GIS AS A DECISION MAKING TOOL FOR INSURER

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Abstract

Geographic Information System (GIS) is very effective tool in spatial and non-spatial database management. It has strong potential to play a vital role in decision making in insurance business. Some of the potential applications of GIS for insurance industry are presented in this article.

Introduction

Geographic Information System (GIS) is a powerful set of tools for storing and retrieving at will, transforming and displaying spatial data from the real world for a particular set of purposes (Burrough, 1986). It is a computer based information system used to digitally represent and analyse the geographic features present on the earth' surface and the events (non-spatial attributes linked to the geography under study) that taking place on it.

A GIS is typically made up of a variety of information systems like Cartographic Display System, Map Digitising System, Database Management System, Geographic Analysis System, Image Processing System and Statistical Analysis System (Fig.1). In many ways, learning GIS involves learning to think - learning to think about patterns, about space, and about processes that act in space.

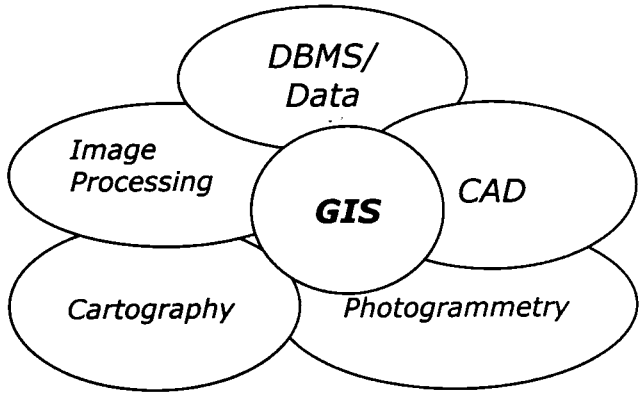

Fig.1: GIS and Related Disciplines

Geographic Data Types

Although the two terms, data and information, are often used indiscriminately, they both have a specific meaning. Data can be described as different observations, which are collected and stored. Information is that data, which is useful in answering queries or solving a problem. There are two basic geographic data types: non-spatial (attribute) and spatial (geometric).

Geographic data are organized in a geographic database. This database can be considered as a collection of spatially referenced data that acts as a model of reality. There are two important components of this geographic database: its geographic position and its attributes or properties (Fig.2). In other words, spatial data (where is it?) and attribute data (what is it?) are the components.

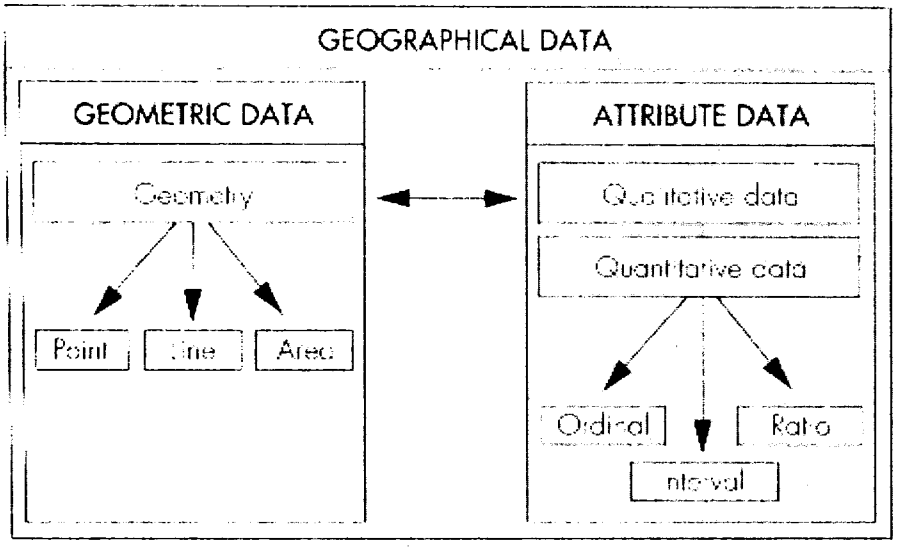

Fig. 2: Geographical data representation

Attribute Data

The attributes refer to the properties of spatial entities. They are often referred to as non-spatial data since they do not in themselves represent location information as shown below.

