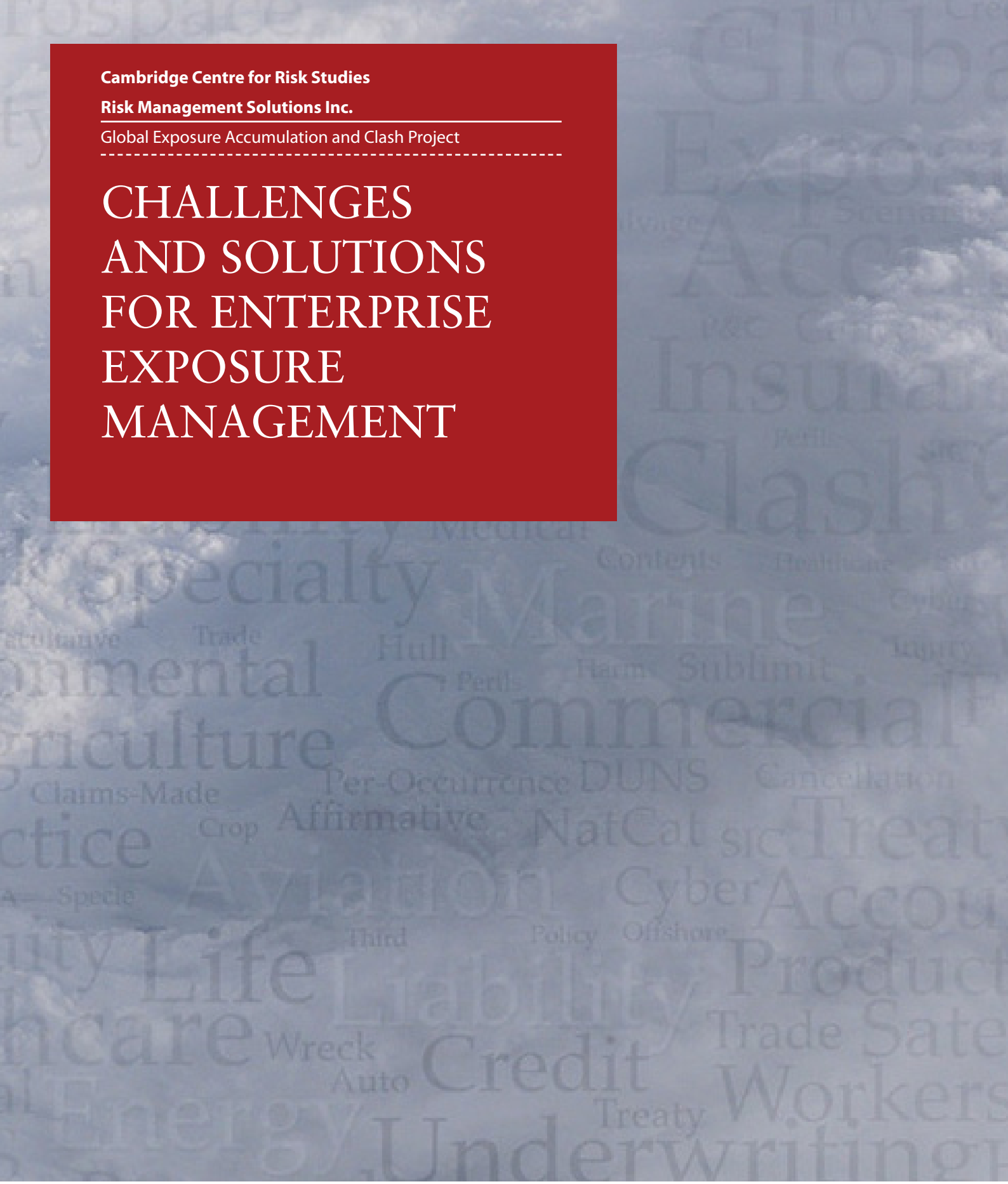
Cambridge Centre for Risk Studies

Risk Management Solutions Inc.

Global Exposure Accumulation and Clash Project

# CHALLENGES AND SOLUTIONS FOR ENTERPRISE EXPOSURE MANAGEMENT

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# Challenges and Solutions for Enterprise Exposure Management

## Contents

# Part I: Overview

## 1. A Data Definition Document for Multiple Lines of Insurance Exposure

This report summarizes the activities and results of a two-year project to coordinate a standardized Data Definitions Document for recording and analyzing exposure data across multiple classes of insurance that will enable at least 90% of insurance exposures by value to be captured in a consistent way.

This report is a companion guide to *Multi-Line Insurance Exposure Management: Data Definitions Document v1.0*, which comprises the Data Definitions Document, developed by Cambridge Centre for Risk Studies in collaboration with Risk Management Solutions, Inc.[1]

The project demonstrates that the data definitions are useable for loss modelling across a broad portfolio of insurance classes, using example scenarios and illustrative loss estimates derived for 'clash' losses to each class of insurance from the same underlying event. This use of the exposure data definition schema for loss modelling and accumulation analysis was one of the main requirements for the schema development.

The project was guided by a steering committee comprised of insurance company representatives, reinsurers, and intermediaries. We gratefully acknowledge their valuable inputs. We also benefited from input from a broader community of reviewers and industry specialists, through a series of consultation documents and interactive workshops. The project entailed:

- Review of 715 articles, reports, and journals concerning exposure management
- Feedback from 130 insurance industry practitioners
- 27 insurance organizations, including regulators and rating agencies
- Interviews with 11 modelling companies, data providers, and analysts

We are grateful to the workshop attendees and to all those who took part in the consultations and provided detailed feedback. We are particularly indebted to the specialists in individual classes of insurance, who provided their time, sample data, and their valuable expertise – and patience – to help us document each of their exposure areas.

## 2. Towards a Consistent View of Exposure

Insurance companies manage multiple classes of business across several geographical markets and have typically maintained each class of insurance as a separate operating division, often with its own methods and exposure management processes.

Many market practitioners view current insurance data management practices as being inconsistent across different classes of exposure. Most recognise the need for greater consistency and a general benchmarking for insurance exposure across the range of classes and lines of business that make up their insurance operations.

Exposure data management practices vary significantly from company to company and they appear to evolve continuously as organizations change. Data organization methodologies today differ in source, design, and application. Businesses group the range of classes of exposure under markedly different management structures, and there are wide variations in nomenclature and terminology.

Companies compile and extract management reports from a variety of different systems across numerous departments within their businesses. Despite consolidation within the industry, multiple systems are still being maintained within large insurance enterprises. International insurers also manage large numbers of different data repositories, exposure data bases, and reporting analysis output archives.

[1] Cambridge Centre for Risk Studies. 2018

Many companies have started to adopt a more strategic and enterprise-wide view of their exposure data supply chain and are creating systems and processes that will feed management views of consistent exposure reporting across their departments. Several companies now regard their exposure data as a critical business asset, wherein having a consistent method of identifying, measuring, and monitoring exposure is vital.

Exposure data standards are in common usage for property catastrophe classes, but other classes of insurance lack similarly common description standards. The Data Definitions Document developed for this project is intended to provide a standardized description of exposure across most classes of insurance, including those that previously did not have a commonly accepted data standard.

## 2.1 Objectives

The Data Definitions schema has been designed for reporting and monitoring insured exposure in a consistent way across multiple classes of insurance. The main purpose of this document is to improve the management of insurance exposure accumulation risk. To achieve this, five objectives were identified by the Steering Committee:

1. Provide a more comprehensive and standardized framework for monitoring and reporting exposure enterprise-wide and function as a system of record, for risk managers, brokers, consultants, and analysts.
2. Improve interchanges of data between market players to improve risk transfer to reinsurers and other risk partners, reporting to regulators, and information exchanged for risk co-share, delegated authority, and bordereau activities.
3. Apply accumulation risk model scenarios for classes of business that currently have less well-developed models available for them.
4. Support clash model analysis for scenarios that impact multiple lines of insurance.
5. Enable a new generation of models and risk analytics as well as expand the scope of potential risk management applications.

