AIRCURRENTS

EXPOSURE DISAGGREGATION: BUILDING BETTER LOSS ESTIMATES

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EDITOR'S NOTE: In this article, Alissa Le Mon, an analyst in AIR's exposures group, discusses how AIR's innovative disaggregation techniques enhance the accuracy and reliability of AIR's high-quality industry exposure databases and provide value to companies who lack detailed exposure data.

By Alissa Le Mon

INTRODUCTION

Catastrophe risk models, like all models, are only as good as the input data. Historically, so-called "aggregate" models, or software, ran aggregate, or coarse, resolution exposure data. This was very useful for producing a quick, if broad, view of the risk.

Catastrophe models, however, have grown in sophistication and detail as new high-resolution geological, meteorological and hydrological databases have become available.

As the models have become more refined, it has become imperative that the resolution of the exposures keeps pace. While the industry is making efforts to improve data quality, exposure data in developing countries—and even in many developed countries—is lagging far behind. Often, reinsurers and brokers are limited to using aggregate data in the sophisticated, detailed models that are now available. To meet the need for high quality data, new techniques for disaggregating company aggregate exposure data to higher resolution have been put to use.

In the last several years, AIR has refined its methodology for disaggregating exposure data within its models. The result is more granular, high-resolution industry exposure databases that are the source for more reliable industry loss estimates, such as those provided by AIR's CATRADER®. Furthermore, these new disaggregation techniques can also be used to improve loss estimates for individual companies with coarse exposure data. Using AIR's "detailed" application CLASIC/2™, these companies can leverage AIR's industry exposure databases to disaggregate the exposure data in their own portfolios to a highly-detailed level in line with the spatial distribution of AIR's industry data.

AIR

WHY DISAGGREGATE?

The benefits of disaggregation to catastrophe modeling are multifold.

Because hazards are highly variable from a spatial perspective, knowing where the properties exposed to that hazard are located is essential for producing reliable estimates of loss. Some of the most damaging winds in extratropical cyclones, for example, are found in fine-scale atmospheric features; the individual tornadoes, hailstorms and straight-line windstorms associated with severe thunderstorms are highly localized; the depth and extent of hurricane storm surge is highly sensitive to distance from the coast and elevation; and earthquake ground motion can vary dramatically depending on the type of soil found at the site of the exposed property. When exposure information is disaggregated to match the geographic sensitivity of the modeled peril, the reliability of resulting loss estimates improves.

Indeed, because the models are becoming ever more refined and detailed, failing to keep pace in terms of the quality of the exposure data used as input to those models means that we will remain victims of the adage "garbage in, garbage out."

Finally, while one might conceivably approximate ground-up losses using other approaches, the fact that the impact of policy conditions on gross and net loss estimates is highly non-linear means that, without property exposure disaggregation, it is unlikely that a model can produce reasonable estimates for gross and net losses.

Companies using AIR's CATRADER system will benefit from improved industry loss estimates derived from AIR's high resolution industry exposure databases. More importantly, using AIR's CLASIC/2, companies that have coarse resolution exposure data can leverage the spatial distribution of AIR's industry exposure databases to disaggregate their own data. The result in both cases is improved catastrophe risk management.

SO WHAT IS DISAGGREGATION?

Simply put, disaggregation is the process of distributing exposure data—whether it is industry data or company data—from coarse geographic resolutions to higher resolutions with the aid of auxiliary information. At AIR, disaggregation leverages both the latest demographic techniques and AIR's own innovative approach.

When the exposures team at AIR builds an IED for a country, it starts by collecting data on risks (insurable properties, in the context of this article) from statistics offices and censuses, business and population registers, construction reports, and other local statistics sources at the highest geographic resolution available. However, for many regions even the highest resolutions are still too low to generate reliable estimates of industry losses.

AIR has therefore developed a comprehensive disaggregation model that combines high-resolution datasets on land-use, impervious surface areas, elevation, slope, and regional data, including, when available, urban zoning information. By integrating these high-resolution datasets into separate risk density functions for each line of business—functions that drive the pattern in which risks are spatially distributed—AIR achieves highly accurate exposures information at 1 km2. As an example of AIR's disaggregation process, the area immediately surrounding Grenoble, France (Figure 1) is examined below.

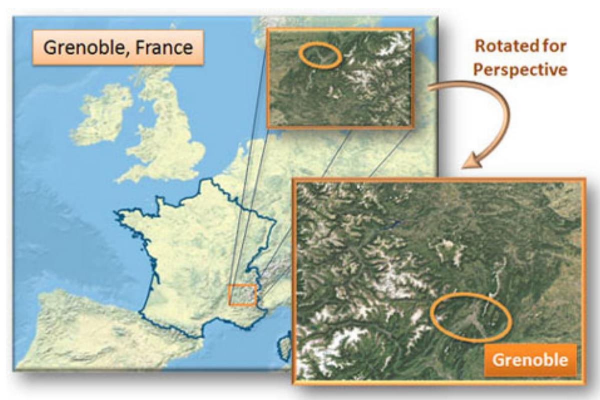

Figure 1. The area surrounding Grenoble, France.

