Insurance Geographics

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When Hurricane Andrew slammed into the Florida coastline in August 1992, it was the crowning event in a run of more than $35 billion in catastrophe losses experienced by the property-casualty insurance industry during the preceding four years—more than the industry had experienced in the preceding two decades. The losses are staggering—and continuing. Since then, an additional $16 billion in catastrophe losses have been recorded. This comes to us together with news from hurricane observers that we are in an upswing in the danger cycle and with continued warnings from the reigning earthquake intelligentsia that its only a matter of time before *The Big One* hits.

While it is unclear whether catastrophes will actually continue at this pace and magnitude in the future, it is clear that insurers, reinsurers, and others have begun to focus more than ever on the dangers of concentrating risks within small geographic areas. The management of these concerns will be handled with support from geographic information systems (GIS). Catastrophe management is just one insurer need that will be addressed by GIS.

During the past few years ISO has researched the geography-related needs of property-casualty insurers and has participated extensively in GIS development activities. We analyzed underwriting and rating functions, reinsurance procedure, actuarial, claims and disaster response, marketing and market planning, and strategic planning functions. We found GIS to be a very practical and powerful tool for our industry.

GIS technology has already begun to significantly enhance insurers' operations and strategic planning activities. The ability to quickly and accurately locate risk addresses—often simply called *geocoding*—is providing more complete hazard information, more accurate information, is reducing operating expenses and, most important, is increasing revenue. Further, the ability to evaluate geography at all levels of detail, against scores of relevant hazards, demographic, and loss experience variables, is beginning to redefine insurer strategies for market expansion and reinsurance planning.

However, while the necessary GIS technology exists, implementation can be troublesome. It can be expensive for an individual insurer to assemble all the components—the geocoding software, address scrubbers, roadbase and boundary data, various modeling procedures, and the large number of hazard-related databases that a comprehensive system requires. Even after the GIS is developed, information must be continually updated and distributed to meet the needs of the organization's users.

A further cost that insurers must consider is associated with imbedding a GIS into their operations. Most GIS products - for example software from Strategic Mapping Inc. or MapInfo, and data bases such as the U.S. Census Bureau's TIGER files or various enhanced roadbases from companies like Geographic Data Technology and ETAK—require significant training to master. These products are geared more toward use by a GIS expert or trained research analyst than by underwriting or claims production areas. Because of such large overhead expenses a number of insurers have scaled down GIS development activities after realizing how costly their own comprehensive system would be. In response to this, a number of applications have been developed by vendors to achieve economies of scale. Whether to make or buy (or do both) is a decision many insurers are considering now.

GIS in the property-casualty industry, or what I will to refer to as *Insurance Geographics*, is here to stay. Property-casualty insurers have unique GIS needs. Our industry is different in fundamental ways from other industries—even others within the financial services. Hence the separate discipline.

Insurance Geographics can be thought of as an industry discipline, much like the actuarial or loss control specialties. As a discipline *Insurance Geographics* is concerned with important industry problems and opportunities, uses a defining set of tools and functions, and produces identifiable end products. This is admittedly one man's view, but you can consider it an argument for embracing available technology with immediate value for insurers.

This paper presents some of what ISO learned in our work with insurers and the leading GIS vendors about the applications of GIS technology, how this technology is put to work today, and what the future might bring.

Exploring Insurance Geographics

We see seven critical areas of exploration in *Insurance Geographics*:

1. Geocoding
2. Mapping of territories and boundary information
3. Geographic distance determination
4. Hazard loss modeling
5. Insurance "answers" and insurance maps
6. GIS/Database integration
7. Risk concentration analysis

I'll discuss each of these issues in turn.

Geocoding

Geocoding is a necessity in Insurance Geographics. A common insurance example will make my point. Property underwriters consider available fire protection by determining the Public Protection Classification code (PPC) for a risk address. This involves complex geographic processing, including fire district boundary definition, geocoding for the fire station, risk address, and water supply, distance calculations between multiple locations, and evaluating the geographic boundaries of automatic aid agreements.