These objectives have been successfully met through the document's five use cases, prioritized by the steering committee and consultation community. The anticipated benefits and solutions are outlined below.

### 2.1.1 Single Policyholder Aggregation Risk

The Data Definitions Document proposes the use of a DUNS identifier and the full text of the legal name of a company to track and aggregate all areas of exposure and different lines of cover being provided to a single policy holder, such as a major corporate insured. Tracking the legal entity holding the insurance policy makes it possible to track and consolidate synonyms for the same organization, subsidiaries, and holding companies that constitute a single source of exposure. Standardizing the tracking of corporate insureds facilitates a useful consolidation of the exposures within a single company, even when the policies within an insurance or reinsurance portfolio originated through different channels, policies, or treaty participation.

### 2.1.2 High Value Single Location Aggregation Risk

The proposed Data Definitions schema makes it possible to identify and quantify the concentrations of insurance assets and liabilities across multiple lines of coverage in individual locations. For example, the destruction of the World Trade Centre in 9/11 triggered losses across many lines of business, some of them unexpected, and several posing record loss pay outs for their line of business. Locations with concentrations of multiple lines of insurance exposure include major airports and rail terminals, prestige commercial developments, retail malls, major industrial facilities, infrastructure and supply hubs. Identifying the locations where many insurance lines have concentrations of risk is an objective for tracking multiline exposure in the data schema.

### 2.1.3 Multi-Line Clash in Complex Loss Events

The Data Definitions schema provides a framework for analyzing how multiple classes of insurance business can potentially be impacted by the same underlying event – i.e. assessing potential for 'clash' between lines of

business. The data definition schema enables exposure to be measured in a consistent way from one class of insurance to another. The structure of the exposure definition document makes explicit the coverages that are offered for the various assets being insured, and the liabilities and guarantees being provided by the insurance policy. This enables a transparent system of loss estimation modelling by tracing the potential for an event to trigger coverages in the policies.

This can be used to assess the impact of complex risk events. Due to commercial interconnectivity and liability relationships between counterparties, non-intuitive losses occur, but have historically been difficult to express across multiple independent schemas. Through the availability of one standardized multi-line data schema, connectivity and consequences from clash events can be identified.

### 2.1.4 Enabling Exposure Analytics in More Classes of Business

The data definition schema is intended to enable loss modelling beyond the lines of traditional property catastrophe models, and to encourage the application of new models to more lines of business. It was not within the scope of the project to develop new risk models for each of the lines of insurance business that the schema covers, but the schema needed to demonstrate that the data definitions were useable in models. To do this, the project has developed sample clash scenarios that used the schema to model the loss within each of the main classes of insurance covered. We believe that this has demonstrated the capability of the schema to support new modelling initiatives. This is described in more detail in this report. We believe that this standardized schema will make it possible for insurers to create and apply their own internal models, and for third parties to develop new models. We hope to facilitate an expansion of risk modelling with the publication of this schema.

# Part II: Defining Data Definitions for Insurance Exposure

The Data Definitions Document was developed as an open multi-line data definitions resource to capture the most significant classes of business exposure within the insurance market. The process was completed in a series of stages, outlined in this chapter.

## 1. Insurance Industry Data Definition Review

The first step in the data definitions document development was a review of the market, and the various schema initiatives which exist. Sixteen schemas and data standards were reviewed, summarized in Table 1, and in most cases a full copy of the structure of the schema was obtained for review.[2]

**Table 1: Insurance Industry examples of existing data definition systems**

| | Organization | Primary Focus | Main Insurance Classes Covered |
|---|---|---|---|
| | **ACORD** | Data Exchange Standards | Non-Life |
| | **International Organization for Standardization (ISO)** | Data Exchange Standards | Non-Life; Life & Health |
| | **British Standards Institution (BSI)** | Data Exchange Standards | Non-Life |
| | **A.M. Best** | Rating Submissions | Life & Health; Non-Life |
| | **Lloyd's Risk Codes and TOM** | Regulatory Submissions and Data Exchange Standards | P&C, Reinsurance |
| | **UNECE: XML Naming and Design Rules** | Data Exchange Standards | Non-Life; Life & Health |
| | **Xuber Xposure** | Policy Administration System | Property |
| | **Russell Group** | Policy Administration System | Specialty Classes |
| | **NIIT Technologies** | Policy Administration System | Specialty Classes |
| | **AIR Worldwide** | NatCat Modeling | Property; specialty, marine, energy, workers' comp, cyber, life and health, agriculture. |
| | **OASIS Loss Modelling Framework** | NatCat Modeling | Property NatCat |
| | **RMS, Inc.** | NatCat Modeling | Property; Industrial; Marine Cargo; Workers Comp; Cyber; Terrorism; Life & Annuities |
| | **Arium Risk Architecture** | Liability Risk Modeling | Casualty Liability |
| | **Praedicat** | Liability Risk Modeling | Casualty Liability |
| | **Willis Re eNTAIL™** | Liability Risk Modeling | Casualty Liability |
| | **AgRisk** | Agriculture Risk Modeling | Agriculture |

The review indicated that there are many different data schemas and standards in operation across the insurance industry. Some classes of insurance exposure are much better described and are captured in greater detail than others. Property Catastrophe is one of the most highly-developed area of exposure capture, with

[2] We gratefully acknowledge the assistance provided by each of the organizations that provided their data schemas for inclusion in the market practice review.

several vendors of analytics specifying exposure data structures that enable the models, and that can capture highly granular detail about the insured assets. Other lines of business tend to be documented in various types of Policy Administration Systems, with an emphasis on tracking accounts, binding authorities, managing claims, and maintaining contractual information about the insurance coverage. Several schemas have been proposed by standards authorities for insurance exposure capture, with a view to standardizing the exchange of data between market participants, or for submission to market regulators or rating agencies.

No single standard provides complete coverage of all the main classes of insurance across the industry and can be adopted for consistent exposure management. Most insurers that we consulted have assembled systems that take components from several of these offerings and then use their own integration techniques to derive management reports across the different classes that they hold.

The review found a fundamental issue to be inconsistencies and differences in terminology and organization of classes of business within the international insurance markets, such as those of the United States, the United Kingdom, and Europe. The terms and conditions, contractual forms, and templates for insurance policies, are significantly different between these different markets.

## 2. Principles

The second step in defining the data definitions was the establishment of principles to guide the decision-making process. The principles where developed through consultation with the insurance community in the v0.1 consultation and were fundamental in later data definition design. The agreed upon principles include:

### a) Exposure and Accumulation Focus

*The primary purpose of the schema is to report and monitor exposure and to manage accumulation. We acknowledge that the schema will also be useful in other areas of insurance such as underwriting and claims management.*

### b) As Simple as Possible

*The schema must be kept as simple as practically possible. The intent of the schema is to provide a consistent framework for benchmarking exposure across all classes of insurance business. Consequently, covering as many classes of business as possible is prioritized over the level of detail for any individual class. Future versions of the schema can be made more complex and detailed over time.*

### c) Make the Schema Hierarchical and Extensible

*The data schema is hierarchical – i.e. it is designed as several layers of characteristics and attributes, each of which is capable of being further subdivided to create more detail. The data dictionaries, for example, are capable of further subdivision to create more detailed versions in the future. The schema must be extensible beyond the recommended minimum standard. Individual companies may create their own sub-categories and add detail as they think appropriate. These will be customizable layers of detail that will be proprietary to that company.*

### d) Asset Descriptions Combined with Insurance Coverage

*The design of the schema must include a set of descriptions about the asset or item-at-risk (the 'risk object') in combination with the insurance coverages, policy, terms and conditions. Separating asset descriptions from insurance coverages enables exploration of the impacts of changing insurance coverage structures on the exposure.*

### e) Make the Data Schema Compatible with Other Standards as Far as Possible

*Where possible, the data schema must be compatible with and capable of translating into other data standards, such as regulator reporting standards, rating agency filings, and ACORD components, that are widely used across the industry.*

## 3. Consultation Document Process

The third step was the community consultation process, which was conducted using consultation documents. Each document was sent to interested participants and was also available online. Feedback was requested within a 2-month window and this input was compiled in the weeks following. Conclusions and recommendations were formulated, for review, approval or modification at steering committee workshops.