District Name	Area	Population
NOIDA	395 sq. km.	6,75,341
Ghaziabad	385 sq. km.	2,57,086
Mirzapur	119 sq. km.	1,72,952

Spatial data

Geographic position refers to the fact that each feature has a location that must be specified in a unique way. To specify the position in an absolute way a coordinate system is used. For small areas, the simplest coordinate system is the regular square grid. For larger areas, certain approved cartographic projections are commonly used. Geographic object can be shown by four types of representation viz., points, lines, areas, and continuous surfaces (Fig. 3).

1. Point Data: Points are the simplest types of spatial data. They are-zero dimensional objects with only a position in space but no length.

2. Line Data: Lines (also termed segments or arcs) are one-dimensional spatial objects. Besides having a position in space, they also have a length.

3. Area Data: Areas (also termed polygons) are two-dimensional spatial objects with not only a position in space and a length but also a width (in other words they have an area).

4. Continuous Surface: Continuous surfaces are three-dimensional spatial objects with not only a position in space, a length and a width, but also a depth or height (in other words they have a volume). These spatial objects have not been discussed further because most GIS do not include real volumetric spatial data.

Network: A network is a series of interconnecting lines and points along which there is a flow of information (e.g. network of rivers and roads).

All these spatial data features are shown in Fig. 3 with examples.

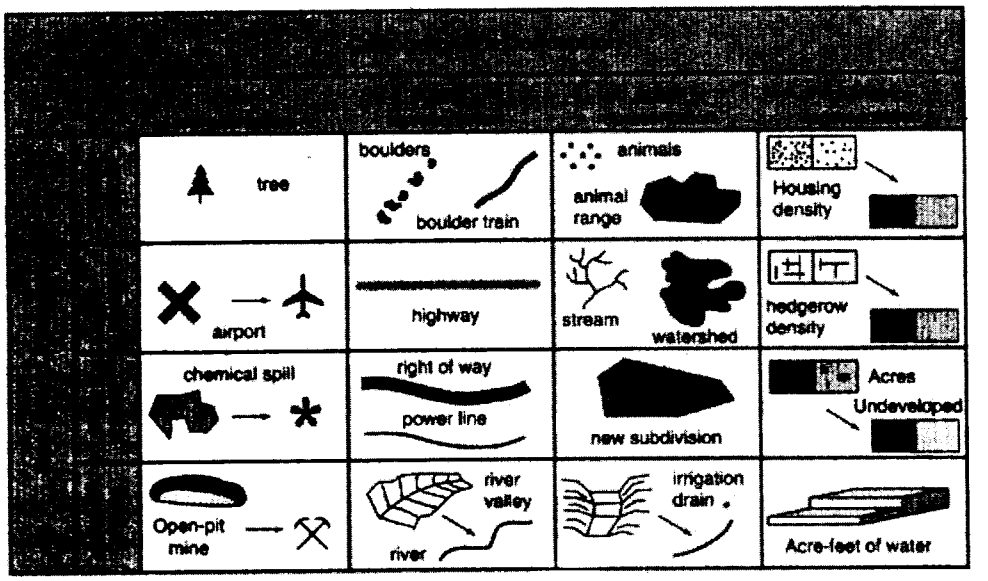

Fig.3. Spatial Data Representation

In this context, GIS is a database consisting of observations on spatially distributed features, activities or events, which are definable in space as points, lines, or areas. A geographic information system manipulates data about these points, lines, and areas to retrieve data for ad hoc queries and analyses.

POTENTIAL OF GIS

The main advantages of GIS are its flexibility, speed, accuracy, cost effectiveness and capability to handle large volumes of spatial and non-spatial data. In addition, the GIS can integrate the satellite data with attributes. It permits digital mapping of conventional analog maps. In past two decades, this has developed as an efficient modern tool in the domain of map analysis and decision-making.

The great appeal of GIS stems from their ability to integrate large quantities of information about the environment and to provide a powerful repertoire of analytical tools to explore this data. Imagine the potential of a system in which dozens or hundreds of maps layers are arrayed to display information about transportation networks, hydrography, population characteristics, economic activity, political jurisdictions, and other characteristics of the natural and social environments. Such a system would be valuable in a wide range of situations--for urban planning, environmental resource

management, hazards management, emergency planning, or transportation forecasting, and so on. The ability to separate information in layers, and then combine it with other layers of information is the reason why GIS hold such great potential as decision-making tools.

