-economic characteristics pose enormous challenges for data processing and analysis (Wilhelmi et al., 2024). Regulatory barriers and outdated policies make it difficult to address these issues because insurance companies are unwilling to change due to unclear guidelines (Lee, Lee, & Hong, 2022).

Despite these challenges, data visualization has transformed risk pricing and assessment models, though issues of fairness and effectiveness persist. Dynamic pricing improves accuracy but doesn't eliminate the risks of extreme catastrophes, which leads to unstable premiums. A better-regulated model, as suggested by Lee, Lee, & Hong (2022), could balance risk using tiered policies and deductibles, making the financial burden more fair and evenly shared. However, most pricing systems don't include these features, leaving policyholders and insurers exposed to changing costs and market uncertainty.

Many visualisation tools lack regulatory compliance metrics, making them less useful for EU insurers who must follow the Solvency II framework (Garayeta, De la Peña, & Trigo, 2022). This reduces their effectiveness in risk assessment and financial reporting. At the same time, while real-time analytics helps improve efficiency, they

also bring up privacy concerns, especially under GDPR, which controls how insurers collect and store personal data. Insurance companies use a lot of personal data, and sometimes this isn't properly regulated or monitored (Muley, 2018; Jaiswal, Gupta, & Tiwari, 2024).

These challenges highlight the urgent need for advanced visualisation technologies that not only enhance transparency but also provide policyholders and insurers with clearer, more reliable insights. Solving problems of bias, automation, standardisation, and data protection, newer techniques can promote a more inclusive, resilient, and compliant insurance culture across the EU.

3. Business Case

The EU has been progressively affected by the consequences of natural disasters (Kalfin, et al., 2022). Every year, floods, storms, and weather wreak havoc across the continent, yet many regions remain underinsured, exposing individuals and businesses to devastating financial losses.

Dataset from the 'European Insurance and Occupational Pensions Authority' (EIOPA) was merged with databases from the 'Centre for Research on the Epidemiology of Disasters' (CRED) and 'EM-DAT:The international database' ; in all cases databases were provided after being revised by the organizations so no data cleaning was further applied.

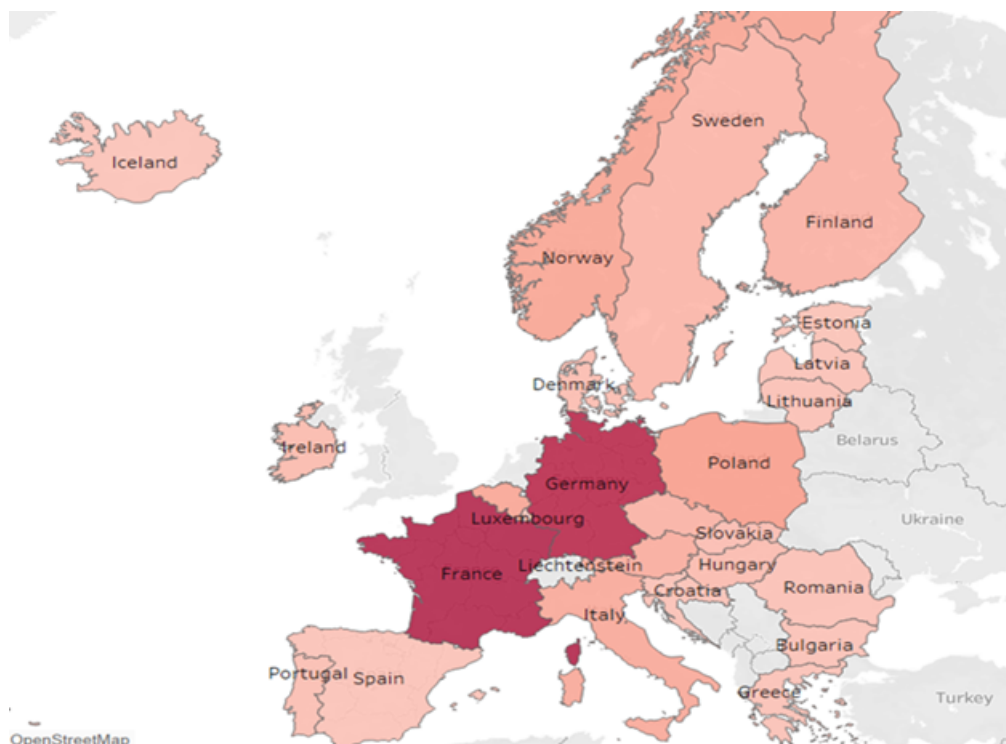


Figure 1: Insurance Protection per Country

Despite common regulations, there are significant disparities in insurance coverage in the EU. Countries like France and Germany experience frequent natural disasters and are surprisingly underinsured. The trend is less extreme but persists in Norway, Poland, and Italy.