LAND USE

High-resolution land use datasets group areas of similar land types into categories such as forests, beaches, agriculture, parks, and urban areas, to name just a few. Although some categories are generalized—"urban" may not distinguish "suburb" from city center, for example—there is sufficient differentiation to classify the land use types into two categories: buildable and unbuildable.

Unbuildable areas are those that are so unlikely to contain property risks that they are excluded from the risk distribution. For example, it would be highly improbable to find an apartment complex atop an alpine glacier, or an industrial plant in the middle of a lake. Land use types such as these are deemed unbuildable, while all other types are considered buildable, and are included when distributing, or disaggregating, risks.

In Figure 2 below, land use categories have been aggregated for demonstration purposes into buildable types, such as urban and agriculture, as well as unbuildable land types such as water and perpetual snow or glacier.

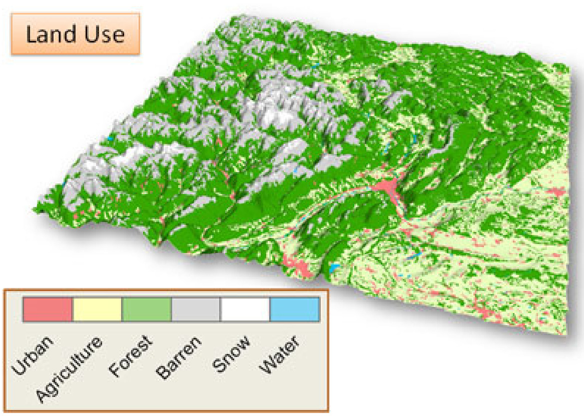

Figure 2. Aggregated land use categories derived from more than 40 distinct categories at a resolution of 100 m for the area surrounding Grenoble, France.

ELEVATION AND SLOPE

High resolution elevation data also provides valuable insight into identifying unbuildable areas. As an example, considering land use alone, a mountaintop meadow might be classified as buildable while, in reality, the likelihood of finding buildings there is very small due to the fact that its elevation isolates it from roads and other populated places.

Slope is calculated directly from elevation, and is also used to exclude unbuildable areas. An area that has a buildable land-use type and is at relatively low elevation can simply be too steep to build on.

Because different geographic regions contain various distributions of elevation, slope, and population, the cutoff values for elevation and slope—above which all values are considered unbuildable—are adjusted depending on the region in question. While many buildings can be expected to be found nestled on the steep slopes of the Swiss Alps, an equally steep hillside in Latvia would be unlikely to hold the same number of buildings; Latvia does not need to build on steep terrain. AIR's methodology takes these inherent regional differences into account when assigning cutoff values for both slope and elevation, thereby ensuring that the final risk distributions are tailored to each region.

IMPERVIOUS SURFACE AREAS

High resolution datasets are also available for what are known as impervious surface areas (ISA) that approximate the density of manmade materials—i.e. buildings, roads, parking lots, and the like. These datasets are often based on nighttime lights and population counts.

In Figure 3, the highest ISA values (shown in red) correspond to areas covered by manmade materials—primarily city centers—and the lowest values correspond to more natural areas, such as rural plains and water bodies. Because manmade materials tend to be constructed for peoples' use, ISA is highly correlated to population density. ISA is used to locate relative hotspots, placing more buildings where there are more manmade materials, and fewer in less populated places.

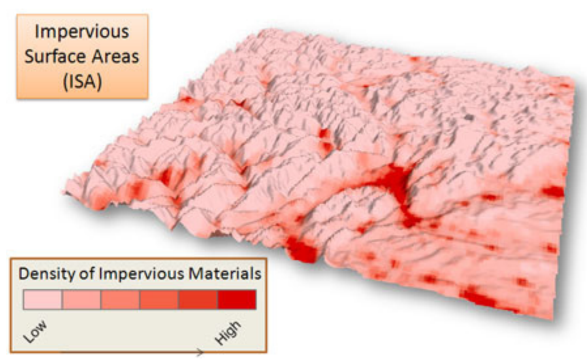

Figure 3. The Impervious Surface Areas from USGS. Higher values (dark red) indicate higher densities of manmade materials, which are correlated to higher population densities.