### Version 0.1: Principles and Prioritization

The first stage of the project involved setting out the key principles and prioritization of the classes of business for development of the schema. The version 0.1 Consultation Document described the objectives of the project, provided an overview of current market practice, reviewed the wide range of existing and proprietary data schemas for different classes of insurance that are available and how a data schema can incorporate existing standards and current practice. It proposed a set of principles to be observed when designing the schema. It proposed a phasing and prioritization of classes of insurance to be developed. The views and feedback from the v0.1 consultation was incorporated into the planning, phasing, and structure of the proposed data schema.

### Version 0.5: Outline Structure and Key Components

For each class of business, the version 0.5 of the proposed data definition provided an outline structure and defined the main categories of exposure data for each class of insurance. This was defined in a number of 'dictionaries' – lists of categories that can be applied to accounts to describe and classify information about them for accumulation purposes. The version 0.5 was typically developed through detailed interviews with specialists in the class of insurance being developed. Version 0.5 identified all the dictionaries required but did not attempt to define the full content of these dictionaries – i.e. the fields and categorization, lists of asset types, or attributes of the exposures and coverages. This was addressed in version 0.9. The version 0.5 document was reviewed, and comments and feedback incorporated into the version 0.9 definition.

### Version 0.9 Detailed Structure

Version 0.9 of the Data Definitions Document provided a complete set of data definitions for each class of insurance, with all parts of the data definitions and dictionaries fully populated. These were structured according to the principles and components of the version 0.5 outline. Enumerating comprehensive lists of potential categories of lines of insurance, assets, coverage types, and other aspects involved further detailed interviews with specialists in those classes of insurance, combined with documentation review, and collation of sample data where provided. Version 0.9 of the Data Definitions Document was distributed for review. In addition, version 0.9 was tested for its usability in loss modelling by using it to develop clash scenarios for estimating quantitative claims pay outs from coverages in the schema. Lessons learned from the scenario loss development and feedback from the consultation round were incorporated into a final version of the data definitions.

### Version 1.0 Complete Data Definition

Version 1.0 consists of complete listings of field values, dictionary itemization, and reference tables and definitions. This represents a complete minimum exposure data standard for each class of business.

### Beyond Version 1.0

We expect that there will be future versions of the schema for each class of insurance business, versions 2 and beyond. These future developments might seek to extend the schema or to provide more detail and granularity. These potential embellishments are beyond the scope of this current project.

## 4. Exposure by Classes of Insurance

The insurance industry does not have a unified, agreed-upon, structure for all classes and lines of insurance business and is typically reported and regulated in various categories of insurance. Internally, organizational structures tend to cluster insurance products within the underwriting skills required, the types of customers they

serve, and the geographical markets being covered. This departmental structure varies in different insurance companies, thus terminology for what constitutes a 'class' of business or a 'line' of business is not universal.

### 4.1 Life and Non-Life, Commercial and Personal Lines

The primary division of insurance is into Life and Non-Life insurance industries. These are regulated in different ways. Many general international insurers and reinsurers operate in both the Life and Non-Life industries. We intend the exposure data schema to cover both Life and Non-Life insurance industries.

A second common differentiation of insurance management is between commercial lines, sold to businesses, and personal or consumer lines, sold to individuals. This division applies to Life and Non-Life.

This segmentation provides four 'quadrants' of insurance business: Life Commercial; Life Personal Lines; Non-Life Commercial; Non-Life Personal Lines.

### 4.2 Classes of Business

Existing exposure data definitions already exist for some classes of business, and have been in use for exposure management, accumulation loss modelling, and insurance analytics for many years. These include:

- Commercial Property
- Residential Property
- Workers Compensation
- Cyber Insurance[3]

These have been defined and evolved over the years to provide a consistent approach to measuring exposure. For this project, we have provided a Data Definitions Document for an additional 15 classes of insurance, prioritized by the steering committee and community of insurance companies. The data definitions for these classes apply similar principles to those of the previously-existing exposure data schemas, to enable consistent metrics of exposure to be applied across the whole of a multi-line insurance portfolio.

The Data Definitions Document covers the following 15 broad classes of insurance business:

A. Casualty and Liability
B. Marine
C. Energy
D. Aviation
E. Trade Credit
F. Surety
G. Life
H. Health
I. Agriculture
J. Political and Security Risk
K. Annuities and Pensions
L. Personal Lines
M. Commercial Lines
N. Specialised Underwriting Classes

The data definitions for each these classes of insurance are provided in *Multi-Line Insurance Exposure Management: Data Definitions Document v1.0*.

## 5. Data Definitions Structure

The Data Definitions Document proposes a set of information that can be applied to an individual policy. A policy is an insurance contract with an insured party, either an organization or an individual. An insured party may

[3] In 2016 the Cambridge Centre for Risk Studies developed a Cyber Data Exposure Schema v1.0 that has been widely adopted in the market, specified in Cambridge Centre for Risk Studies (2016).

represent an 'account' to an insurance practitioner, and an account may consist of several policies, possibly in different classes of insurance.

A policy may have additional schedules attached to it, such as lists of the assets or risk objects (such as people or products) that are being insured under that policy. The Data Definitions Document proposes a minimum set of attributes for each of the assets or risk objects on the schedule.

The data definitions for each class of business includes of a number of 'dictionaries' or lists of defined categories that can be applied to account holder, policy, asset or risk object details to describe and classify information about them for accumulation purposes. These dictionaries are defined in the Data Definitions Document for each class of business.

Within the Data Definitions Document, dictionaries can either be general to all classes of business (General Table) or specific to a class of business (Class Specific Table). The use of general tables allows for information to be referenced across multiple lines of business, such as account holder details, employee information, or policy particulars. This is compared to the Class Specific Tables list information, which is only relevant to the class of business. This ensures that specialized information concerning class of business specific assets can be captured as extensions to the general asset tables.

We recognized throughout the process that there is a geographical difference in terminology and organization of insurance. Where possible, we have included equivalences and known terms that refer to the same coverage. When one market has a different common practice from another, we offer both as options within the dictionary lists, for example 'Commercial General Liability' is a specific type of Casualty Liability insurance in the United States, whereas there is a similar but different product type 'Employers Liability' offered more commonly in markets outside the United States. The schema lists both types as options for coding a policy.

It should also be recognized that translating and recategorizing from one market practice or internal system to a single standard has the potential for introducing additional uncertainty into a company's exposure management. However, the benefits of a common standard for describing exposure are recognized as being sufficiently important to try to describe a consensus for most of the main types of exposure.

Table 2 summarizes the dictionaries that are usually used, and the information contained, when using the Data Definitions Document.