ROLE OF GIS IN INSURANCE INDUSTRY

Insurance companies are increasingly using GIS as an essential business tool (Thomas, 2000). A central goal of every insurance company is to mitigate exposure to risk by ensuring a wide spatial distribution of policyholders. It will not be a good business to only insure people in earthquake-prone Himalayan region, for example, as a single trembler could wipe out profits for years or even result in bankruptcy. GIS provides ways to use maps to analyze and understand how geography affects insurance business. It is an effective tool for all types of insurance applications including risk assessment, resource deployment, premium pricing, product marketing, and customer support and information systems.

GIS can be used to provide maps, latest Census demographic data and special functions to allow the insurer to tie in the data used every day in the work. With GIS, one can visualize data in new and different ways, unearth geographic patterns in the data, and convey information in a straightforward way.

For an individual, the risk of losing everything in a house fire or river flood is a terrifying proposition. Insurance policies help alleviate these fears by providing people with monetary security in the event of a catastrophe. Successful insurance businesses are based on the premise that individual contributions and risks can be pooled into a far less risky portfolio. To set a fair price so that policyholders don't over or under pay, insurance companies charge based on expected property loss in the event of catastrophe. GIS provides a framework for pricing the policies, especially for infrequent perils including earthquakes, tornadoes, floods, landslides, subsidence and cyclones. GIS also provides vital inputs required for crop insurance.

To perform pricing operations with GIS, insurers must first produce a model of the loss process for an area. It is normal to split the problem into two parts: hazards and vulnerability (Thomas, 2000). Hazard deals with the intensity, frequency and location of natural or manmade events giving rise to insurance claims, where as vulnerability quantifies the number and the amount of claims at a given hazard intensity. Hazards should be modeled using external data and vulnerability is best determined using historical internal claims data for events in which hazard intensities are known or can be modeled. By determining vulnerability from claims data and mathematically combining that information with hazard probability for a geographic area, insurers can derive a loss curve to estimate the total cost of disaster. From the loss curve, policy premiums can be

calculated as a percentage of the total loss. Using GIS to assess hazard probability is subject to the availability of number of model inputs and the data quality. For this reason, insurance companies typically rely on professional hydro-meteorologists, especially if climate change trends are likely to have a significant effect on a region.

Some of the potential applications of GIS for insurer are briefly presented next.

1. Worldwide Natural Hazard Atlas of Swiss Re (Cornelia Schmidt, 2003)

Reinsurance companies share the information on risks that direct insurance companies cannot carry alone. In addition to using GIS for research and analysis, Swiss Re (Swiss Reinsurance Company, Zurich, established in 1863) has developed a service, Catastrophe Network (CatNet), that disseminates information to direct insurers and other organizations via an ArcIMS application. It provides information on 5,00,000 locations, including risk rates and CRESTA Zones (i.e., insurance industry zones that separately evaluate total exposure in different areas), so users can more intelligently evaluate risks.

In USA, in 1999 alone, insured losses caused by natural catastrophes amounted to $24.4 billion of which $7 billion resulted from storms and earthquakes (Cornelia Schmidt, 2003). These ominous developments coupled with the globalization of the insurance industry have created an increasing demand for global information on natural hazards and ways of insuring against them. Swiss Re's Reinsurance and Risk division is helping meet this demand with CatNet, an Internet-based electronic atlas (www.swissre.com). Clients have comprehensive information on natural hazards worldwide, country-specific insurance information, and loss event data.

The atlas, powered by ArcIMS 3, includes typical identification, zooming, panning, and view extent tools and buttons for displaying legends and printing maps. Specific display and query functionality for natural hazard information is built into CatNet. Clicking the Hazard button displays the following list of natural hazards for which data is available.

- Natural perils
- Seismic hazard
- Volcanoes
- Wind hazard
- Flood hazard (selected countries only)

Historic event collection on earthquake epicenters, tropical cyclone tracks, and tornadoes as well as CRESTA Zone information is also accessed from the CatNet.

2. Maptitude: A GIS Solution for Insurance

Maptitude (http://www.caliper.com/Maptitude/Insurance/default.htm) is a GIS based software which provides ways to use maps to analyze and understand how geography affects the insurance business. Maptitude is an effective tool for many types of insurance applications. Some of the features of Maptitude are presented briefly to highlight the role of GIS in Insurance Industry.

