Insurance Calculators for Geo-Disaster Premium Estimation: A Review

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**Abstract.** Accurate insurance premium estimation tools are critical for managing financial risks associated with geo-disasters such as floods and earthquakes. This study presents a comparative analysis of five web-based insurance quotation tools: FEMA’s Risk Rating 2.0, the Private Market Flood tool by The Flood Insurance Agency (TFIA), the California Earthquake Authority’s (CEA) Premium Calculator, GeoVera’s My GeoSource, and the Policybazaar home insurance calculator. Each tool was evaluated using a standardized property scenario to generate quotations and was assessed across four criteria: risk modeling, data integration, transparency, and adaptability. Risk Rating 2.0 and CEA’s calculators are government-backed tools that integrate publicly available datasets (FEMA flood maps, USGS seismic data). Private Market Flood provides flexible features like multi-year rate locks, while GeoVera offers precise location-based pricing using ZIP-code segmentation, and Policybazaar provides aggregation services. Findings show variation in risk modeling and data use, but pricing transparency remains limited. This review contributes to the evaluation of insurance pricing and highlight the need for more transparent, data-driven platforms for geo-disaster insurance premium calculations.

# INTRODUCTION

Geo-disasters, a subset of natural disasters, refer to catastrophic events arising from geological and hydrological processes. These events cause devastating impacts on populations and economies, resulting in significant loss of life, widespread destruction of infrastructure, and severe disruption of socio-economic activities [1]. Geo-disasters are becoming more frequent and severe due to urbanization, population growth, environmental damage, and climate change [2]. In 2024, geo-disasters resulted in around $320 billion in damages [3]. To address these challenges, governments and the private sector have responded to enhance resilience [4].

Insurance remains one of the most widely adopted mechanisms for transferring financial risks associated with geo-disasters [5]. However, for insurance to work effectively, it is crucial that premiums are calculated accurately and fairly[6]. Researchers have identified that effective premium calculators must incorporate diverse risk factors (e.g., disaster frequency) [7], high-quality data (meteorological, geological, socio-economic) [8],[9] adaptability (dynamic updates based on evolving hazard maps or risk data) [10],[11], and transparent methodologies (disclosure of internal risk factors and their impact on pricing) [12]. This paper evaluates five geo-disaster insurance calculators by comparing the above-mentioned factors, highlighting strengths and limitations.

# METHODOLOGY

This study compares five geo-disaster insurance calculators using structured comparative methodology as shown in Figure 1. The tools selected include both government-backed and privately managed platforms. Platforms were selected based on relevance to floods, landslides or earthquakes, geographic scope, and online quotation availability. The research began with a thorough literature review of academic studies, industry white papers, and publications from disaster risk management and insurance organizations. This review helped determine four key evaluation criteria that guided the analysis: the sophistication of risk modeling, the quality and range of integrated data sources, the transparency of premium determination logic, and the adaptability of each system to new information and evolving hazard patterns.

Five tools were selected for detailed examination: FEMA’s Risk Rating 2.0, TFIA’s Private Market Flood platform, the California Earthquake Authority (CEA) calculator, GeoVera’s My GeoSource, and Policybazaar’s home insurance premium calculator. Each system was reviewed using a standardized test scenario involving a mid-value residential structure situated in a moderate-to-high-risk zone. Platform functionalities were assessed through practical hands-on usage, supported by documentation such as official reports, technical guides, and regulatory filings. Findings were thematically analyzed to identify strengths, limitations, and shared practices. The resulting comparative matrix provides a consolidated view of how current platforms are addressing the complex challenge of geo-disaster insurance pricing.

A diagram of a comparison between two different types of analysis

AI-generated content may be incorrect.