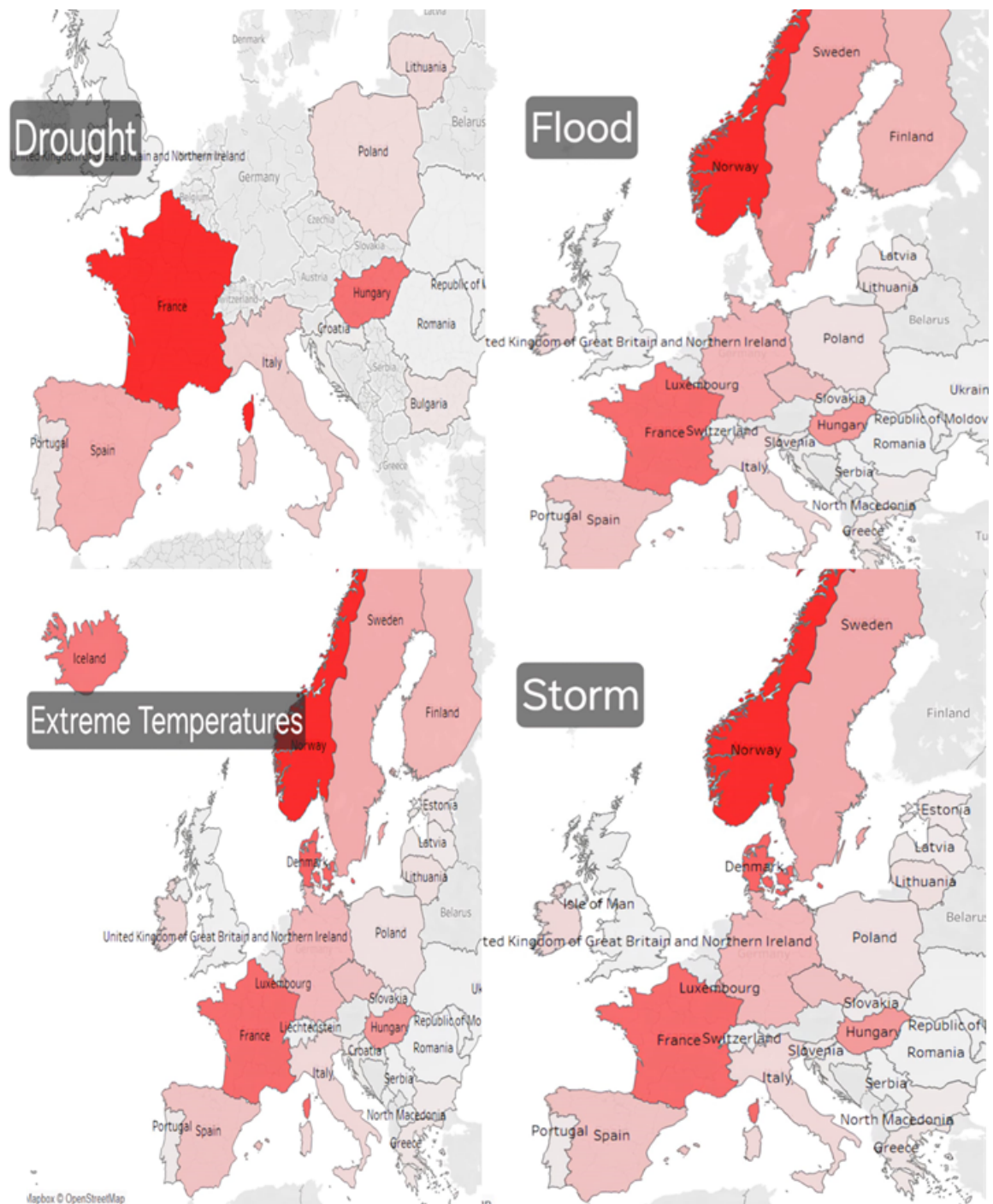


Figure 2: Frequent Risk Exposures

According to the European Parliament (2024) and verified by data, the EU is very susceptible to floods, storms and heat related disasters. France, Norway, and Hungary are among the most affected.