➢ Assess the Risk Exposure

A portfolio can be mapped and then its exposure to various risks can be determined. For example, aggregate risks by ZIP Code, county, or around a given location such as a fault line or coast line (Fig.4). One can also identify overexposed and underdeveloped areas in this way.

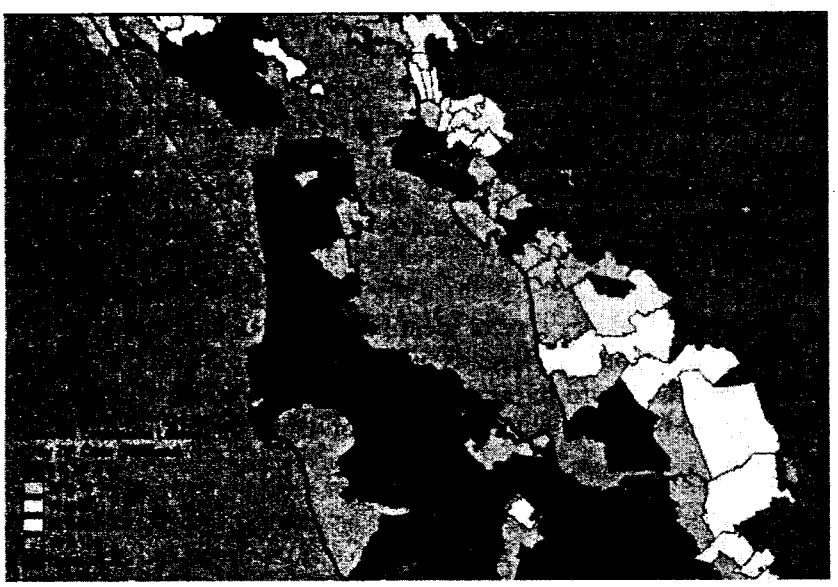

Fig. 4. Assess risk exposures such as the aggregate cost by ZIP Code for an earthquake (Source: Maptitude)

➢ Locate Customers and Resources

A GIS base map for the nation can be prepared with street wide details to pinpoint map locations anywhere in the country. On this map, information about policyholders, their policy limits, and other characteristics can be overlaid to enable assessing the risk exposure. This can also be used to determine a branch's area of influence and assist adjusters in the field to plan a series of visits (Fig.5).

➢ Insurance Underwriting

One can map locations that are prone to various risks or that have particular demographic characteristics. For example,

- Identify areas on a map with a high population density, a large concentration of rental properties, or other demographic characteristics that effect whether to underwrite a property for fire or burglary insurance.
- Determine if a home is in a flood plain (Fig. 6), near a fault, or is susceptible to fires (Fig. 7) and other hazards to make informed decisions on whether to underwrite a property for hazard insurance.