**Table 2: Data Definitions Document Dictionary and Schedule Types**

| Dictionary Name | Schedule/ Dictionary Type | Information Included |
|---|---|---|
| Information About the Insured | General | Schedule regarding the insured individual or organization |
| Policy Level Exposure Capture | General | Schedule regarding the policy, including financial details, coverage inception and expiration, inclusions and exclusions |
| Type of Insurance and Coverage | Class Specific | Dictionaries regarding the accepted segmentation of the market into the range of insurance products offered to cover sets of assets and insurance needs with appropriate attentions. For each type of insurance, the Data Definitions Document identifies the coverage type which would be applied, for example physical damage, liability, business interruption and so on. |
| Type of Asset | Class Specific | Dictionaries listing a hierarchical categorisation of assets typically covered in the insurance type. |
| Locations Schedule | General | Schedule that captures location information about the asset. This can either be an individual location or an aggregate location, depending on the schedule used. |

| | | |
|---|---|---|
| General Asset Schedule | General | Schedule which captures basic information about a physical asset. |
| Class of Business Specific Attribute of Asset or Location | Class Specific | Additional schedule table that lists asset or location specific attributes that have major exposure implications that are not captured in the general tables. |

## 6. A Visual Atlas of Global Insurance Exposure

In addition to the development of the data definitions document, a core objective throughout the project was to better understand the insurance industry's scope and interconnectivity. This was desired when prioritizing the work flow in the project and identifying the areas and co-dependencies of which would most value from multi-line data definitions uniformity. This was approached by considering the total insured value for each of the proposed classes of business and identifying the types of exposure contributing to the total dollar value.

### 6.1 Estimating Global Exposure Value

When estimating the global exposure, we took the estimated total aggregate insured limit represented by each class, using gross written premium information,[4] and took the average or approximated ratios between premium and total limit. When estimating investment products, we took exposure to represent the total assets under management, as the potential loss or devaluation that could occur to those assets.

We estimate that the global insurance industry manages around $540 Trillion of exposure in aggregate limit and assets at risk. The total estimated exposure in each insurance class is provided in and illustrated by the size of each square in Figure 1.

### 6.2 Estimating Global Exposure Type

When estimating the global exposure value, we also considered the type of exposure, or contractual obligations of insurers to compensate their policyholders for the different types of loss process or indemnification of their liabilities. In the case of financial guarantees, or annuity assets under management, the insurer has exposure to the potential devaluation of financial assets. The exposure type reflects different risk analytics that are needed to analyse and manage these classes of insurance business. This was summarized into six different types of exposure, indicated by colour coding in Figure 1.

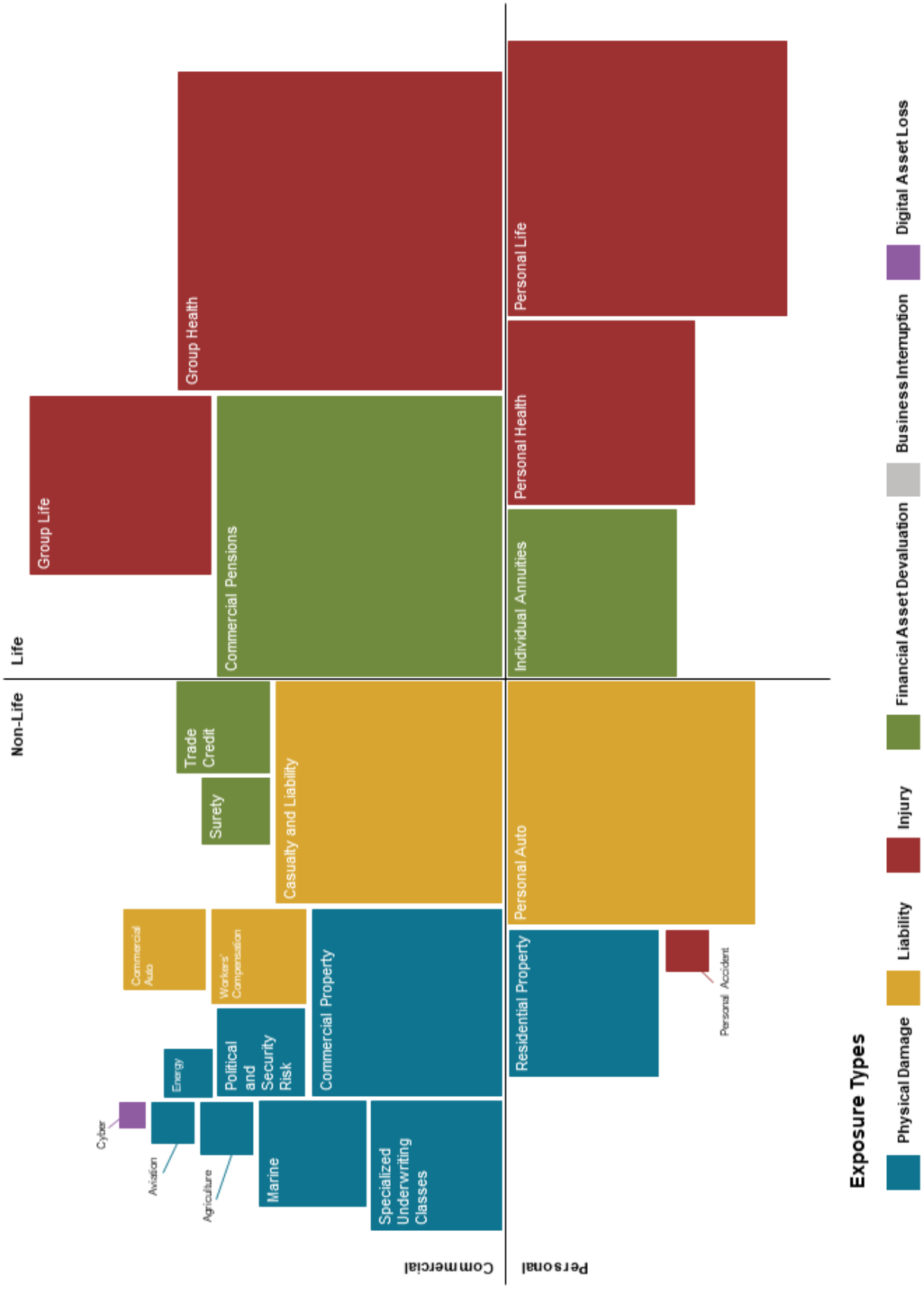
### 6.3 Loss Ratio Volatility

Table 3 also provides indicative assessments of the level of risk of each class of business, as measured by loss ratio volatility. This is an indicator of the historical annual variability of loss ratios[5] (claims that have occurred relative to the premium received), and the potential for catastrophe loss to occur in that class of business. Volatility, risk, and catastrophe potential for any class of insurance business vary significantly across geographical markets and over time. Accordingly, this measure is only indicative, and it is intended to provide comparison between classes of business for context in the prioritization of classes of business for schema development.

[4] We gratefully acknowledge the compilation of GWP worldwide by insurance class of business provided to us by AXCO Insurance Information Services Ltd. specifically for this analysis.

[5] Loss Ratio Volatilities for different lines of insurance business in international markets are reported in Aon Benfield; 2016 ("Global Risk, Profitability, and Growth Metrics" 2016)