These can be delicate GIS operations. Geocoding (or determining the longitude and latitude for) the risk address, the fire station, and the water supply demands the highest level of location specificity, not simply because each location itself is important, but because any geocoding error is compounded when the necessary distance calculations are factored in. Needless to say, postal carrier route, Zip Code, or census tract centroids--which form the basis of traditional GIS systems--suffer from placement error. Even with enhanced TIGER files (Topographically Integrated Geographic Encoding and Reference files, the primary street database developed by the U.S. Bureau of the Census) and sophisticated geolocation software, no one method will consistently yield an exact point geocode for every risk address attempted. And when the mark can't be hit directly, underwriters need to know how close the system has come to locating each part of the equation. An underwriter's GIS would need to present "confidence" information.

As of this writing, the author has supervised six insurer studies of Public Protection Classification coding error and has found error rates that range from 12% to 35% of sample portfolios. The direction of error—significant underrating— is clear. This is an industry concern that involves hundreds of millions of dollars.

The importance of point geolocation carries throughout Insurance Geographics.

Mapping of Territories and Other Boundary Information

I would turn your attention next to geographic boundaries. Insurers rely heavily on the ability to assign risk locations to small predetermined geographic areas and make their most basic business decisions—underwriting and rating—based on location. Perhaps no other industry is more dependent for its pricing and revenue on the specific location of its customers.

Insurers define territories in their legal rate filings for personal auto, homeowners and dwelling fire, commercial property, and others. Insurers further need to identify risk locations within the boundaries of coastal windpools or beach plans, or within earthquake, flood, or brush-fire prone areas. Property underwriters need to assign risks to the appropriate classified area for public fire protection, as discussed above.

State and local governments also define insurance-related territories for premium taxes and at least six states use unique fire district boundaries to define tax allocations. Some states are quite vigilant in auditing insurers' compliance and assess fines for failure to allocate premium tax payments to the correct taxing districts. Other states carefully audit existing policies to ensure that risks are correctly assigned to insurers' territories that have been legally filed with the state.

Finally, insurers have a variety of underwriting and loss control data available to them at the census tract level of observation. Detailed information regarding the frequency of major types of crime, for example, is available from companies like CapIndex and ISO, and can be used with correct the risk address geocode and identification of the particular census tract in which a risk is located.

It is not uncommon for a single risk location to be associated with a half dozen or more overlapping territories. While some territories are defined by clear and current political or statistical boundaries, many are defined in terms of geological data, street-level data, or historical boundaries which must now be interpreted at the street level.

Geographic Distance Determination

The ability to determine distances between geographic entities is intrinsic to GIS technology. Consider the three basic geographic entities in a GIS: points, lines, and polygons. A point is a specific location like a risk address or a fire station. A line can represent a street or part of a coastline. And polygons are any enclosed areas like territories, census tracts, counties, or interpolated Zip Code boundaries. Once any of these entities are loaded into a GIS' database, the system can easily determine distances between them, e.g., calculating the straight line distance from an Outer Banks beach house (a point) to the Atlantic Ocean (a line).

Insurance industry professionals need to determine various geographic distances. Regulators and underwriters evaluate potential storm and wind blown water damage by determining the distance from the risk address to large bodies of water like the oceans, the gulf, the Great Lakes, or large bays. The distance from a risk location to the paths of historical storm events like hurricanes and tornadoes is an important component in catastrophe planning and is used in products from Risk Management Solutions, EQE, Applied Insurance Research, and ISO.

Automobile insurers can verify drive-to-work distance. ISO's personal auto statistics show that more than 70% of personal auto risks are classified for "pleasure use," which is the rating class assigned to insureds who drive less than three miles to work. But published research indicates that about one-third of automobile owners consider it to be acceptable to underestimate driving mileage in their insurance applications. Such conflicting statistics suggest significant underpricing, and ISO has conducted research with a number of insurers that supports this suggestion. Vendor products like Equifax' HomeWork utilize powerful GIS technology and delivery platforms to provide accurate information to insurers during application processing.

Another important distance measurement for *Insurance Geographics* relates to a risk's proximity to environmental hazards. In the near future, we believe as much as 30% of all commercial underwriting, and a significant portion of personal lines underwriting, will involve assessment of this hazard. The environmental problem has been characterized as a *black hole* for insurers that might represent one of the largest threats ever. Banks have already felt the pain of loss and have reacted by including environmental assessment as a part of their normal business operations. They are concerned with protecting the collateral value of real estate, helping borrowers remain solvent, and informing trust officers whether they should accept responsibility for real estate or businesses.