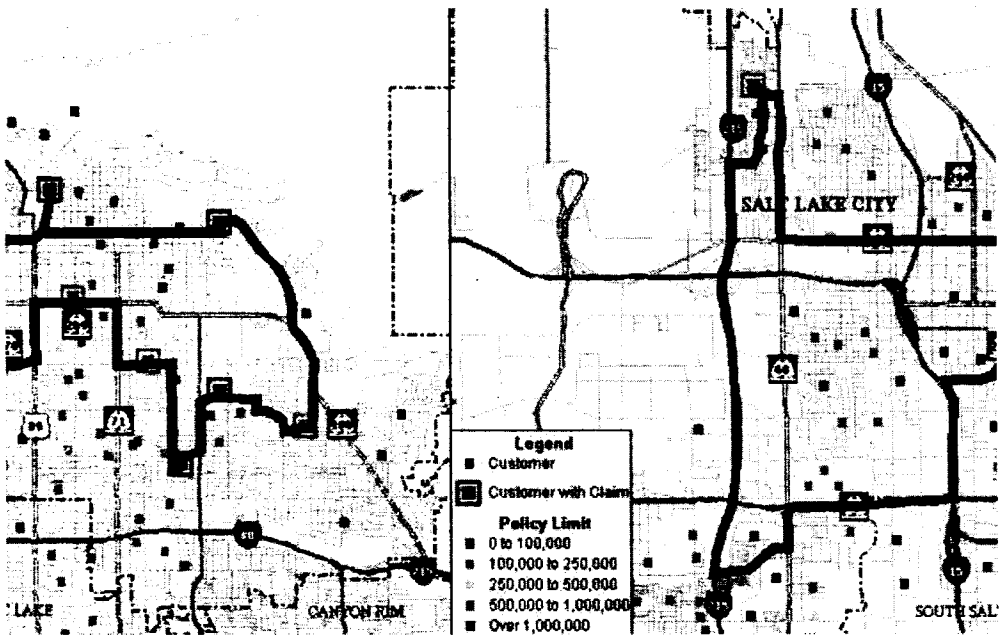

Fig. 5. Find policyholders and display information about them on a map or find a route for a claims adjuster to visit a set of them (Source: Maptitude)

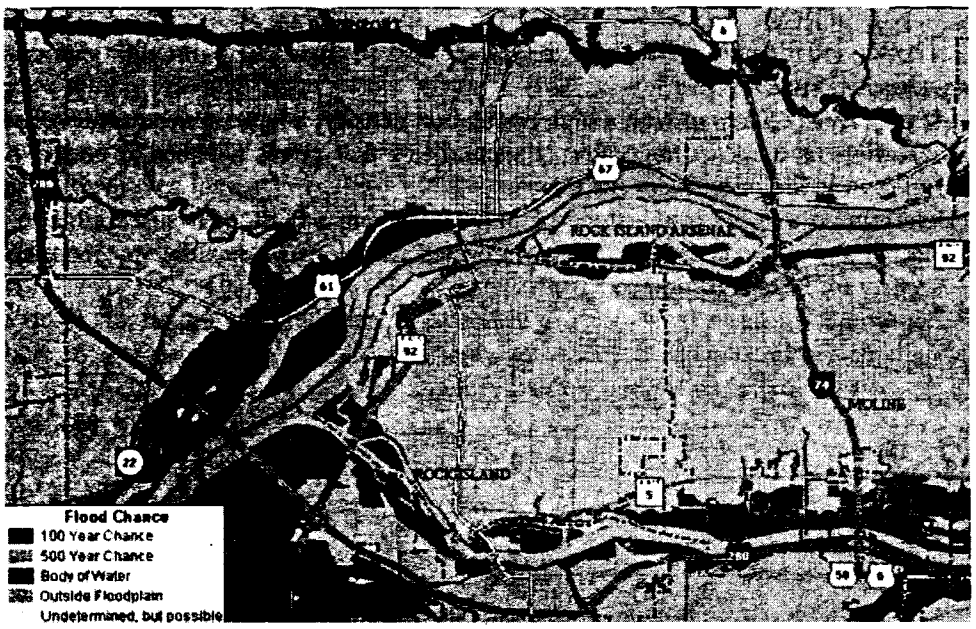

Fig. 6. Find policyholders and display information to determine if a home is in a flood plain or not (Source: Maptitude)

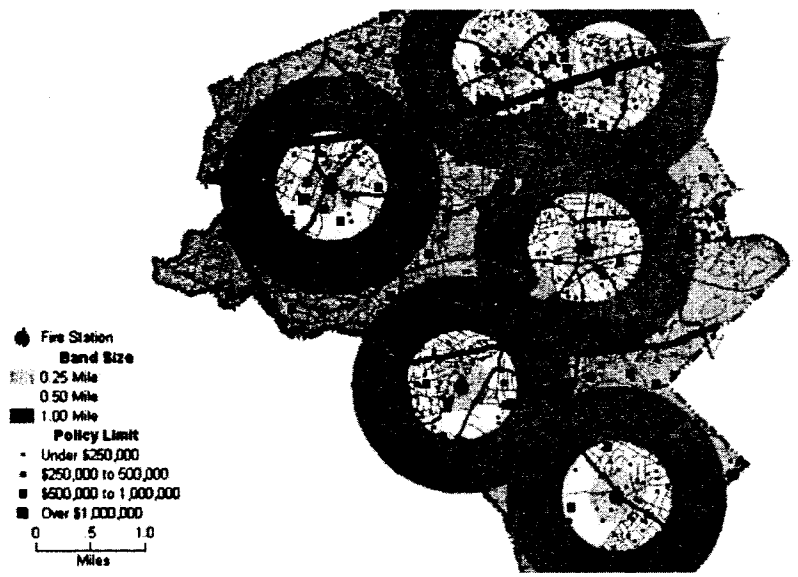

Fig. 7. Find policyholders and display information to determine the fire insurance premium for a home (Source: Maptitude)

➢ Find Marketing Opportunities

GIS can be used to include substantial demographic, social, housing, and income data from the census to identify locations with desirable characteristics for company growth. Analysis tools even provide opportunity to compare the demographics around several different sites to determine their market potential (Fig. 8). Similar analysis can be performed for any region of interest by creating the appropriate spatial database.