**Figure 1: Atlas of Global Total Insured Exposure**



Source: Cambridge Centre for Risk Studies

**Table 3: Classes of Insurance Business and their Prioritization for Data Schema Development**

| Class of Insurance | Type of Insurance[6] | Total Global Exposure (Trillions) | Loss Ratio Volatility (Cat Potential) |
|---|---|---|---|
| **Non-Life** | | | |
| **Commercial Non-Life** | | | |
| **Commercial Lines** | Commercial Property | $ 31.7 | High |
| | Commercial Auto | $ 5.9 | Low |
| | *Total:* | *$ 37.6* | |
| **Specialized Underwriting Classes** | | $ 15.0 | Moderate |
| **Energy** | | $ 1.7 | High |
| **Agriculture** | | $ 2.4 | High |
| **Cyber** | | $ 0.4 | Moderate |
| **Aviation** | | $ 1.4 | Moderate |
| **Political and Security Risk** | | $ 7.3 | High |
| **Marine** | | $ 10.0 | Moderate |
| **Trade Credit** | | $ 7.4 | High |
| **Surety** | | $ 3.7 | High |
| **Casualty and Liability** | | | |
| **Casualty and Liability** | All other Types of Liability Insurance | $ 45.0 | Moderate |
| | Workers Compensation | $ 8.5 | Low |
| | *Total:* | *$ 53.5* | |
| **Personal Non-Life** | | | |
| **Personal Lines** | Residential Property | $ 20.0 | Moderate |
| | Personal Accident | $ 1.5 | Moderate |
| | Personal Auto | $ 58.6 | Low |
| | *Total:* | *$ 80.1* | |
| **Life and Health** | | | |
| **Life** | Group | $ 28.7 | Low |
| | Personal | $ 66.9 | Low |
| | *Total:* | *$ 95.6* | |
| **Health** | Group | $ 92.6 | Moderate |
| | Personal | $ 30.9 | Moderate |
| | *Total:* | *$ 123.5* | |
| **Annuities and Pensions** | Pensions (Commercial) | $ 70.0 | Low |
| | Annuities (Individual) | $ 30.0 | Low |

[6] Some types of insurance have been highlighted within their classes of business for visual effect

# Part III: Exposure Management and Accumulation Scenarios

## 1. Exposure Monitoring and Reporting

### 1.1 Exposure data reporting

The Data Definition Document has been designed to enable quantification, routine monitoring, and reporting of exposure in a consistent way across multiple classes of insurance. It enables exposure reporting at high levels of granularity, for example parsing the exposure represented by individual components of coverage. It has been designed to be hierarchical, to be able to provide exposure summarized at each level of the hierarchy. Uniform and consistent exposure reporting is a key part of the rationale for using the data definition structure being proposed.

### 1.2 Granular and flexible exposure analysis

The exposure can be analyzed in terms of potential loss to an insurer, by assessing the cumulative limits at risk within lines of insurance, locations and jurisdictions, asset types, coverage categories, and qualified by many attributes of the assets in the policies. The potential for reporting and analyzing exposure by combinations of these exposure data descriptors make it a very flexible and detailed structure for exposure interrogation.

The principal use cases of exposure monitoring, identified as important value propositions for users of multiline data definitions, enable exposure analysis in a number of specific ways:

a. Single policyholder aggregation risk - Allows the consolidation of the exposures of a single company across all its different classes of insurance, through tracking the unique identifier of the legal entity holding policies in each area of business.
b. High value single location aggregation risk - Enables exposure to be analyzed by geography, using locator information to enable spatial queries to identify high concentrations of exposure and geographical proximity to other key insured asset locations.
c. Multi-line clash in complex loss events - Enables analysis of scenarios of loss to be assessed through assumptions about claims patterns using loss modelling.

## 2. The Use of Scenarios for Accumulation Management

### 2.1 Scenario-based loss estimation

Scenarios form the basis of loss estimation that is commonly used in managing insurance accumulations. The scenarios help insurers examine what scale of loss they could potentially suffer, from their portfolio of insurance policies. ‘Accumulation’ or concentrations of exposure can occur in a number of ways and could lead to an insurer experiencing higher than expected losses, or higher than their market share, because they have unknowingly written policies that have clusters of exposure in one place or have commonalities that could cause numbers of them to make claims from the same underlying event or cause. Keeping insurance portfolios diversified is an important principle of exposure management.

Scenarios are a good way of testing the amount of loss that could potentially occur and managing portfolios to minimize losses from the chosen scenarios. To test that the data definitions document is appropriately structured to be useable in the development of scenarios, we used the data definitions document to develop three clash scenarios that each address a number of the classes of insurance covered in the data schema.

It is important to note here that the emphasis of the analysis of these scenarios was to test and demonstrate the practicability of using the data definitions document for scenario development. It was not to produce highly developed loss estimation models for each of the classes of insurance.

Understanding the use of scenarios and the roles they play in accumulation management was a core step in ensuring the data definitions document supports the needs of insurers. Scenarios are commonly used in managing insurance accumulations. They can help insurers examine the scale of loss which could be potentially suffered from their portfolio. ‘Accumulation’ or concentrations of exposure can occur in several ways and can lead to an insurer experiencing higher than expected losses. This can be from unknowingly writing policies that

have clusters of exposure in one place or have commonalities that could cause numbers of them to make claims from the same underlying event or cause.

### 2.2 Spatial accumulation scenarios

Accumulations can occur geographically – policies have exposure within them that are clustered in the same place which is impacted by a peril or cause of loss that affects a particular spatial area. Many of the key insured perils affect locations spatially, with a particular region being impacted by an event that can be described by a footprint on a map, such as an earthquake isoseismal, a hurricane wind field, a flood extent map, an explosion pressure wave, or many other potentially loss-causing events. To assess accumulation scenarios for these types of events, the scenario needs to define the spatial extent of a potential future event, with the intensity of the phenomenon that is experienced at each location, together with an assessment of the consequences and the loss that would be expected to result to each of the exposure types when they experience the phenomenon at a certain intensity. The spatial definition of the intensity of a phenomenon is often referred to as a *hazard model*. The relationship between a metric of intensity of the hazard and the insurance loss that would be caused to the exposure types at each level of intensity is typically referred to as a *vulnerability model*.

By spatially locating the exposures that are contained in the schedules of an insurance policy, insurers can use scenarios of the locations and extents of geographical hazards to manage their spatial accumulations. This requires diligence to ensure that all the significant exposures in all the insurance policies in a portfolio are spatially referenced, otherwise the true extent of the potential loss will not be revealed.

### 2.3 Non-spatial accumulation scenarios

Accumulations can also occur in non-spatial ways, particularly for some classes of insurance and coverages. Classes of insurance such as casualty liability, trade credit and surety, and coverages such as contingent business interruption, can have losses that flow through other types of commonality between policies than geographical proximity of the locations of the insured assets. Losses might be triggered in policies that are all held by companies with similar businesses activities, practicing in the same sector, or providing products to the same creditor.

Assets are increasingly interdependent, and networks are far more complex with the increased system dependencies. This creates challenges in both identifying sources of risks and interpreting how far spread the impact may be. The risk landscape is arguably becoming less geographical, and more of a global network, with location being less important than dependencies and relationships.

To manage non-spatial accumulation risk requires the use of scenarios where insurance losses flow through business practices and trading flows. These types of accumulation scenarios, while less common, are increasingly sought after. The exposure attributes that enable these accumulations to be assessed include business activity sector coding, and information about third party counterparties, which are incorporated in the *Data Definitions Document v1.0*.

To test the suitability of the data definitions document for use in both types of accumulation risk management, three clash scenarios were developed that require loss estimation for both spatial impact of hazard, and non-spatial impacts (such as trading flows and non-spatial correlation between policies in other classes of insurance).

## 3. Coverage Trigger Pathways

The linkage between exposure definitions contained in the data definitions document and a loss estimation process was made explicit through the consideration of coverage trigger pathways. For a given scenario, this used the exposure data definitions to consider ways that a particular event could trigger a pay out of claims under the coverages provided for that type of exposure. This uses the concept of ‘reverse stress testing’ – i.e. it identifies the major categories of exposure and considers ways that severe losses could be experienced to that exposure, due to the scenario’s occurrence.

### 3.1 Scenario narrative to coverage

The schema design and scenario development were iterative processes. When we began to estimate a loss based on the scenario narrative, we would often find that more research was needed to flush out a given type of insurance and the respective coverages. We would conduct research and interviews to determine the correct type of insurance and coverage for a particular scenario narrative, which then informed further updates to the schema.

This exercise provided a complete schema design that will enable loss modelling by allowing for a quick transition from a scenario narrative into the type of insurance and coverages affected. For example, our scenario narrative could state that several shareholders see significant losses and sue a given company known to have been impacted by a catastrophe. We can easily identify that this will hit the type of insurance of Directors and Officers (D&O) and more specifically the coverage of 'Side C – Securities Entity Cover'.

