IBM Insurance Information Warehouse Support for Catastrophe Modeling

Whitepaper

IBM

Introduction

Catastrophe modeling is the process of using computer-assisted calculations to estimate the losses that might be sustained due to a catastrophic event such as a hurricane or earthquake. Catastrophe modeling is especially applicable to analyzing risk and is at the confluence of actuarial science, engineering, meteorology, and seismology. The process involves the modeling of catastrophic events in specified geographic locations in order to analyze the exposure of insurers and reinsurers to these events. Insurers and reinsurers use catastrophe models to help calculate the potential amount of capital needed to discharge claims associated with catastrophic events.

Catastrophe models calculate the exposure of (re)insurers over a prolonged period and not just over the course of a single year. Catastrophe models help (re)insurers to identify, understand and manage the fluctuation in the number and severity of claims associated with large catastrophic loss events. An assessment of exposure to risk should not only consider the incidence of claim occurrences and the level of losses, but also be informed by a better understanding of all factors leading to claims including the location of insured risks and the characteristics of these risks also.

This understanding of risk exposure can inform and validate risk pricing, support the better risk management of exposures in terms of risk concentration and also provide new insight in support of reinsurance and risk transfer decisions.

Business Context

Catastrophe models have been in widespread use for many decades. They arose out of the severe financial impact on the insurance industry from the aftermath of catastrophic events. For example, Hurricane Andrew in 1992 led to the insolvencies of insurers and reinsurers. The impact of these catastrophic events has highlighted the need to better understand, manage and control the level of risk associated with them. Catastrophe models have evolved over that period to become a part of how insurance organizations view risk from underwriting, pricing, reserving and reinsurance perspectives.

The fundamental issue is that given the relatively recent development of catastrophe models and the lack of enough historical catastrophe data, combined with changing climate conditions (rising sea levels and changes in weather patterns) and evolving building codes and regulations, it is a complex operation to assess what the impact of these events are. A major catastrophe event such as a hurricane can have an altogether different loss outcome today than previously not only based on its trajectory of the hurricane but also due to changes in construction standards and methods in addition to societal changes (level of insured risks, quality and compliance with building codes). A more holistic approach is required encompassing not only an understanding of the hazard events themselves (where and how they occur) but also an understanding of the vulnerability of different types of exposures to these events.

When viewing catastrophe losses over time, it can be seen that the level of losses in recent times is greater, possibly due to the increasing value of assets, and the level of insurance penetration and changing demographics. What is more significant is that peak loss years are having a much higher financial impact and are also happening more frequently.

Severe catastrophic events such as the earthquake and tsunami in 2011 that devastated north-eastern Japan have heightened the interest in catastrophe modeling and raised concerns about the accuracy/validity of the models. Historically, different catastrophe model providers have evolved different approaches and competencies. Organizations have depended on these models to accurately project their level of risk.

However, the variances in their own actual claims experience versus the projections provided by catastrophe model providers has led many to consider capturing a more unified view of risk. In conjunction with this changing industry viewpoint, rating agencies and regulatory changes, such as Solvency II, are mandating greater ownership of results from catastrophe models by insurers and reinsurers.

Catastrophe modelling projects can suffer when ingesting data from a multitude of different source systems, all defining and describing risk exposures, products and risk pricing in variety of different ways. There is a need for a standardized approach to describing elements of risk so different policies, products and risks can be understood and compared in a similar way.

IBM Insurance Information Warehouse (IIW) provides broad coverage in support of catastrophe modeling and reinsurance. IIW catastrophe modeling coverage aims to help insurers and reinsurers understand how to capture the data inputs into, and outputs (results) from, catastrophe loss models in a data warehouse. This involves the identification of the parts of the model that are relevant to this business requirement from reinsurance, policy and exposure data, claims data, hazard footprints and event data, location information and also to identify how the results can be captured.

The comprehensive coverage in IIW can help catastrophe modelling projects define products, pricing and risk information in a standardised way, with well defined and flexible data structures, which can capture data from the simplest of risk characteristics to complex reinsurance treaties.