Insurers are beginning to conduct environmental assessments too, in part due to a 1993 requirement by the Securities and Exchange Commission to include details of their exposure in their financial reports. The American Society for Testing and Measurement (ASTM) is currently working to define assessment criteria for insurers and such assessment will include determining actual and proximate hazards to the risk. ISO is serving on ASTM committees now to consider such standards. The three major suppliers of environmental reports--Environmental Data Resources, Environmental Risk Information and Imaging Services, and Vista Information Solutions--will undoubtedly respond to the need.

The *Insurance Geographics* specialist needs to combine technology and data to produce decision making information. Distance determination is simply part of the technology.

Catastrophe Loss Modeling

Risk locations exist in proximity to such various geological and geographical hazards as mines, sinkholes, flood zones, earthquake prone areas, urban-wildland interface areas, and other hazards. A GIS which can bring together all the necessary data to facilitate underwriting and rating decisions is indeed valuable to insurers. GIS technology can be used as an analytic tool to assist in developing predictive loss models.

The fundamentals of earthquake loss mitigation provides a good example. To understand the potential for loss due to earthquake, one needs to have access to such data as active fault traces, soil type, and soil liquefaction potential. Some of this data is available from the U.S. Geological Survey, but not all and not for all affected areas. While soil type, for example, has not been surveyed in all areas, available mathematical models are effective in interpolating soil type to unsurveyed areas. Thus, a building can be assessed against both geological data and specific property information such as construction type, size, and number of stories of the building. This assessment yields estimates of loss which could result from earthquake damage. Underwriters need a GIS which is able to assemble the geological data, point geocode the risk locations, and apply the mathematical models which develop the loss estimate. All of this is available today.

Wildfire exposure areas--or what has been expanded by many observers to include all urban-wildland interface areas--produces its own challenge for insurers and is of keen importance to *Insurance Geographics*. Loss potential varies with a risk's proximity to brush, the type of brush, the slope of the location and surrounding areas, the effectiveness of available fire protection service, road access, wind potential, and construction type. The National Fire Protection Association has developed guidelines for insurer assessment of this hazard and the Western Conference of Governors is undertaking analyses to assess mitigation policy. The author is currently working with a group of insurers who comprise about 60% of the Homeowners DWP in California to develop GIS tools that would assist their underwriters in following established guidelines regarding on-site inspections and ensure uniformity in risk assessment. The tools that insurers will use to assess brush potential in their underwriting processes will be GIS tools.

Insurance "Answers" and Insurance Maps

Mapping has a secure place in *Insurance Geographics*. Visualization of spatial data can convey immediately what would otherwise require an extensive analysis of tables and graphs. But while maps are important, their value can be limited, especially in point-of-sale operations in which immediate information access is required.

Let's consider two GIS applications--one in which maps work well and one in which they become burdensome. We recently completed a study for an insurer which enabled them to visualize the concentration of risks and insured coverage amounts for a risk portfolio in the Northeast. They were preparing for a high level review with their Board of Directors. This job required the production of a base map with overlays and tabular data aggregation. Mapping was an absolute necessity.

However maps are not always the appropriate geographic tool. Consider the underwriter who is attempting to verify territorial assignments for PPC, commercial property territory, tax district, and extended coverage zone. Here maps would be burdensome, and require further analysis by the underwriter. Why force an underwriter to analyze a map? What is really required is a GIS that provides the answers that an inspection of a the base map and overlays would reveal. For example, PPC code = 6, commercial territory code = 032, etc. These *answers* are what feed insurance operations and should be supplied directly by the GIS. The same rationale applies to almost all distance calculations. Why force an underwriter to sit with map and wheel and manually determine the distance from a risk address to the ocean? Give him the answer—800 feet. And to make the point even more poignant , any automated underwriting system would *demand* an answer-based GIS.

Discrete data elements—GIS *answers*—and detailed custom maps are different outputs or end products of a GIS. Having both is crucial to effective use of the technology.

GIS/Database Integration

A comprehensive GIS for insurers will need to include access to a variety of hazard databases. Such databases exist for crime, toxic waste and hazardous materials, historical and recent storm events, earthquake data, and others.