**FIGURE 1.** The research methodology

# OVERVIEW OF SELECTED INSURANCE CALCULATORS

The National Flood Insurance Program (NFIP), established in 1968 and administered by FEMA since 1979, provides flood insurance coverage across all 50 U.S. states and territories. In 2021, FEMA introduced Risk Rating 2.0 as an advancement of the program, replacing broad flood zone classifications with a property-specific, actuarial pricing engine. Through its Direct-to-Customer (D2C) tool on FloodSmart.gov, users can input basic property data to obtain individualized quotes. The system utilizes national flood hazard maps, hydrologic data, and third-party catastrophe models to produce more risk-reflective premiums [13]. In comparison, TFIA’s Private Market Flood platform was launched in 2013, following the Biggert-Waters Flood Insurance Reform Act. It was among the first large-scale private flood insurance providers in the U.S., offering multi-year rate locks and coverage across more than 40 states. While the exact model is proprietary, Private Market Flood reportedly employs stochastic catastrophe models from firms like AIR Worldwide and CoreLogic, which simulate thousands of possible disaster scenarios to estimate flood risk more accurately [14]–[16]. In the realm of earthquake insurance, the CEA is a state-managed but privately funded provider of residential earthquake insurance available exclusively in California. The CEA Premium Calculator enables users to estimate insurance policy costs based on property characteristics, coverage amounts, and deductibles. It incorporates seismic data from the United States Geological Survey (USGS) and scientific inputs from the Pacific Earthquake Engineering Research (PEER) Center to adjust premiums based on local risk conditions [16],[17]. Similarly, GeoVera is a private earthquake insurer serving high-risk states such as California, Oregon, and Washington. GeoVera employs advanced, location-based risk modeling techniques that integrate ZIP-code-level segmentation, Modified Mercalli Intensity (MMI) bands, and GIS-based hazard data to assess seismic risk with greater precision [18],[19]. In contrast, Policybazaar, India’s largest digital insurance aggregator, does not underwrite insurance directly. Instead, it enables users to compare quotes from multiple insurers through a single interface, based on factors such as home value, construction type, contents, and location. However, it does not operate its own risk model and relies entirely on pricing structures provided by its partner insurers [20].

# COMPARATIVE ANALYSIS

This section compares five geo-disaster insurance calculators based on four key criteria derived from the literature review: risk modeling, data integration, premium transparency, and adaptability (Table 1).

In terms of risk modeling, Risk Rating 2.0 employs property-specific actuarial model that incorporates multiple variables such as flood frequency and elevation [21]. This represents a shift from traditional zone-based pricing toward individualized risk estimation. In contrast, Private Market Flood uses proprietary stochastic catastrophe models to simulate thousands of flood scenarios at the property level, enabling a probabilistic approach. The CEA utilizes a ZIP-code-based seismic model informed by ShakeMap and PEER datasets [17]. GeoVera applies a more granular, GIS-informed seismic model that incorporates Modified Mercalli Intensity (MMI) bands tailored to regional conditions [18]. Unlike the others, Policybazaar does not operate its own model but instead relies on pricing structures developed by its partner insurers.

Regarding data integration, Risk Rating 2.0 stands out for its use of diverse sources, including FEMA flood maps, topographic and hydrological data, and third-party catastrophe models. Private Market Flood’s data sources are not publicly disclosed, but based on available features, the platform appears to incorporate digital elevation models, historical flood claims, and property-level details [16]. CEA integrates USGS [17] seismic data and structural retrofit information via institutional partnerships. GeoVera draws from similar seismic datasets but complements them with localized hazard and property-specific data. Policybazaar’s data integration varies by insurer, as the platform functions as a digital aggregator rather than a direct underwriter.

Transparency refers to how clearly a platform explains its pricing—this includes disclosure of input variables, clarity of data sources, and whether the premium logic is interpretable to users [22]. While all platforms allow users to input property and coverage details and receive estimated premiums, none disclose the internal logic or weighting of variables used in their pricing models. Although platforms like Risk Rating 2.0 and CEA use publicly available data (e.g., FEMA, USGS), their pricing methodologies remain proprietary and undisclosed, limiting user understanding and independent verification. Policybazaar, as an aggregator, provides no insight into the premium calculation processes of its partner insurers, offering the least transparency among the platforms reviewed.

**TABLE 1.** Comparative analysis of geo-disaster insurance calculators

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Tool | Risk Modeling | Data Integration | Transparency | Adaptability |
| Risk Rating 2.0  (Government-backed) | Property-level actuarial model | FEMA maps, third-party models | Partial breakdowns shown, risk model / formulas not disclosed | Supports annual updates |
| Private Market Flood (Privately Managed) | proprietary stochastic catastrophe models | Not disclosed | Partial breakdowns shown, risk model / formula not disclosed | Adapt to changing flood patterns |
| CEA (Government-backed) | ZIP-based seismic model with ShakeMap | USGS, building data | Partial breakdowns shown, risk model / formula not disclosed | Uses UCERF3 seismic data |
| GeoVera (Privately Managed) | Proprietary regional seismic model using ZIP-code segmentation and MMI bands | USGS, local hazard data | Partial breakdowns shown, risk model / formula not disclosed | Rapidly adjustable |
| Policybazaar (Privately Managed) | None (relies on partner insurers) | Varies by insurer | Highly depends on 3rd party. | Varies. Depends on insurer |

The non-disclosure of pricing logic across all reviewed platforms is primarily due to proprietary and regulatory reasons. Insurers develop actuarial models as intellectual property, investing significant resources in data acquisition, research, and calibration. Publicly disclosing these models could compromise competitive advantage and expose the system to manipulation by users seeking to lower premiums without reducing actual risk.