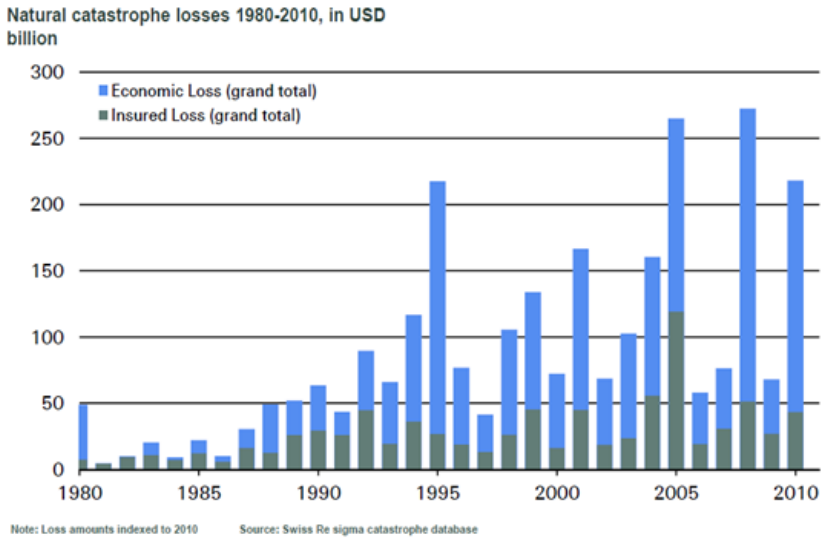


Figure 1. Natural catastrophe losses 1980-2010

Benefits of Catastrophe Modeling with IIW

Data Standardization

- Use IIW to apply a standardized approach to the capture and definition of products, coverages, policies, reinsurance treaties, different types of policy limits and excesses etc. This can support a single version and understanding of the inputs to the catastrophe models.

Insight

- Risk Concentration/Portfolios – IIW supports improved risk analysis at the lowest granularity, and by geolocation. The Analytical Requirements can help insurers understand the risk related to where they are located (risk concentration and accumulation) and risks associated with the type of risk exposures covered (portfolio analysis).
- Real-Time Analysis – New data sources and real-time data such as flood sensor data can be integrated in IIW. This allows for greater understanding of events as they occur using analytical applications.

Decision Support

- Reinsurance/Risk Mitigation policy - Understand the exposure portfolio and match with the appropriate reinsurance treaty using IIW improved support for Reinsurance.
- Risk Pricing – an IIW-based risk exposure data warehouse can help provide insight into how insurance products are costed (coverages, terms and conditions).

Catastrophe Modeling

- Model Integration - IIW supports one version of the data and can provide support for the inputs to, and outputs from, catastrophe loss models.
- Loss Model Validation - IIW data coverage for risk assessments can be used to define a common method for understanding the results for multiple catastrophe models and in so doing promote greater transparency and confidence in these results.

Reporting

- Capital Requirements - Comprehensive support for Solvency Capital Requirements in particular to relation to Solvency II.
- Claims versus loss projections - IIW includes coverage for the capture of catastrophe model results (projected losses for extreme event scenarios, and loss projections such as average annual losses) which, when considered with claims, can support greater understanding of the variances between actual and predicted losses for multiple scenarios.
- Visualizations – Data visualization tools, such as ESRI and IBM Cognos Business Intelligence, can be used with IIW-based data warehouses/data marts to overlay data points (location of properties/claims), shapes (flood zones, elevation maps, flood scenarios) and lines (roads, hurricane trajectories) with other maps to give them context and provide new insight.

Geospatial Support

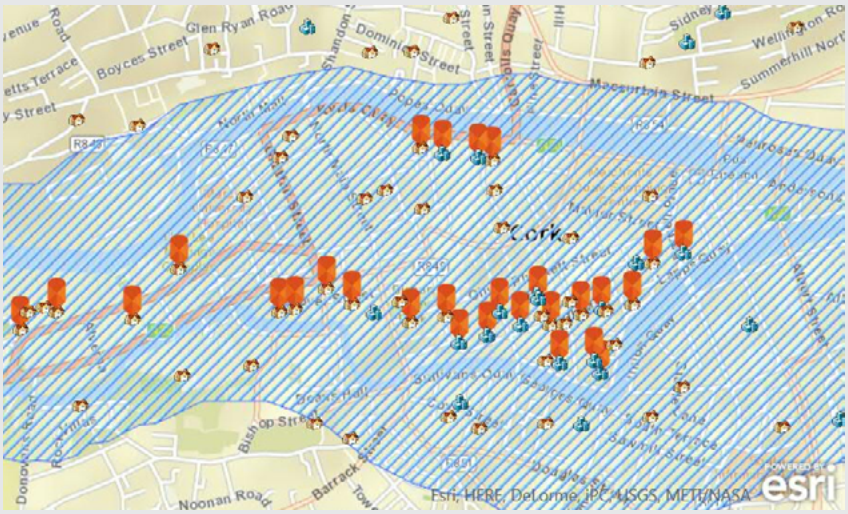
IIW data models deployed on geospatial enabled database technology can provide a whole new understanding of the role that location plays in risk exposures:

- Map data can be loaded into an IIW-based data warehouse for flood or hurricane zones. Geospatial functions can be used to determine whether properties are located within specified zones.
- IIW supports geospatial data constructs such as area polygon, line segment, and point, enabling greater accuracy in capturing location data and event data. It is aligned with geospatial libraries, such as IBM PureData Spatial ESRI Package (Netezza) and DB2 Spatial Extender, enabling easy deployment and data manipulation.