➢ Use Own Data and Models

One can create maps using own data and models. Data from a number of data sources already available with the insurer such as Access, Oracle or SQL Server can be joined and aggregated to any of the nationwide geographic files such as states, counties or PIN Codes or to own custom made territories.

➢ Provide Customers with Web-enabled Access to Information

Web enabled GIS is a specialized version of GIS that has special capabilities for designing and running interactive map applications and location-based services on the World Wide Web (WWW). Some of the features include

- Create a web-based interactive information system that allows auto insurance customers to find the nearest authorized auto repair center or health insurance customers to find the nearest specialist in a network.
- Create a hazard assessment information system for use by agents that maps a location and displays corresponding risk and pricing information.

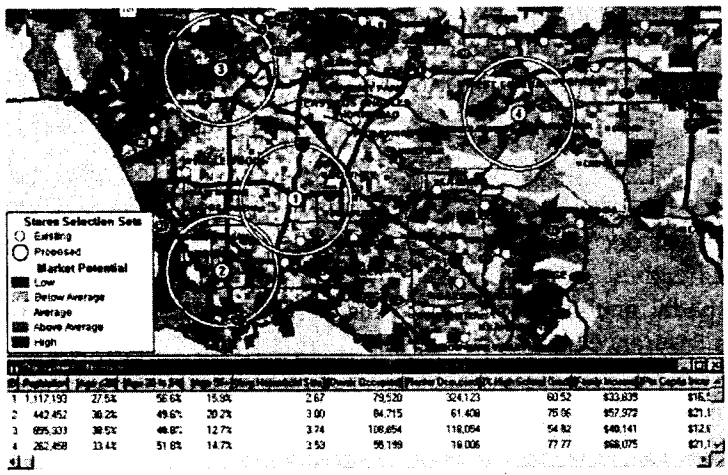

Fig. 8. Site analyses can be performed using the included Census data. The map and table show the demographics of the population within five miles of several locations (Source: Maptitude)

GIS functions can be further harnessed for modeling, data collection, data analysis, and specialized insurance applications. One can have a built-in interface to Global Positioning System (GPS) devices. With a GPS and a laptop, users in the field can create accurate geographic files. Create a database of fire hydrants for the most detailed fire hazard assessments, or get precise measurements of fields for crop insurance underwriting. Surface analysis and 3-D mapping functions can be used to build contour maps, which could overlay with soil analysis data to determine land slide risks.

3. Crop Insurance using GIS (RMA, USDA)

The U.S. Department of Agriculture (USDA), Risk Management Agency (RMA) administers the Federal crop insurance program (Fetters et al., 2002). Its purpose is to provide an actuarially sound risk management program to reduce agricultural producers' financial losses. GIS is used to provide mapping tools and products for decision makers and the process of integrating crop insurance policy data with GIS in order to visualize various aspects of crop insurance business. GIS is applicable to many areas of the crop insurance business. Some of the potential applications for the crop insurance business are (Fetters et al., 2002):

- Geographically code policy information to show where business is located, including: program participation, loss ratios (ratio of Indemnity paid to Premium collected) and causes of loss.
- Compare crop insurance participation with demographic information in order to identify under served and minority populations
- Define risk areas more accurately by analyzing physical factors that affect crop insurance risk
- Integrate crop condition information assessed from satellite remote sensing with GIS to identify the vulnerable zones of crop failure in advance (Nagesh Kumar, 2002).

Conclusions

Potential of GIS as a decision making tool for insurer are discussed with illustrations. GIS is very cost-effective solution that utilizes demographics, geographic data, and sophisticated spatial analysis tools as powerful methods to convey information and to analyze risk for insurance business.

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