Economic Losses Vs Insured Losses

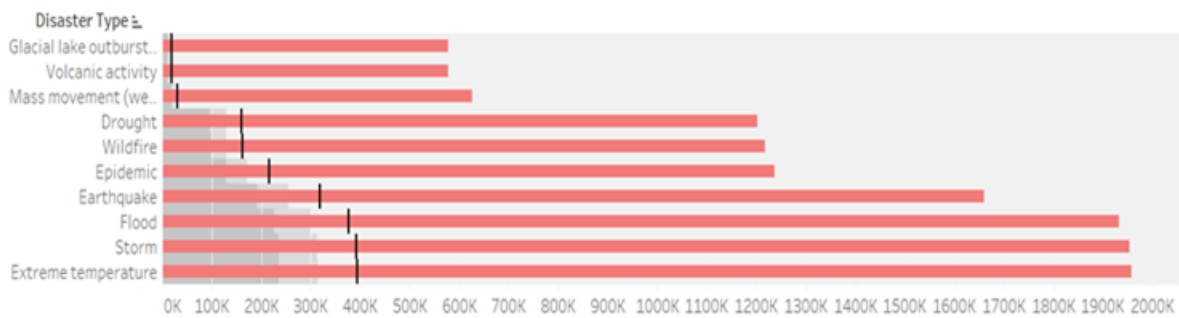


Figure 3: Insured losses compared to economic losses for individuals

Findings show a stark reality: no natural disaster is fully covered by insurance. Extreme temperatures, storms, and floods are the most financially damaging, yet they receive relatively better protection than others. The discovery opens the door for analyzing the 'Insurance GAP', measure that compares insured and uninsured losses:

Insurance_GAP

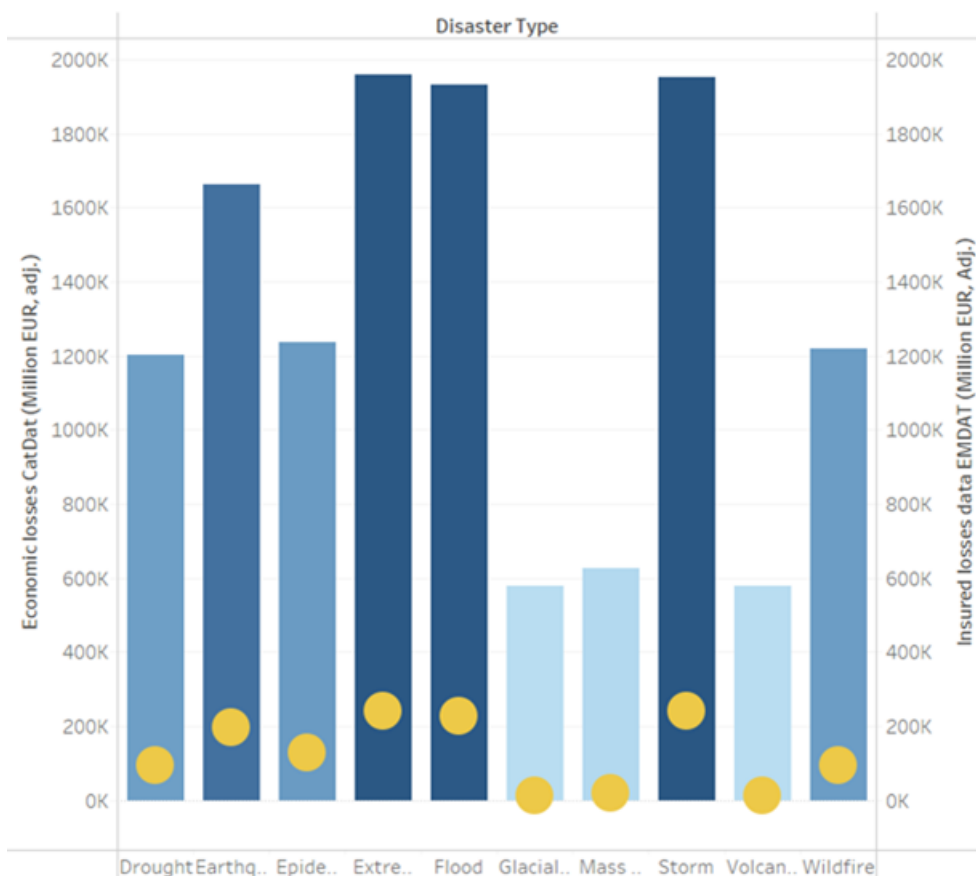


Figure 4: Uninsured losses Vs Insured losses (Insurance GAP)

Amounts not covered represent a potential market for insurance companies. However, entering 'frequent disasters' zones (more occurrence of bad events), together with

investment decisions and the price of the service are factors directly related to profitability (Hull, 2010), to understand better the importance of this last factor, further measures were created.