IIW is designed to capture the data at the location resolution required.

Figure 2. This sample report is based on a sample data set for Hurricane Katrina and includes the capture of the hurricane track and also information about claims and policies exposures.

Figure 3. This sample report is based on a sample data set for a simulated flood scenario and highlights the number of claims and type of properties affected.



New Approach to Catastrophe Modeling

Catastrophe modeling providers are responding to the changing needs of the insurance industry by opening up their modeling platforms and allowing greater scrutiny. New standards, such as Oasis Loss Modeling Framework, are emerging which advocate alternative open and transparent methods of calculating levels of risk and uncertainty.

New data sources which can increase our understanding of risks are also available, for example detailed maps developed by specialist model providers (including high resolution hazard foot prints), real-time sensor data collected for floods, windstorms etc., and a growing number of publically available data sources on the intensity of events for example, average wind speed and trajectory of a hurricane from National Oceanic and Atmospheric Administration (NOAA).

This data can be used to harness the inherent insight available in claims and underwriting experience to derive new understanding of the vulnerability of risk exposures to these catastrophic events. This changing landscape, combined with continuing improvements in geospatial technologies for the definition and visualization of geospatial data, highlights the need for a fresh look at how catastrophe modeling is supported in insurance businesses and to identify opportunities to transform and extract new value and insight from catastrophe modeling.

This new approach should focus on consolidating and standardizing the data sources that feed catastrophe models. Having more accurate data can help calibrate loss model data inputs, and can better reflect the characteristics of the risks, provide for better predictions, and facilitate new insights, including real-time analysis, which might help mitigate against losses before they occur. The critical component needed to operate successfully in this changing landscape is an exposure data warehouse which provides a consolidated view of risk, considering not only the inputs into catastrophe models both also relating the catastrophe model results with those inputs..

IIW provides business content and comprehensive data structures to support catastrophe modeling initiatives and helps to accelerate the scope definition, data model design and physical deployment of an exposure data warehouse.

IIW can help catastrophe modeling projects deliver value and identify new patterns in exposure data. IIW's coverage can support the development of a risk exposure data repository around the key data components in the lifecycle of catastrophe modeling.

Figure 4. Approach to catastrophe modeling

Inputs

Policy Terms - Capture different types of policy terms (for example, limits/sub limits/deductibles/reinsurer share) regardless of level of complexity of insurance or associated reinsurance contracts. This flexible coverage can support the appropriate allocation of policy financials to ground up losses which are needed to determine the true financial loss for the exposures on risk. IIW can help with moving from the difficulties of trying to define types of products and policies from different systems to a standard definition using one model and one set of business terminology.

Risk exposures - IIWs rich support and detailed definitions for insured risks, including property and location characteristics, allows for a more detailed definition of risk characteristics. Capturing this data is an opportunity to harness additional policy/proposal information available in source systems or hidden within policy documentation (unstructured data). This can then be included in loss modeling scenarios (for example, understanding how elevation of a property within a high risk flood zone can impact claims.)

Hazards/Events - IIW supports different types of intensities (for example, wind speed, rainfall, richer scale) and scores for catastrophe event footprints from the trajectory of hurricanes to the damage path of a flood. These events can be defined in time and with different location designations such as GPS points, shapes (lines for example, hurricane trajectories), or polygons for example, flood zones. It might not be necessary to capture all this data within the data warehouse but IIW is designed to capture the data at the different levels of detail as required. This can include place assessments/scores, readings for catastrophe-related events, and event categorisation, which are critical to defining the level of intensity of these events and that can be related to claims experience.

Claims and Vulnerability - The data coverage for catastrophe events, such as floods or hurricanes, can be used in combination with IIW's claims coverage to derive new statistical insight from an insurers' own claims experience, bridging the relationship between flood levels or wind speeds and the level of claims. External data sources such as damage data for different types of building construction or specialist flood models with high-resolution maps can also be loaded into IIW statistical data coverage.