Adaptability varies by platform architecture. Risk Rating 2.0 supports annual updates based on evolving flood hazard assessments, while Private Market Flood offers dynamic pricing structures such as multi-year rate locks. The platform also adapts to evolving flood exposure by recalibrating pricing based on regional catastrophe modeling trends. CEA adjusts premiums according to updated seismic datasets (e.g., UCERF3), and GeoVera frequently recalibrates rates in response to market conditions. Policybazaar’s adaptability depends on its network of third-party insurers and lacks centralized control.

In summary, Risk Rating 2.0 and Private Market Flood use property-specific flood models built on both public and proprietary data. CEA and GeoVera emphasize seismic risk, with GeoVera adding MMI-based regional detail. Policybazaar, as an aggregator, lacks its own model and depends on insurer-provided quotes. None disclose their pricing logic, limiting transparency. The platforms differ in risk modeling, data integration, transparency, and user interpretability, reflecting different design priorities and limitations in current geo-disaster insurance tools.

## Premium Comparison Using Standardized Property Profile

In Table 2, we present premium estimates generated by each platform. To ensure consistency in evaluation across all selected platforms, a standardized residential property was selected: a single-family home constructed in 2005 with slab foundation, located at 4160 Wilshire Blvd, Los Angeles (ZIP: 90010)—a moderate-risk zone relevant to both flood and earthquake hazards. The home was modeled with a building coverage value of USD 50,000 and contents coverage of USD 10,000 where applicable. Default deductible settings were used unless the platform required adjustments (e.g., GeoVera’s $100,000 minimum dwelling limit).

The location was used across FEMA’s NFIP quoting tool, TFIA’s Private Market Flood, CEA’s Homeowners Choice platform, and GeoVera’s Quake Select. For Policybazaar, a comparable property value was used in Bhopal, India, with local equivalent INR amounts based on FX conversion. These selections reflect both government and private tools, U.S. and international availability, and flood and seismic risk coverage types. Each platform was navigated using the test profile to retrieve base premiums under typical conditions.

**TABLE 2.**  Sample premium quotes for identical property profile across platforms

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Platform | Hazard Type | Coverage (USD) | Annual Premium (USD) | Notes |
| Risk Rating 2.0 | Flood | 50,000 (building only) | $381.77 | FEMA-backed |
| Private Market Flood | Flood | 50,000 + contents | $914.00 | Includes building code + loss use |
| CEA | Earthquake | 50,000 + contents | $914.00 | Standard deductible |
| GeoVera | Earthquake | 100,000 (building only) | $150.00 | 10% deductible; minimum allowed |
| Policybazaar | Multi-peril | 50,000 + contents equiv. | $12.80 | ₹1,063 converted at ₹83/USD |

# LIMITATIONS OF THE RESEARCH

This review is limited to publicly accessible tools, excluding those restricted to agents. It relies on platform-provided information, which may be biased in some cases. Most insurers do not disclose their internal risk logic or data weighting. While non-disclosure is justifiable from a regulatory and proprietary perspective, the resulting lack of interpretability for end-users poses significant challenges. Consumers cannot understand how risk factors affect their premiums, leading to trust gaps and reduced comparability across insurers. Post-quote processes such as claims handling and long-term outcomes are also not assessed. Further research should involve insurer collaboration, wider geographic coverage, user experience analysis and analysis of premium-payout correlation over time. For example, premium-to-payout comparisons using FEMA’s NFIP claims database or private insurance loss data could reveal whether higher premiums consistently provide greater financial protection, thereby validating or challenging current pricing models.

# CONCLUSION

The comparative analysis of various insurance quotation generator platforms reveals significant differences in their capabilities and features. Government-backed platforms like Risk Rating 2.0 and CEA serve large user bases and are supported by substantial documentation, including clearly identified data sources such as FEMA flood maps and USGS seismic data. Private providers like Private Market Flood and GeoVera emphasize product flexibility, with Private Market Flood notably offering rate-lock options. Policybazaar broadens accessibility in developing regions by aggregating insurance offering from multiple third-party providers. However, none of the platforms examined publicly disclose the full structure or formula of their underlying risk model.

To improve transparency without compromising proprietary models, insurers could implement explainable AI (XAI) frameworks that highlight which factors—such as hazard exposure, construction type, or historical claims—most influenced the final premium. Additionally, regulatory bodies could require standardized “premium breakdown” disclosures, similar to credit score explanations, to help users interpret premium results without needing full access to the model.

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