

Managing Wildfire Risk

Carson City, Nevada

Proposed By

- Anmol Fernandez
- Anvi Kothari
- Atharv Deo
- Mounika Thatipamula
- Rakshit Madan

precisely





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Executive Summary

The project addresses the challenge of accurately analyzing wildfire risks in Carson City, Nevada, to optimize insurance premium calculations. Leveraging data from Precisely and ArcGIS (1980–2022), it utilizes advanced clustering techniques to classify properties into distinct wildfire risk levels. This approach integrates external data on historical wildfire patterns, enhancing the precision of risk assessments and uncovering actionable insights for stakeholders.

The analysis employs K-Means clustering to group properties into risk categories based on metrics such as fire frequency, proximity to past incidents, and building attributes. Key findings indicate patterns that enable more dynamic and accurate risk evaluations. Recommendations include customizing premiums by risk cluster, incorporating additional variables like vegetation density, and scaling the model to other regions.

This scalable, data-driven methodology not only improves underwriting accuracy but also supports insurers in meeting regulatory demands while effectively managing wildfire-related risks. The project exemplifies how geospatial analytics and enriched datasets can transform the insurance landscape, leading to better customer outcomes and operational efficiencies.

Business Challenge

Insurance companies in Carson City face significant difficulties in calculating premiums due to the lack of precise risk data. Traditional methods, reliant on static data points, fail to incorporate historical wildfire patterns and geospatial factors.

Client's Process:

- Current practices rely heavily on manual assessments and insufficient datasets.
- Risk factors such as proximity to wildfire incidents and building materials are often overlooked.

Objective:

To develop a dynamic risk classification system leveraging external data and advanced analytics to enhance risk prediction and optimize premium pricing.

Literature Review

Industry Overview

The global insurance industry, valued at approximately \$7.4 trillion in 2022, is undergoing rapid transformation driven by cutting-edge technologies, evolving customer expectations, and the growing demand for data-driven decision-making. Historically reliant on actuaries and manual underwriting, insurers now increasingly leverage artificial intelligence, machine learning, geospatial analytics, and the Internet of Things (IoT). These innovations have enhanced operational efficiency, reduced costs, and improved risk assessment accuracy while delivering better customer experiences.

Precisely's Role in the Insurance Ecosystem

The Precisely Data Integrity Suite exemplifies this technological shift by enabling insurers to process and analyze accurate, consistent, and contextually relevant data. Its key functionalities include:

- **Data Integration and Quality Assurance:** Addressing challenges of fragmented datasets.
- **Geospatial Analytics:** Improving risk assessment for natural disasters and property-level risks.
- **Governance and Enhancement:** Ensuring reliable, actionable insights.

By incorporating tools like spatial analytics and geo-addressing, Precisely helps insurers identify high-risk areas and estimate wildfire impacts with up to 30% greater precision. This has resulted in cost reductions of up to 70% through automation and shorter policy issuance times.

Impact on Risk Assessment

Geospatial analytics, in particular, has transformed underwriting processes by integrating historical data and predictive modeling. For instance:

- **Risk Prediction:** Accuracy improvements of 20-30% using enriched datasets.
- **Customer Retention:** Tailored products and services enhance client satisfaction, improving retention by 30%.

Relevance to Wildfire Risk Analysis

Precisely tools are critical for tackling challenges specific to wildfire risk modeling. By ensuring high-quality data and leveraging advanced analytics, insurers can address pricing, compliance, and risk modeling issues more effectively. These capabilities position companies to meet increasing regulatory demands while navigating climate-related risks.

Data Overview

Precisely Dataset: It contains 37,395 unique properties that were affected by the wildfire that occurred in Carson City, NV. The dataset includes metrics such as severity ratings, frequency, risk description, room counts, building types, and more. To ensure accuracy and consistency, we eliminated duplicate address locations. For instance, an apartment complex with multiple units was initially listed across several rows. After this data cleaning process, the dataset was refined to 16,256 rows.