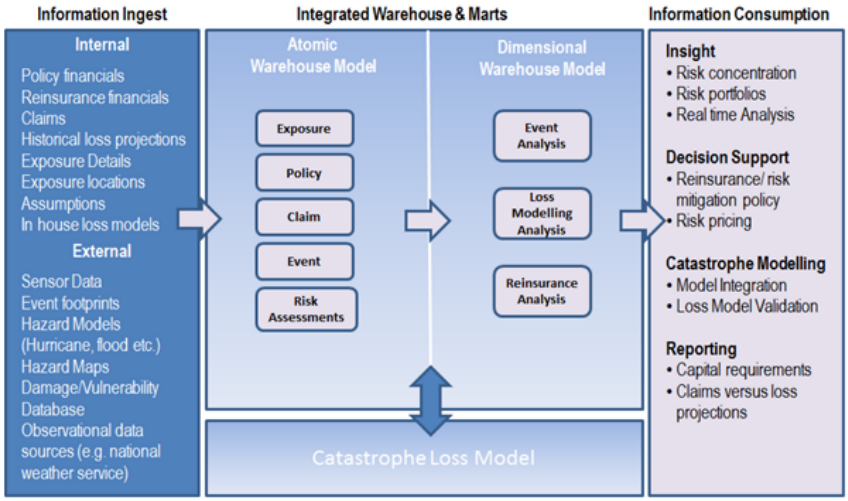


Figure 5. Approach to catastrophe modeling - detail

Outputs - *Risk Assessments* - IIW data models provide for the capture of risk assessment data requirements including both the inputs and outputs.

Analysis - IIW provides coverage for catastrophe modeling reporting requirements. This coverge connects the inputs to, and outputs from, the catastrophe model which can support greater insights into the loss model results at the required granularity.

IIW Support for Catastrophe Modeling

IIW is a set of models that enables insurance organizations to build and deliver a business-oriented, enterprise-class data warehouse or data repository. IIW comprises the following components:

Project Views

Project Views are business-subject-area views that span across all IIW components with the following functions:

- Provide predefined business scope of business terms related to the various components of the catastrophe modeling from a data perspective (catastrophe model inputs and results, hazards, exposure data, policy terms including reinsurance and so on)
- Provide pointers to the parts of the IIW models which would be relevant to a catastrophe model project data scope or to address a particular exposure analysis reporting requirement.
- Can be extended as required with an organizations specific customizations.

Analytical Requirements

IIW contains an extensive list of Analytical Requirements, reflecting the most common queries and analyses for business performance measurement and reporting, while supporting other analytical functions such as ad hoc reporting, data mining and decision support.

Analytical Requirements enable rapid scoping and prototyping of data marts, which provide a subject-specific analytical layer in a data warehouse solution. Analysts and business users can use Analytical Requirements to gather the reporting and analysis requirements of their organization quickly.

Each Analytical Requirement can be divided into measures, which are numerical facts that convey quantitative information of importance to the organization, and dimensions that categorize measures. These measures and dimensions are mapped back to the data warehouse, so that the scoping of the reporting and analysis requirements automatically selects the most appropriate data warehouse entities and attributes to support those requirements. The analytics development team can use Analytical Requirements to create designs for specific data marts or dimensional solutions that can serve as the source for a range of reports and charts. Data Definition Language (DDL), for the required physical database implementation, can be generated to accelerate reporting development. IIW supports the automatic generation of DDL into IBM PureData System for Analytics (Netezza.)

Analytical Requirements for catastrophe modeling include event analysis (for hurricanes and floods), loss modeling (leveraging insight from catastrophe model outputs) and reinsurance analysis.

Business Terms

The Business Term glossary enables non-technical business experts to describe and define, in their own words, the concepts they use every day. Clearly defined business terms help standardization and communication within an organization. Mappings to the data models make it possible to create a common, enterprise-wide picture of the data requirements and to transform these requirements into IT data structures.

As part of IIW, the glossary is a comprehensive list of terms pertaining to insurance, financial services and general business that includes:

- Definitions written in plain business language
- Detailed data elements that specify what each business term means for the insurance organization.
- Terms that might be related to one another through relationships.

Significant extensions have been made to the Business Terms coverage not only for catastrophe modeling but also for reinsurance.

Business Example Diagrams

IIW also includes business view diagrams:

- Overview diagrams provide an explanation of where in the model the coverage for catastrophe model data can be found using IIW business terminology.
- Entity/Relationship scenario diagrams provide an initial scoped model diagram including entities and relationships to provide an initial acceleration point for catastrophe modeling, risk exposure or reinsurance data warehouse project, which can be customized as needed and from which a physical model can be generated and deployed.

Business Data Model

The Business Data Model is a logical model that represents the essential entities and relationships of the insurance industry. It provides a business view that excludes technical implementation considerations such as details related to any specific database.

The Business Data Model is the first point at which the various business requirements are brought together and modeled in an entity-relationship format. It enables organizations to perform the initial modeling of their business requirements and helps the organization understand the various constraints, relationships and structures that can be implied in their business require¬ments. This is the essential model of the business, providing the overall business context and a common basis for the downstream models that can be used in the actual deployment of the physical data warehouse. The information reflected in the data model is independent of organizational structure and has been validated by multiple sources within the industry.

Atomic Warehouse Model

The Atomic Warehouse Model is a logical, specialized model derived from the Business Data Model. It is optimized as a data repository that can hold long-term history, usually across the entire enterprise. The Atomic Warehouse Model provides the data design support needed to create a uniform model of the enterprise-level business requirements defined by the Business Data Model into specific, flexible and efficient structures dedicated to the long-term storage of historical facts.