The 'Loss Ratio' was calculated as the 'Insured losses' (How much insurers have paid) in relation to the risk premiums they are allowed to charge given regulations gives an idea of how legal requirements can affect profitability in the sector.

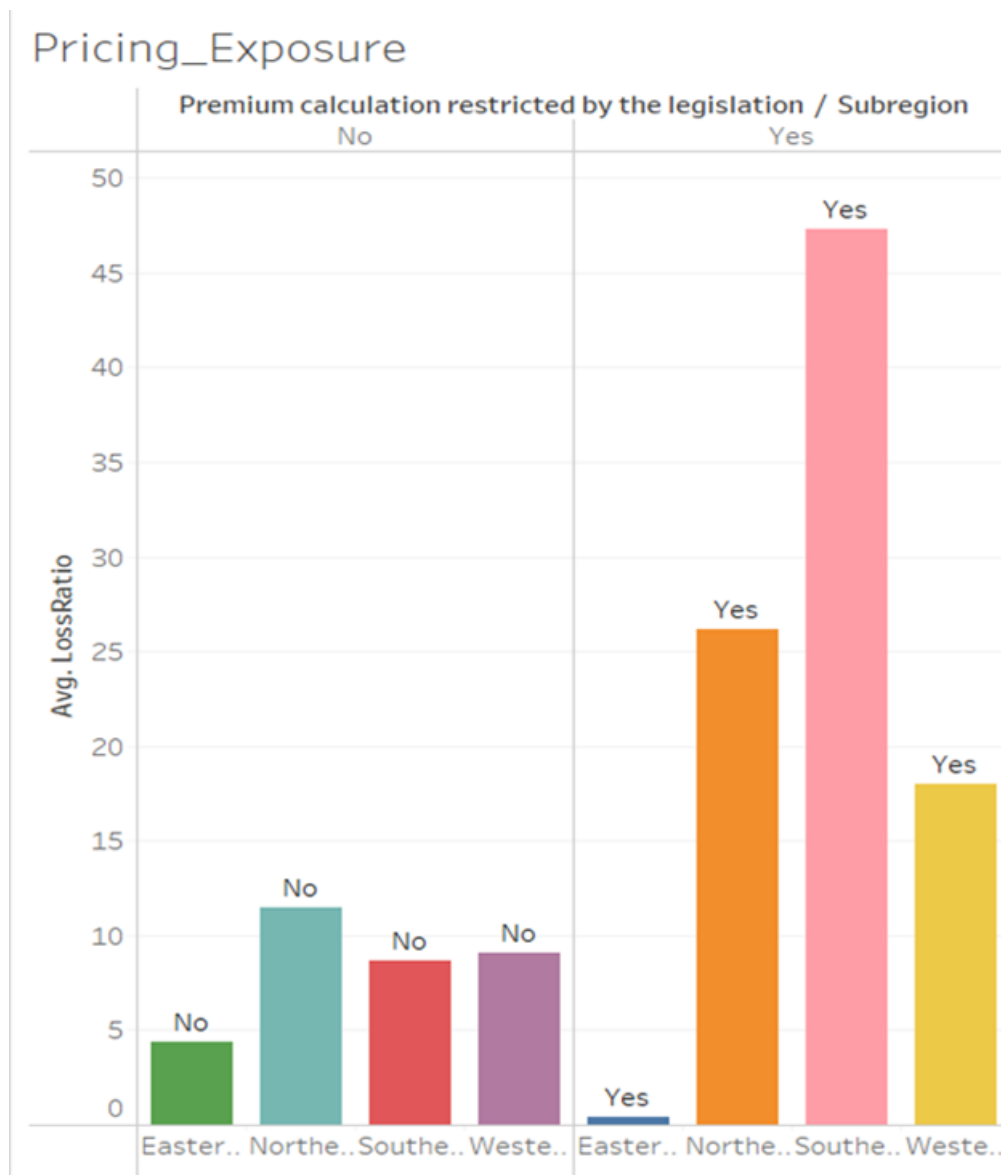


Figure 5: Pricing constraints

The analysis of risk premiums reveals that markets with government-imposed pricing restrictions tend to limit insurers' flexibility. While these policies protect consumers

from exorbitant rates, they also reduce insurers' ability to price contracts based on true risk.