External Data: ArcGIS fire data (1980-2023) was used. To ensure high accuracy in matching latitude-longitude coordinates, we employed the Ball Tree algorithm, an efficient data structure designed for nearest-neighbor searches in multi-dimensional spaces. By organizing data hierarchically into nested "balls," where each ball contains a subset of points defined by a center and a radius, the algorithm significantly reduced the number of distance calculations compared to brute-force methods by pruning irrelevant regions during searches. This approach enabled a spatial join with a 95% accuracy, confirmed using the Haversine distance to calculate the distance between two points. This data helped us identify different incidents of fire that were not available in the Precisely database and facilitated the creation of a new variable, 'Distance from Nearest Fire (Km)'. Additionally, wildfire parameters and the area affected by each fire from this external dataset were utilized for further analysis, showcasing the Ball Tree's scalability and performance for geospatial matching tasks.

New Variable: Distance from Nearest Fire (Km) was calculated for 16,256 unique locations.

Outcome

A robust dataset for clustering and risk modeling, providing actionable insights into wildfire risks.

Data Analysis

Goal: Classify Properties Based on Wildfire Risk

- Clustering Method: K-Means Clustering
- Attributes Used: Risk, Fire Frequency, Distance from Fire, Number of Bedrooms, Building Type
- Number of Clusters: 4 (Identified with the Elbow Method)

Cluster Descriptions

Cluster 1: (Low Risk): 9,220 properties, average distance 3 km, low frequency (0.67).

Cluster 2: (Moderate Risk): 2,987 properties, average distance 2 km, moderate frequency (23).

Cluster 3: (High Risk): 3,928 properties, average distance 1.5 km, high frequency (34.5).

Cluster 4: (Low Risk – Unique): 121 properties, average distance 3 km, frequency (3.1).


Business Recommendations

- Expand Risk Assessment Factor

Incorporating factors such as vegetation density and proximity to fire stations into risk assessments directly benefits both Precisely and insurance companies. For Precisely, it demonstrates the versatility and scalability of its data integrity and geospatial analytics solutions by offering more granular insights into property risks. For insurers, these additional factors enable a more comprehensive understanding of wildfire exposure, resulting in enhanced underwriting precision and more reliable premium pricing. This leads to better risk differentiation, minimizes loss ratios, and positions insurers as forward-thinking leaders in the industry.

- Use of Clusters for Risk Management

The K-Means clustering technique provides Precisely with a clear use case for its advanced analytics capabilities, showcasing its ability to transform raw data into actionable insights. For insurance companies, clustering allows for targeted risk



management strategies, such as focusing resources on high-risk properties and designing tailored mitigation initiatives. This not only reduces overall risk exposure but also enhances operational efficiency. Additionally, insurers can leverage these clusters to improve customer engagement by offering personalized advice and services, strengthening customer loyalty and trust.

- Consider Various Ratings to Assess Risk

Introducing Damage Ratings and Mitigation Ratings into the risk assessment process highlights Precisely's capacity to integrate complex data points into cohesive frameworks, further solidifying its position as a leading provider of data-driven solutions. For insurance companies, these ratings provide a more nuanced and detailed understanding of property vulnerabilities. This enables insurers to offer tailored recommendations, encourage mitigation measures, and align pricing with individual risk profiles. The result is better alignment of premiums with actual risks, reduced claims payouts, and stronger regulatory compliance.

- Customized Insurance Premiums

Precisely's advanced analytics and geospatial tools play a pivotal role in enabling insurers to develop customized insurance premiums. By offering detailed risk insights, Precisely empowers insurers to differentiate their pricing strategies, thereby improving competitiveness in the market. For insurance companies, this approach helps attract a broader range of customers by demonstrating fairness and transparency in pricing. Moreover, it incentivizes policyholders to adopt risk-reduction measures, ultimately reducing claims frequency and severity. This creates a win-win scenario where insurers lower their operational risks and Precisely strengthens its reputation as a value-adding partner in the insurance ecosystem.

References

- Precisely Dataset
- [ArcGIS wildfireFire Data \(1980-2023\)](#)
- [Ball Tree Algorithm](#)
- [Haversine Distance](#)
- [BLM NV Wildland fire Perimeters](#)