The Atomic Warehouse Model features a flexible atomic data area (primary data storage area) as well as the typical summaries needed by most insurers to roll up the detail data for analysis purposes. A portion of the Atomic Warehouse Model is generated in the initial project phase. Other areas can be generated as the insurer covers more business areas over time. The Atomic Warehouse Models contains data structures needed by an insurance organization to support a wide variety of business requirements such as regulatory requirements (Solvency II reporting requirements), customer insight, claims, fraud, life insurance, investment management, general insurance, reinsurance and catastrophe modeling.

Dimensional Warehouse Model

The Dimensional Warehouse Model is a logical model derived from the Business Data Model and the Analytical Requirements and provides an optimized data repository for supporting analytical queries. The Dimensional Warehouse Model provides the data design support needed to transform the enterprise-level business requirements in the Business Data Model into busi¬ness-specific and efficient structures dedicated to the design of a dimensional data repository.

This repository holds sufficient and complete data to meet the needs of business user analysis. Dimensional models are more easily understood by business users. They are optimized for data querying rather than for transactional speed, and their structure makes it is easier to extend them to support new data requirements. New queries can be created without having to redesign the data structures, while old queries can still operate without change.

The Dimensional Warehouse Model contains star schema style dimensional data structures organized around fact entities that support the Analytical Re¬quirements.

Features & Benefits

Business Terms

- Significant expansion of coverage of catastrophe and reinsurance-related business terminology
- Terms now available in IBM InfoSphere Information Governance Catalog

Analytical Requirements

- Illustrated Analytical Requirements mapped through to logical design to accelerate and provide inspiration for the definition and deployment of catastrophe model projects. Now available in IBM InfoSphere Information Governance Catalog.

Logical Model Design

- Atomic and Dimensional Warehouse improvements to support the capture of catastrophe events including hazard footprints, geospatial location definitions, policy and reinsurance terms, claims and catastrophe risk assessments.
- Business Example diagrams for the catastrophe model scenario which can help accelerate project scoping and requirements definition.
- Models available in InfoSphere Data Architect can be readily deployed on numerous database options including IBMPureData for Analytics (Netezza), DB2 and Hadoop etc.