Not all lines of business relate to ISA in the same way, a fact that is taken into account when developing the relationship between building counts and ISA values. While apartments and commercial buildings tend to populate city centers, areas with relatively high ISA values, single family homes are more prominent in the suburbs and outskirts of cities. For this reason, each line of business is assigned a unique probability distribution in relation to ISA.

REGIONAL DATASETS

In addition to land use, elevation, slope, and ISA data, which are available worldwide, a variety of local datasets are used to fine-tune disaggregation to the characteristics of a specific region.

In the Caribbean, for example, some countries have high-resolution zoning maps that distinguish between areas designated for different lines of business. Where the less-detailed worldwide land use datasets tend to classify populated areas as simply "urban", these zoning maps split urban areas into smaller subsets such as hotels, commercial, industrial, and residential areas, to name a few—providing further guidance on the disaggregation of risks.

DERIVING THE PROBABILITY DENSITY FUNCTION

Using land use, elevation and slope to distinguish buildable from unbuildable areas, and combining these with ISA and any additional regional data, AIR's exposures team generates a probability density function that determines the pattern of disaggregated risks for each region and line of business at a resolution of 1 km2 (Figure 4). In Figure 4, this distribution is shown in 3-D to emphasize the areas with the highest values. The highest peak is the center of Grenoble, and corresponds to the area with the largest number of disaggregated risks. Depending on the line of business, the highest peak in the distribution does not always fall in the middle of a city, but instead reflects the area with the highest concentration of risks in that line of business.

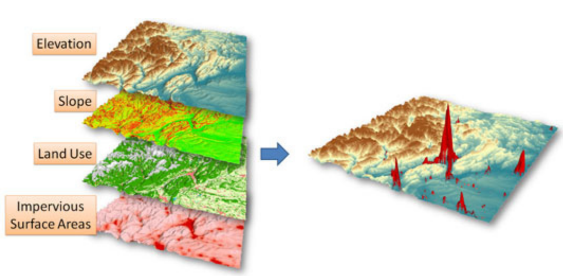

Figure 4. Deriving the final probability distribution.

VALIDATION

Throughout the disaggregation process, numerous validation steps ensure the highest level of accuracy possible. Comparison against satellite imagery, for example, helps ensure the accuracy of disaggregated risks. Figure 5 shows the final distribution of risks overlaid on satellite imagery. The darker pink areas contain the densest risks. Areas that contain no color received no risks. The areas with no risks in the two upper corners are the Isère River, while the area in the lower right corner contains a mix of forest and unpopulated fields. Where there are risks (the pink areas), numerous buildings can be seen beneath the distribution.

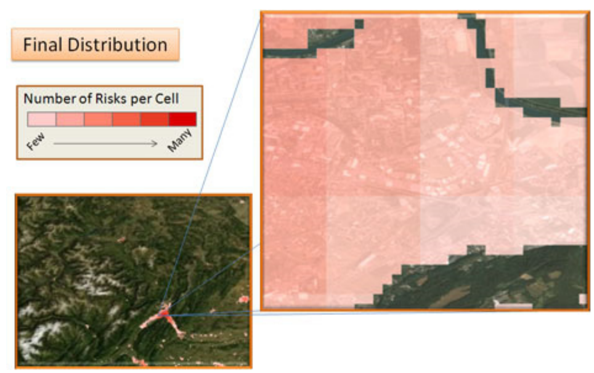

Figure 5. The final distribution of disaggregated risks, overlaid on Bing satellite imagery.

In addition to satellite imagery, statistical reports, known risk locations and, where available, high-resolution risk data all help in calibrating the disaggregation process to particular regions and in validating the disaggregation methodology overall.

CONCLUSION

One of the most valuable features of all AIR catastrophe models is the underlying industry exposure database, and AIR invests significant resources in their development. They account for all insurable exposures—that is, any property that could be insured by the private insurance market—at a detailed level for every country modeled by AIR.

The IEDs provide a foundation for all modeled industry loss estimates, whether for simulated events from a stochastic catalog, the re-creation of historical events, or for actual events unfolding in real time. Indeed, developing an estimate of industry losses for an actual event unfolding is impossible without an industrywide database of detailed property information.

Using its new disaggregation methodology, AIR has already enhanced the IEDs for more than 50 countries. Models that do not account for the spatial distribution of exposures are not able to capture an independent, high-resolution view of risk. The higher level of accuracy resulting from the recent enhancements directly benefits companies using either CLASIC/2 or CATRADER. Clients can have confidence in the improved accuracy of AIR's disaggregated, high-resolution industry data and in using it to improve their own catastrophe risk management.

While disaggregation provides companies with the best methodology when detailed exposure data is not available, AIR continues to emphasize the importance of using detailed high-quality data for catastrophe analysis. Indeed it is AIR's ultimate goal that the industry use only detailed, quality data to derive the most reliable model results.

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