### 3.2 Risk object and attribute selection

When selecting policies to apply losses to, it is critical to filter for policies that meet certain criteria. For example, when estimating pollution liability, we can filter marine hull policies that cover single versus double-hull oil tankers to estimate a loss for each type of vessel as the pollution liability limits differ by this risk attribute. The schema encourages this level of data capture to better improve loss modelling estimates. Insurers may find it challenging to capture all the risk attributes we have proposed in the data definitions, but we are recommending them as desirable to improve their accumulation management.

Further, we have determined that within Casualty and Liability policies, the asset at risk (or risk object) is not the traditional assets we consider for property insurance, but instead are civil legal liability exposures such as:

- Wrongful Act[7]
    - Breach of duty (Negligence)
    - Error or omission
    - Breach of contract (unintentional)
- Misstatement or misleading statement
- Wrongful death
- Wrongful termination

These are the legal principles that liability policies cover and relate to the assets captured. For example, when insuring Directors and Officers, you still want to capture information about the directors and officers, but the fundamental object at risk is their breach of duty to their employees and shareholders.

### 3.3 Need for better modelling

Estimating losses from all classes of insurance highlights the need for better modelling methods. To estimate losses from Casualty and Liability, we developed a legal liability model for each type of insurance and parameterized it based on historical litigation. This model creates a consistent framework for evaluating all types of liability loss and determines the percentage of cases that are settled pre-trial, are dismissed or that go to trial. A consistent framework like this is needed for other classes of business as well, such as trade credit and for contingent business interruption (CBI) within the Commercial Lines class.

## 4. Scenario Development Methodology

The Cambridge Centre for Risk Studies has been developing stress test scenarios since 2009 and has developed a robust methodology and scenario framework that can be adopted to a wide variety of threats that may need to be modelled. These methods provide recommended techniques for developing scenarios that utilize the exposure data definitions document.

[7] The full list of civil legal liabilities is available in the Data Definitions Document.

Computational risk modelling overlays exposure data with hazard and vulnerability models to generate probabilistic and deterministic risk estimates.[8] However, modelling also requires consideration of how insurance claims arise, are made, and are ultimately settled. This report captures three stress test scenarios that can be used for clash accumulation management by multi-line insurers. The following steps were taken to develop each scenario:

1) Background Research – to understand the chosen catastrophe, the research team completed a set of background research, this informs the written scenario narrative.
   a) Timeline and Footprint – research into the potential timing of the catastrophe and the geographic footprint is done to aid in the scenario narrative. For the pandemic research was done to understand how spread of the virus geographically through analysis of airplane networks.
   b) Historical and Physical Context – we look at historical catastrophe examples for inspiration into the potential magnitude and scale of the event. Whenever possible, we will look at historical data to bind the scenario to a 1-in-100-year magnitude. For the hurricane scenario, a review of all potential hurricane footprints was completed to identify the path that caused the most insurance losses.
2) Scenario Development Workshop – we host internal and external scenario development workshops to elicit expert opinions on the narrative and scenario parameters, i.e. how large could the event be, what lines of insurance will be most impacted and so on.
3) Narrative – The above steps can be cyclical in nature, for example following the scenario development workshop we may need to do more research before we can write the narrative as we learn additional contextual information that will limit or change several key scenario parameters. Once we are comfortable with the scenario we will draft a narrative, trying to consider the direct and indirect losses that the scenario will cause to better estimate the insurance loss.
4) Loss Assessment – as part of this research project we have refined our process for determining impacts to the insurance industry. The new process now involves identifying all 'coverage trigger pathways' that could be impacted by the scenario. These are sub-narratives that are taken from the overall narrative that specifically describe an individual insurance loss. For example, in the China-Japan war scenario, we consider that buildings suffer physical damage due to bombing during the war. We will then connect this to a coverage, i.e. 'physical damage'. Further, we will connect that to a type of insurance, which in this case is Security Risk/Crisis Management (type of insurance) and Political Violence (subtype of insurance) as this is the form of property insurance that covers physical damage due to war related named perils. Finally, this loss can be shown at the class of business level of Political and Security Risk.
5) Industry Impact – once we have identified all the coverage trigger pathways, we will model the potential losses to the insurance industry both as an economic loss[9] and insured loss[10]. In this modelling we aim to develop consistent frameworks for estimating loss so that it easier to compare the losses within and across classes of business.

Our main guiding principle in scenario development is to create scenarios that are plausible but extreme as a means to stress an insurer's portfolio. This follows the recommendation of Lloyd's, Bank of England PRA and the US Federal Reserve Board. We typically create at least three scenario variants, as follows:

- S1 variant as the expected outcome conditional on the scenario definition.
- S2 variant applies more pessimistic assumptions for the key variables that drive the loss
- X1 variant assumes extreme but plausible values and combinations of extreme conditions

These scenarios are stress tests and are not predictions.

[8] "Risk Models - Understanding Disaster Risk Modelling" 2015
[9] Losses before insurance participation is considered
[10] Losses after insurance penetration is considered. This category can be further broken down to ground up losses (GU) where just insurance penetration considered and gross losses (GR) where limits and deductibles are considered.

## 5. Applying the Data Schema in Clash Scenarios

Following the completion of the data schema document, three scenarios were tested to validate its use. The scenarios varied in scale and proceedings but were all clash events which were expected to trigger significant losses from a wide number of classes of business. The scenarios were aimed at looking beyond property losses, and explore more specialized classes of insurance, such as energy or life insurance. The scenarios were also selected to trigger losses that have been traditionally difficult to model, such as liability or trade credit. By triggering losses from multiple classes, the scenarios trialled the clash capability of the data definitions and aided in understanding the potential overlaps and distinctions which can occur in traditionally independently viewed classes of insurance.

The three scenario events were selected by the project steering committee, and involve a natural catastrophe, a global pandemic, and a geopolitical conflict. The scenarios were developed as the different phases of the data definitions were developed, so cover increasingly large numbers of classes of insurance from the schema and are designed to test the applicability of modelling to the specific classes of insurance within the schema. The number of classes impacted increases across the three scenarios as more phases are developed, as shown in Table 4.

**Table 4: Data Definitions Document Scenario Validation – Clash Scenarios**

| Class of Business | | Hurricane | Pandemic | Geopolitical Conflict |
|---|---|---|---|---|
| Commercial Lines | Property | 45 | | Losses to property with war cover is Included in Political and Security |
| | Non-Property | | 10 | 3 |
| Marine | | 10 | | 17 |
| Energy | | 49 | | * |
| Aviation | | 9 | | 6 |
| Personal Lines | Property | 84 | | * |
| | Non-Property | 3 | 10 | 3 |
| Casualty and Liability | | 20 | 81 | 59 |
| Specialized Underwriting Classes | | | 15 | 0.2 |
| Political and Security Risk | | | | 168 |
| Cyber | | | | 5 |
| Agriculture | | * | 9 | * |
| Trade Credit | | * | 10 | 41 |
| Surety | | * | 1 | 1 |
| Life | | * | 227 | * |
| Health | | * | 412 | 1 |
| Annuities and Pensions | | | Market risk potential | Market risk potential |

* Potential for minor losses, but not included in the scenario loss analysis

# 6. Hurricane Kayla – Property Casualty Clash Scenario

Large natural catastrophes pose significant risk for clash, with the potential to trigger losses in many property lines and casualty liability. The primary challenge for modelling clash in this example was to augment property loss with casualty liability loss analysis, which proved tractable and valuable to steering group members.