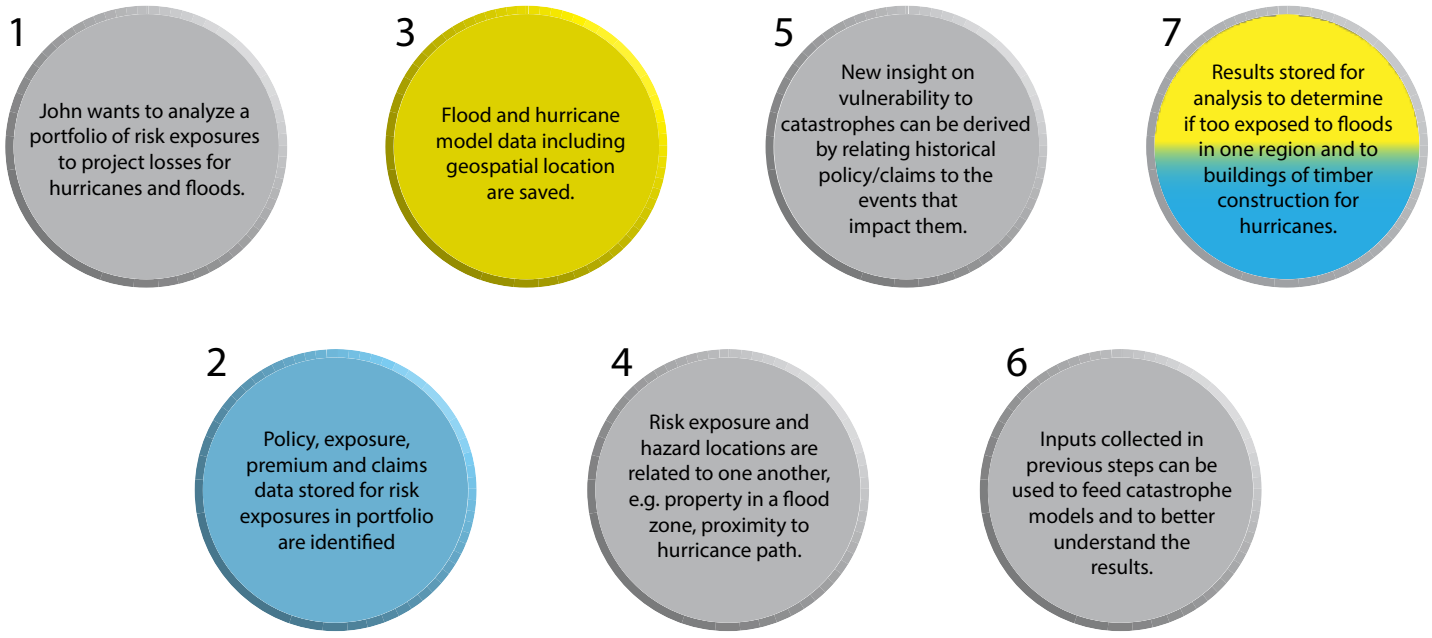


Figure 6. Approach to catastrophe modeling - scenario

Hurricane Event Analysis Use Case

The amount and severity of claim incidents resulting from severe windstorm and hurricane events are increasing and is of growing concern to insurers and reinsurers. Changing weather patterns, changes in demographics (where people live) and changes in the type of construction mean that insurers cannot rely on past historical claims as a predictor of future losses. Insurers and reinsurers need to better understand which types of structures (construction/material) have greater propensity to wind damage and the structure profile of their exposures. New approaches need to be considered and new data sources used to improve the understanding of hurricane risk.

IIW business content and logical model coverage supports this need. IIW helps combine policy data, exposure data (such as structure, claims, premium) together with new data sources for hurricane events (historical hurricane tracks, hurricane models) and the loading of this into the data warehouse to improve consolidate insight and analytics.

IIW includes data coverage to feed all aspects of hurricane-related catastrophe loss modeling both in terms of inputs to and outputs from these models. Using IIW as the basis of a risk exposure data warehouse allows for this consolidation of insight into one data store to support the different views of risk exposures needed which might inform the types of buildings to provide hurricane cover for.

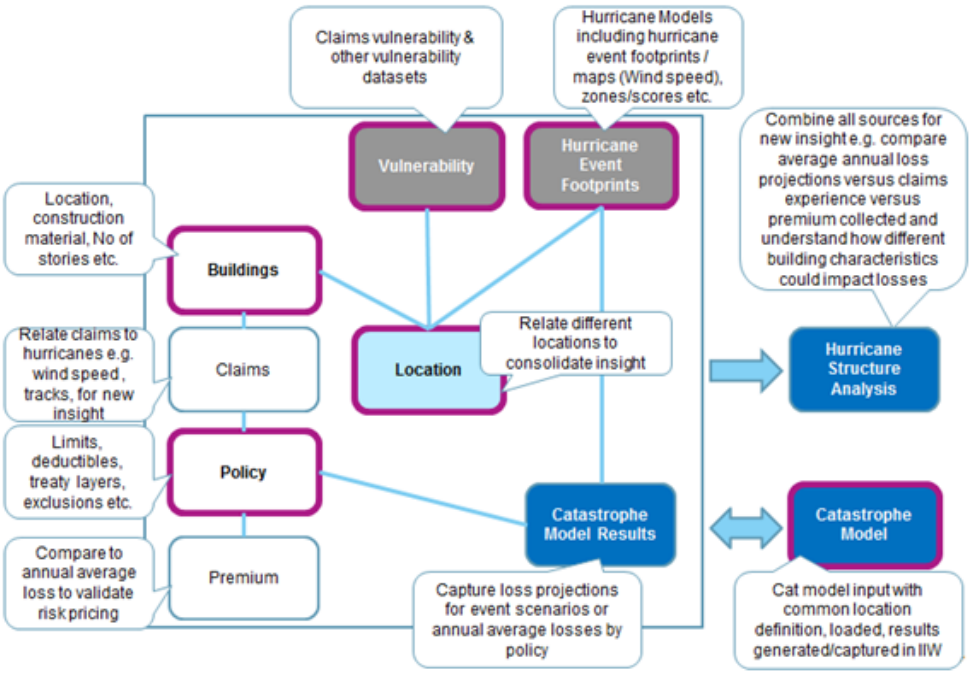


Figure 7. Hurricane event analysis use case

IIW supports geospatial coverage, including defining the location of exposures relative to the trajectory of hurricanes, both in terms of previous actual hurricanes such as Hurricane Katrina and simulated hurricane events. Using geospatial tools and technology, risk exposures can be defined within the boundaries of hurricane zones or alternative zones created for example, hurricane zones, which consider not only the risk propensity of a hurricane but also the type of building construction prevalent in that zone. This multiple view of location can be captured in IIW. IIW hazard coverage supports the capture of footprints for previous historical catastrophes, such as Hurricane Katrina, within the data warehouse.

Using geospatial libraries provided, such as those available with IBM PureData for Analytics (Netezza, for example Spatial ESRI Package), geospatial queries can be performed to determine the intersections between the damage paths of hurricanes and the location of risk exposures. This common IIW-based definition of location across exposures, claims and hazards can shed new light on the contributing factors for hurricane claims and their relationship to location. The key elements of wind catastrophic events, including wind speed, atmospheric pressure, the declared categorizations of these events (for example, Tropical Storm category 5), and their various locations at a point in time, can be stored with IIW.