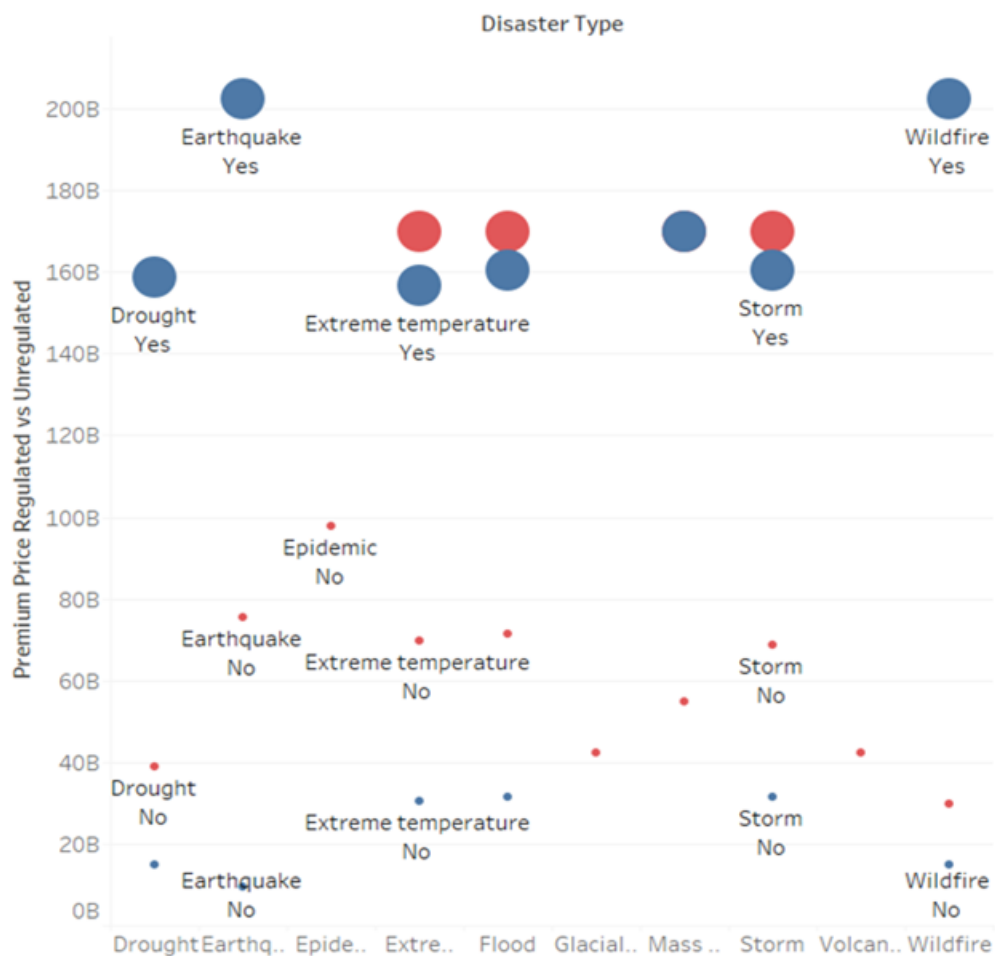


Figure 6: Price restriction effect

Surprisingly, the difference between regulated price limits and actual contract prices is relatively small, suggesting that some flexibility still exists in pricing. However, competition among insurers forces companies to keep rates within a narrow range, making it crucial to find new ways to optimize profitability while expanding coverage.

Natural disaster data in the EU was visualized together with major concerns of insurance companies in the economic and legal dimensions to derive the following business implication:

The EU is exposed to several types of natural disasters risk and in most cases, there is not enough coverage. This demonstrates the opportunity for insurance companies to expand their market share. However, it is important to consider price restrictions on risk premiums to balance competitiveness and profitability.

Certain disaster types (e.g., floods or earthquakes) receive significantly lower coverage despite high economic losses. Offering specialized policies in these areas can bridge this gap.

Another factor to consider is the possible lack of awareness among consumers as a reason for not being insured, a proper strategy can dedicate resources to increasing marketing efforts, target new potential clients and offer better tailored alternatives.

Not only can the EU benefit from insurance companies operating on its territory but also these firms because of Europe's strong market (Kondovski, 2021). Visualization techniques were applied to reveal insights about the current coverage and opportunities for insurers offering natural disasters coverage in the EU.