## 6.1 Historical Precedent

Hurricane Kayla is similar, but more severe than, Hurricane Katrina that hit the US Gulf of Mexico in 2005. Katrina generated the largest single loss in the history of insurance,[11] with estimated insurance losses as high as $54.6 billion (2017 Rate Adjusted)[12]. There were over 1.7 million claims across six states, and $16.1 billion in losses from property and business owners insured against flooding by the National Flood Insurance Program. Off-shore energy facilities saw insured damages upwards of $3 billion[13]. This is considered a strong clash scenario, with multiple classes of business being impacted by a single event.

Since 2005, many more hurricanes have occurred along the Gulf Coast, although none have been as costly Katrina. 2017's Hurricane Harvey brought a historic 50 inches (127 cm) of rain to southern Texas but did not cause the same level of storm surge as occurred with Katrina. Harvey triggered an estimated $20 billion insurance loss[14] and left almost half-a-million people reliant on federal aid. It raised major issues around low flood insurance penetration for properties in the affected areas.[15]

## 6.2 Scenario Narrative

A strong CAT 5 hurricane hits the Gulf of Mexico. We selected a track from the RMS US Hurricane model that would impact the offshore oil fields and track across the ports and concentrations of marine exposures of the Gulf coast, and potentially affect aviation exposures at airports. Winds, storm surge and heavy rain causes property damage, modelled by RMS, to which additional analysis considers losses to other classes of exposure, including marine hull, aviation, and casualty liability. In the more severe variations of the scenario, we assume that preparedness is poor, and that full evacuation and shut-down procedures are not taken. The three variants are summarized in Table 5.

**Table 5: Hurricane Kayla Scenario Variants**

| Scenario Variant | S1 | S2 | X1 |
|---|---|---|---|
| Hurricane Warning | Standard Response | Delayed Warning | Severely Delayed Warning |
| Evacuation Status | Full Evacuation | Delayed Evacuation | No Evacuation |
| Hurricane Category | Category 4 | Category 4 | Category 5 |
| Storm Surge (m) | 1.8 | 1.8 | 2.4 |
| Peak Sustained Wind Speed (km) | 257 | 257 | 305 |

## 6.3 Estimated Impacts

The hurricane track was selected to impact concentrations of offshore and onshore energy assets in the Gulf of Mexico, that would suffer significant damage from high wind speeds, wave heights, inland flooding, and sea bed disturbance. This was coupled with projected environmental liability and clean-up costs that could be expected from active platforms. As the scenario variants scale, we assume that fewer preventative measures are taken, and losses increase. A large-scale oil spill is modelled for the X1 variant, which lasts for several weeks. Marine losses are triggered through both personal and commercial hull damage, especially susceptible from high storm surges in the coastal regions. Ports are forced to close during the immediate repair process, affecting commercial marine trade. Cargo and specie face significant damage due to the storm surges and flooding of coastal warehouses and storage facilities. Perishables are especially hit, due to the long delays and power

[11] Towers Watson 2005a
[12] Towers Watson 2005a
[13] Towers Watson 2005a
[14] Meyer, Gray, and Fleming 2017
[15] Meyer, Gray, and Fleming 2017

outages. The aviation industry faces modest impacts, with small and midsize airports located in the hurricane path. Personal aircraft are subject to damage, and aircraft equipment suffers water damage in some airfields. In more severe scenario variants, a large aircraft crashes in the periphery of the storm, with a 100% fatality rate. This is attributed to human error during storm conditions. Liability and casualty claims rise in the months following the storm, due to perceived negligence and a failure in duty of care. Significant cases include medical malpractice lawsuits by patients treated during the hurricane, workers compensation claimed by emergency personnel injured during the response, and technical errors and omissions following failures in transmitting evacuation warnings via Emergency Communication Systems (ECSs). Total loss estimates are summarized in Table 6, below.

**Table 6: Phase One Loss Estimates**

| Class of Business | Type of Insurance | Ground Up Loss: S1[16] | Ground Up Loss: S2 | Ground Up Loss: X1 |
|---|---|---|---|---|
| Commercial Lines | *Total* | *$ 23* | *$ 31* | *$ 46* |
| | Commercial Property | $23 | $31 | $46 |
| | Commercial Auto | $0.1 | $0.2 | $0.3 |
| Personal Lines | *Total* | *$ 48* | *$ 62* | *$ 88* |
| | Residential Property | $46 | $60 | $84 |
| | Personal Auto | $2 | $2 | $3 |
| Casualty Liability | | $ 7 | $ 11 | $ 20 |
| Energy | | $ 17 | $ 42 | $ 50 |
| Marine | | $ 1 | $ 3 | $ 10 |
| Aviation | | $ 2 | $ 4 | $ 9 |
| **Grand Total** | | $ 98 | $ 153 | $ 224 |

[16] Each of these values, for S1, S2 and X1 are economic losses without insurance taken into account. For this report we called this ground-up (GU) losses.

## 6.4 Coverage Trigger Pathway example

**Class of Business:** Marine

**Type of Insurance:** Wet

**Sub-Type of Insurance (1):** Hull

**Sub-Type of Insurance (2):** Hull and Machinery

**Coverage:** Physical Damage

**Coverage Trigger Pathway:** Fishing Vessels docked at local Marinas face damage due to wind and storm surge.

**Historical Precedent:** During Hurricane Katrina, commercial vessels were heavily damaged due to the storm surge. Within a 2007 study of Hancock, Harrison, and Jackson counties, 87 percent of commercial vessels were damaged following the hurricane.

**Coverage Trigger Pathway Variables:**

- How many fishing vessels are typically in operation within the hurricane footprint?
- What percentage of vessels are likely to be docked in the affected coastline?
- What is the historical evacuation rate for marine vessels?
- What is the average damage distribution for marine vessels?
- What is the average value of a commercial fishing vessel?

# 7. Pandemic – Life, Health, Casualty and Financial Lines Clash Scenario

Infectious disease outbreaks are examples of non-destructive threats with the potential to disrupt the economy without a great impact on property insurance lines. Pandemics are not primarily spatial events – the disease spreads through human contact and impacts are felt globally. The Steering Committee selected a pandemic scenario as a clash event that would contrast with the property casualty clash scenario from phase 1. High levels of the population becoming sick puts stress on healthcare insurance while disease-related mortality stresses life insurance portfolios, and disease-related absenteeism in the workforce causes non-damage business interruption with potential for economic damage and triggering financial exposures such as trade credit and surety. Casualty liability lines are likely to suffer losses from increased levels of claims in medical malpractice and litigation that would follow business failures and economic hardship. All geographies and jurisdictions are likely to be affected, so insurers need to assess their potential exposure at a global level.

## 7.1 Historical Precedent

Pandemics occur two or three times a century with pathogen genetic shifts. Pandemics vary in severity, with the characteristics of the infectiousness and virulence of the virus. The 1918 'Spanish Flu' influenza outbreak was the most severe pandemic in recent history[17], with roughly 30% of the globe infected.[18] 50 million people died globally, [19] equivalent to 3% of the population. Future pandemics will be mitigated through emergency preparedness measures, the availability of antiviral and antibiotic medication, and rapid development of a vaccine to combat it, but modern transportation networks will facilitate the spread of the disease rapidly to human populations around the world. The scenario used here is based on a pandemic scenario originally developed and published by CCRS in 2014.[20] This produces similar conclusions to more recent published scenarios, such as simulations by the Institute for Disease Modelling.[21] One of the major concerns about a future pandemic, identified by the World Health Organisation,[22] is that the recent rise of antimicrobial resistant (AMR) strains of common bacteria could render less effective some of our medical treatments to secondary infections from pathogens, which could greatly increase the potential impact of a future pandemic. This potential is explored in the X1 variant of the pandemic scenario, in which AMR bacteria are assumed prevalent in the populations of countries where antibiotic treatments are routine.