Claims for different types of buildings can be related to hurricane events to understand how different levels of wind speed or gusts impact wind damage claims for different types of buildings. IIW can then be used to feed a catastrophe loss model to project average annual losses over time, which can then be related to actual premium collected. This comparison might identify that certain types of buildings should only be covered under certain conditions and might lead to a different view of risk pricing associated with buildings in hurricane zones but which have a rigid construction which has withstood previous hurricanes in the past.

IIW provides support for the capture of industry damage databases, which provide a profile of wind damage intensity. Separately, IIW provides the ability to collate historical hurricane tracks and wind damage claims allowing them to be related to each other.

With this consolidated view, a new insight and picture emerges for example, an understanding of how the intensity of the hurricane at particular locations relates to claims might indicate that particular types of housing construction are more resilient to hurricanes.

Using this new insight, catastrophe loss projections can be calibrated with risk exposure information and assumptions more suited of the true risk profiles of the underlying risks. The outcome from this lower-level analysis might lead to changes in policy conditions for example, exclusions; endorsements or pricing, which more accurately reflect the risk characteristics leading to claims. It might also lead to more accurate and discrete catastrophe risk assessments and inform a more measured policy to mitigate against different risk profiles.

IIW provides a number of supports for hurricane event analysis from Business Term and Analytical Requirements coverage which aid requirements definition; to logical data models, which can capture the data needed and dimensional model coverage, which provides support across risk exposures, wind events, claims and catastrophe model results.

Flood Event Analysis Use Case

Flood damage is a growing problem for insurers and reinsurers. Climate changes appear to indicate an increase in the severity and incidence of extreme weather events. This level of unpredictability requires insurers and reinsurers to reassess flood risk areas to take into account these changing weather patterns and to better reflect the exact location of a property within a flood zone.

IIW business content and logical model coverage supports this need. IIW provides a number of supports for flood event analysis such as Business Terms and Analytical Requirements coverage which aid requirements definition for flood risk concentration analysis. IIW data models can capture the data needed for the analysis of floods while dimensional model coverage provides assistance for flood event analysis in the form of data for risk exposures, flood events, claims and catastrophe model results.

By using IIW as the basis of a risk exposure data warehouse, all key information can be consolidated into one data store to support the different views of flood risk exposures needed for flood risk concentration analysis.

IIW facilitates the combination of policy data, exposure data such as structure data, claims data, and premium data with new data sources for flood events. These new flood data sources (for example, flood sensor data, flood models, which may be in the form of maps) can be combined with reports to provide visualization using tools such as Cognos and/or can be loaded into a data warehouse to consolidate insight.

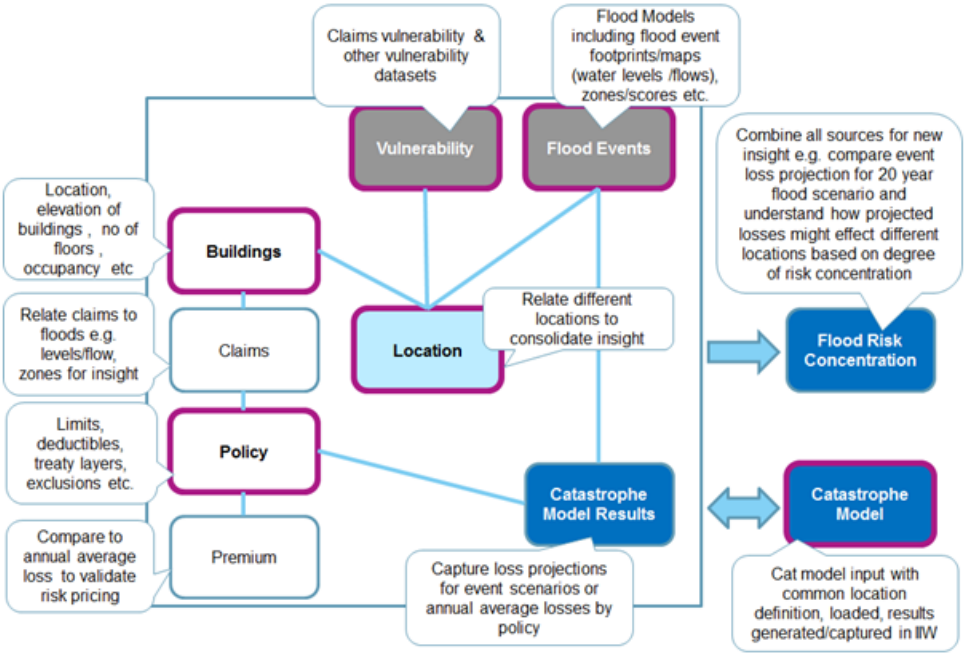


Figure 8. Flood event analysis use case

IIW includes data coverage to feed all aspects of flood related catastrophe loss modeling both in terms of inputs to and outputs from these models. Using IIW as the basis of a risk exposure data warehouse allows for this consolidation of insight into one data store supporting the different views of risk exposures needed for risk concentration.