A considerable absence of 'Insurance protection' was identified but also price constraints in the most common types of incidents. Findings can suggest a necessity of improving consumer awareness while being conscious of markets where regulations are more flexible to appropriately balance profitability and affordability for insurance companies while giving adequate protection to their clients.

4. Barriers

In the use of data visualization to address climate risk protection gaps in the EU insurance market, several barriers may prevent effective adoption and utilization. To begin with, data quality and integration present significant challenges. Insurers face fragmented data from numerous sources, such as the EM-DAT International Disaster Database and the EIOPA Insurance Protection Gap Dashboard, which may complicate data cleaning and processing. Inaccurate or incomplete data leads to misleading visualizations that can compromise decision-making processes (Belhadi et al., 2023; Timms et al., 2022). Merging datasets on disaster incidents and insurance policies must be carefully conducted to avoid analysis distortions.

Second, competency and training of staff are key concerns. Proper utilization of sophisticated visualization tools such as Tableau requires expertise that most insurance firms have not yet developed. There is usually a steep learning curve for these technologies, and without adequate training programs, workers might not be able to leverage available tools in risk assessment and pricing models. The facts of the application of data-driven information across the insurance industry are well documented over time and they are a call for change (Tanninen, 2024). And then there will be resistance to new technology forecasted with organizational cultures valuing more the traditional method of working than data-driven information.

Third, regulatory limits and industry norms. The insurance industry is highly regulated, and the visualization project must operate under existing legislation that covers data privacy and consumer protection. Laws may deter data transmission and the possible ways that the data can be visualized or used, suppressing creativity and finding it hard to offer great images of stories (Mullins et al., 2021).

Possessing the ability to overcome these challenges will be the key to unlocking the full potential of data visualization to transform the risk management procedures of the insurance sector.

5. Recommendations & Roadmap

Based on the reviewed business case and identified barriers, the report outlines key recommendations and a structured roadmap for adopting visualisation tools in the insurance sector. While the dataset includes multiple countries, France, Germany, and Norway were chosen as recommendations due to their high exposure to certain natural disasters and large insurance gaps.

France faces high drought and storm risk, requiring geospatial analytics for drought monitoring, real-time storm tracking dashboards, and parametric insurance models for automated payments. The roadmap includes climate risk dashboards, satellite integration, AI-driven storm claims automation, and much more. Regional, anticipated risks, including the long-term impacts of climate and environmental change, need to be accounted for in policy pricing and coverage by insurers.

Germany, as a flood-prone nation, can benefit from AI-driven flood prediction models, urban flood risk heatmaps, and data-driven premium recalibration. The roadmap recommends launching interactive flood maps, integrating real-time weather, and expanding AI-driven pricing models. Insurers must also develop policies appropriately priced based on the level of disaster risk so that premiums reflect the actual potential damage from these disasters.

Norway's vulnerability to storms and extreme temperatures renders it in need of storm impact forecast dashboards, anomaly detection algorithms, and more climate-related insurance policies. The roadmap priorities extreme weather visualization, automated invoicing, and predictive climate models.

In order to encourage the uptake of insurance across the EU, a real-time dynamic pricing model, powered by machine learning, allows the business to increase premium precision and stay competitive. Clear visual messaging, like infographics and targeted digital marketing, can help raise awareness and encourage policy uptake. Study of previous data can allow companies to spot areas where individuals are not insured, plug protection gaps, and unlock new market opportunities. Organizations ought to utilize graphical information while engaging with policymakers to advocate for regulatory reforms in favor of adaptive pricing and customized national strategies.

6. Conclusion

This report underscores the growing need for natural catastrophe visualization technology in the EU insurance sector. To enhance risk management, insurers must integrate geospatial analytics, AI-driven predictive models, and parametric insurance platforms. These technologies improve risk pricing accuracy and offer a competitive advantage by enabling personalized and responsive policies. Additionally, long-term climate change forecasting is crucial for policy pricing, disaster protection, and marketing strategies.

Nevertheless, several challenges remain. The report does not address the financial and operational costs of adopting these technologies, which can vary significantly between insurers. Additionally, while it outlines a roadmap for implementing natural disaster visualization tools, regulatory differences across EU countries may require strategy adjustments. Moreover, the findings do not consider consumer trust and data privacy concerns, particularly regarding the use of personal data in predictive analytics.

Although these technologies present substantial opportunities, their practical implementation requires overcoming these barriers. Careful evaluation of costs, regulatory landscapes, and consumer trust issues is essential to ensure their successful adoption and integration within the industry.

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