The U.S. Bureau of the Census demographic database also has significant utility for Insurance Geographics, providing aggregate information at the census tract level of observation for an endless variety of social characteristics such as household counts, persons per house, average income levels, average home values, average rents, percent of dwellings that are owner occupied, percent of households with children, and various age group information. So-called "geodemography" will certainly find its way deeper into the marketing departments of insurers as competition forces increased emphasis on niche marketing, and will begin to move outside marketing as underwriting and actuarial managers gain easier access to the data.

Insurers will also gain GIS access to aggregate loss data submitted to ISO in statistical filings.

It is interesting to note that the very success of GIS applications in other industries will contribute to the data which become available to insurers. GIS is being used in retailing, banking, commercial and residential construction, real estate, and the general sales management activities of many businesses. Governments at all levels are also furthering their investment in developing GIS databases for use in activities of interest to insurers, such as disaster preparedness, fire services, health services, sanitation, building codes, transportation, economic development, housing, land-use control, and property assessments.

These databases should be integral to the GIS. They should permit linking to all layers and applications, including all polygons, modeling procedures, and the risk address geocoder. These databases will also need to be cross-referenced with each other. Considering that data expenses can consume more than 75% of the costs in developing a comprehensive GIS, proper integration is mandatory.

Risk Concentration Analysis

Finally, we see the ability of the insurers to analyze their geographic distribution of risks as a key GIS service. Insurers will produce maps and associated data aggregation tables to assist in a variety of planning activities. Many insurers are unaware, for example, of how heavily concentrated their risks might be in a given geographical area until severe losses occur. Hurricane Andrew made this clear. Insurers are using GIS to make strategic marketing decisions based on their current concentration of risks.

Hailstorm exposure presents another important risk concentration problem for insurers. In April 1994, the Midwest was pounded with hail for four days. According to the Property Claims Service, this storm produced about 300,000 claims—more total claims than from Hurricane Andrew or the Northridge Earthquake. Data from the Climactic Data Center and the National Weather Service show patterns of hail concentration that can be used to examine areas of danger and areas of opportunity. Without knowledge of the real geographic exposure patterns, insurers face the risk of concentrating too large a portfolio in high hazard areas and can lose the opportunity to write business in comparatively low risk areas. Again, an insurer's GIS can deliver powerful utility.

Reinsurers and reinsurance intermediaries are becoming increasingly aware of the utility of GIS technology and in fact are the leaders in using such technology. GIS-aided risk concentration analysis is already becoming a standard feature in treaty negotiations. And when disaster does strike, claims managers will use the same data and technology in their work. They'll be able to generate detailed maps showing the location of their affected risks, enabling rapid response to assist their insureds. Decisions regarding where to locate claims handling emergency centers and the number of adjusters to assign can be assisted well by a GIS.

Finally, *Insurance Geographics* will facilitate sales planning and monitoring by analyzing concentrations of risks in conjunction with other available geographic data such as demographic and historical loss data. When rating and hazard variables are overlaid with demographic variables, key areas of opportunity can be uncovered. For example, insurers can ask a GIS to identify a niche: Find the target market areas that have dwellings that exceed $350,000 in value, in established low-crime communities, with low to medium catastrophe exposure, that are in PPC classes 5 though 8. Marketers have used demographic data extensively in the past but have not integrated buyer characteristics with rating and hazard information to the extent possible. We predict that this will change in the near future, as the data become increasingly available.

Insurance Geographics: Available Technology With Immediate Value

GIS obviously offers significant benefits for strategic planning, underwriting, marketing and sales, and claims handling. But what is really selling the technology now are the hard quantifiable benefits that can be achieved by proper rating in PPC and drive distance and by detecting errors in rating territory assignments. These benefits are available now and the future portends even greater benefit at lower cost. In our view, *Insurance Geographics* is available technology with immediate value.

Notes:

1. The author is an Assistant Vice President at ISO where he manages the Risk Decision Information Division. He is responsible for ISO's Geographic Underwriting System which incorporates most of the decision tools discussed in this article.

2. This paper is an extension of a previous version originally presented at the *GIS in Business* conference in December, 1994.