By using geospatial libraries and database functionality, it is possible to determine where the locations of properties are relative to different location definitions for example, are they within a high risk flood zone. It is also possible to derive new definitions of zones, which may be used to feed catastrophe models for example by determining a particular neighborhood might be zoned together given an insurer's high risk exposure concentration, a common type of building structure and the zone's propensity for flooding.

Claims by location can be related to flood events to understand how flood levels, rain fall and water flow impact on the level of claims. IIW can further be used to feed a catastrophe loss model to project losses in the event of a catastrophic flood scenario. Understanding this impact might change an insurer's perspective on the level of risk retained and might indicate that no more business should be written within a given rated/defined flood zone.

Deployment

IIW can be used to develop a risk exposure data warehouse and acquisition layer for proprietary catastrophe models or alternatively for open source and in-house models.
IIW can be used to define the data input and output requirements for catastrophe models.

This can be readily deployed on IBM PureData for Analytics (Netezza) using InfoSphere Data Architect. Visualisation tools such as ESRI ARCGIS in conjunction with reporting tools such as Cognos can be leveraged to provide new geospatial insight on risk exposures and catastrophe events.

Conclusion

IIW can help insurers and reinsurers address the technical challenges of catastrophe modeling by supporting the deployment of a logical data warehouse architecture that encompasses both new and traditional data structures and deploys across multiple technology platforms.

IIW helps capture data inputs for catastrophe models such as reinsurance, policy, exposure, and claims data. It provides support in the following areas:

Event analysis

- Flood zone risk concentration analysis
- Flood risk portfolio analysis
- Hurricane location analysis
- Hurricane building structure analysis

Loss modeling

- Annual exceedance probability analysis
- Loss distribution and vulnerability analysis
- Occurrence exceedance probability analysis

Reinsurance analysis

- Finite reinsurance decision analysis

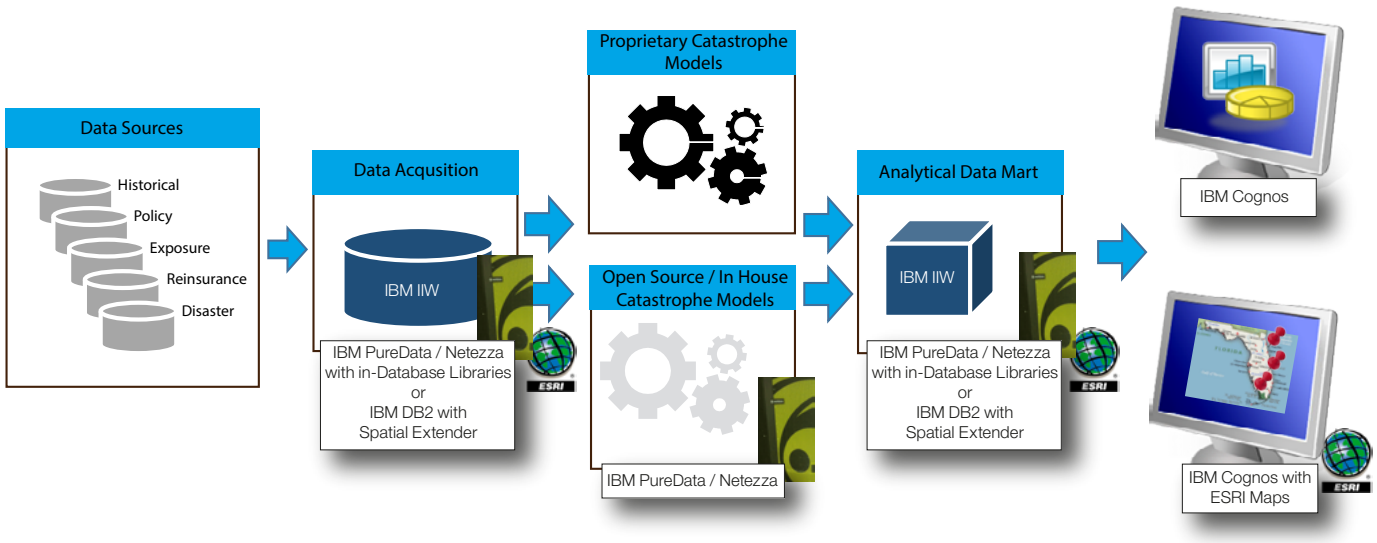


Figure 9. Sample deployment environment using IBM Software

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