## 7.2 Scenario Narrative

A highly infectious, fictional strain of influenza virus (H8N8) spreads across the globe, with over 40% of the global population infected. Primary healthcare physicians are overwhelmed by the demand for treatment. Hospitals are unable to handle the influx of more severely ill patients and set up temporary treatment sites and triage care systems. Anti-microbial resistant strains of bacteria are the cause of the secondary infections in extreme scenario variants, which evade conventional treatments and lead to higher death rates than those resulting from the flu virus alone. The virus originates from poultry farms in Brazil, and is quickly spread via air travel, following major aviation routes. Due to the pandemic, illness and absenteeism cause many commercial industries to suffer economically. Liability lawsuits are triggered from the handling of the pandemic by both medical and public staff. Impacts are felt across a range of other insurance classes, including contingency/cancellation insurance, liability, trade credit, surety, and agriculture. The rate of infection, illness and deaths scales across the three scenario variants. These are summarized in Table 7, below.

[17] CDC 2017
[18] Taubenberger and Morens 2006
[19] Taubenberger and Morens 2006
[20] CCRS. 2014
[21] Loria 2018
[22] Wise 2017

**Table 7: Pandemic Scenario Variants**

| Scenario Variant | S1 | S2 | X1 |
|---|---|---|---|
| Variant Description | Standard Scenario | Response Failure | AMR |
| Duration of Infection Wave | 7 months | 10 months | 12 months |
| Number of People Requiring Medical Treatment | 2.9 billion | 3.4 billion | 3.8 billion |
| Portion of the Global Population Requiring Medical Treatment | 40% | 46% | 52% |
| Number of People Requiring Hospitalisation | 113 million | 133 million | 154 million |
| Portion of the Global Population Requiring Hospitalization | 1.5% | 1.8% | 2.1% |
| Number of Fatalities | 12 million | 22 million | 30 million |
| Portion of the Global Population - Fatalities | 0.2% | 0.3% | 0.4% |

## 7.3 Estimated Multi-Line Insurance Loss Impacts

The greatest gross losses within this scenario are experienced by Life and Health classes of business. This is attributed to the large number of people who require medical services during the pandemic, and the number of fatalities that occur over a short period of time. These losses scale with the event severity, to account for the higher virulence, increased antimicrobial resistance, and emergency response failure which occurs in more severe scenario variants. Due to the transference of disease between poultry and humans, government slaughters are ordered in affected areas. This causes substantial losses in the Brazilian agriculture market, which has high poultry production. The scenario scales to address the increased proportion of poultry which are required to be culled. Due to the high amount of employee absenteeism, companies suffer economically. This is coupled with the lowered consumerism, dampened by fears of community social interaction and virus contagion. Many organizations suffer as a result, with the highest concentrations seen in hospitality and retail. These reflect into the Trade Credit market, triggering a rise in claims internationally. The final significant loss stems from liability, as a proportion of patients treated in temporary centres claim negligence during their medical treatment. Further claims arise from workers compensation, employer's liability, and product liability. Total loss estimates are outlined in Table 8 below.

**Table 8: Total Loss Estimates: Pandemic Scenario**

| Lines of Business Impacted | S1 ($ Billions) | S2 ($ Billions) | X1 ($ Billions) |
|---|---|---|---|
| Life | 122 | 172 | 227 |
| Health | 275 | 343 | 412 |
| Agriculture | 4 | 6 | 9 |
| Trade Credit | 3 | 4 | 10 |
| Surety | 1 | 1 | 1 |
| Liability (U.S.) | 45 | 63 | 81 |
| Specialized Underwriting Classes | 5 | 10 | 15 |
| Personal Lines | 1 | 5 | 20 |
| Commercial Lines | | | |
| **Total** | **456** | **604** | **775** |

### 7.4 Coverage Trigger Pathway: Case Study

**Pandemic**

**Class of Business:** Health

**Type of Insurance:** Individual

**Sub-Type of Insurance:** Individual (Habitant)

**Coverage:** Outpatient & GP Benefits

**Coverage Trigger Pathway:** An individual becomes ill from the pandemic and is required to see a general practitioner.

**Historical Precedent:** A deadly influenza virus spread from China all around the globe within 6 months in 1957, hitting Australia, North America, South Africa, and the Middle East. Transmitted predominantly by sea lanes, the infection had several waves with varied severities and fatal secondary infections. 1 in 4000 people is estimated to have died, putting the total death rate at over 1 million people, including 80 000 in the USA alone.[1]

**Coverage Trigger Pathway Variables:**

- How many people are infected by the virus?
- How many infected people are likely to seek medical treatment?
- What type of medical treatment will be sought? GP consultations, hospitalisation, prescriptions?
- What percentage of patients are likely to have health insurance?
- What is the average cost of medical treatment in the infected areas?

## 8. Southeast Asian Geopolitical Conflict – All Lines Clash Scenario

Geopolitical conflicts have the potential to cause losses across nearly all the lines of insurance that we have documented. A geopolitical military conflict between two major powers would have far-reaching ramifications, not only causing losses to commercial and personal assets in the conflict zone itself, but also would have impact on trading relationships across the world, disrupting supply chains, and causing financial and economic shocks to any modern economy with trading relations to the belligerent countries. The scenario tests the extent that war exclusion terms and conditions would protect insurers from claims arising from damage to standard exposure in the affected regions and explores how the specialized classes of political and security risks, incorporating specific war covers to commercial property, marine, energy and aviation risks, would respond under these circumstances. The fictional Sino-Japan Geopolitical Conflict is based on a CCRS report of 2014.[23]

[23] CCRS 2014b.

## 8.1 Historical Precedent

There are several candidate locations for future military conflicts, with many potential flashpoints around the globe. The scenario of China and Japan becoming embroiled in a conflict that would impact the critical trading zones in the Southeast Asian region was an obvious choice to stress test insurance exposure portfolios that are growing rapidly in Southeast Asia. The two countries have a long enmity, and have been to war with each other twice before, in 1894-1895, and then again in 1937-45. Tensions continue to run high today with disputed island territories and standoffs in claims for naval dominance of the sea straits. The 1937 war was particularly hard-fought and bitter, ending only with the Allied victor in the Pacific theatre in 1945. Today, the memory of both wars persists as a major obstacle to future Sino-Japanese relations and a point of cultural contention between China and Japan.

## 8.2 Scenario Narrative

Conflict between Japan and China escalates over disputed island territory. US policy is to side with Japan but not to engage in military conflict. Increasing tensions introduce trade restrictions and travel advisories, negatively impacting imports and exports to the areas. A series of provocations by both nations leads to missile strikes on commercial territories and limited cities in both countries. Specific targets include assembly plants, office buildings, poets, trucking and rail facilities. Residential areas are not targeted. The conflict is relatively short and leads to a negotiated peace following public solidarity and pressure from the international community to end the war. The scenario variants within the Sino-Japan Geopolitical Conflict are outlined in Table 9.

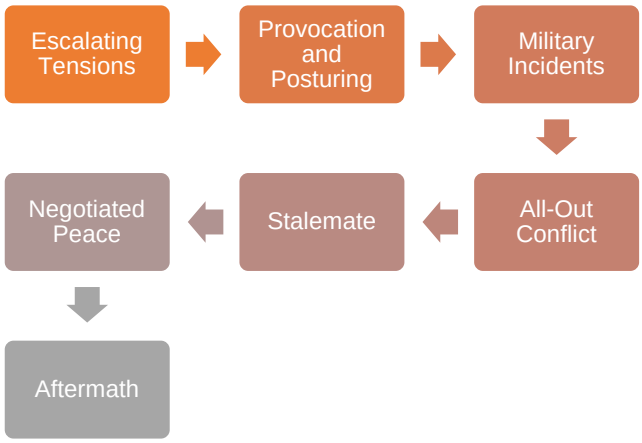



**Figure 2: Sino-Japan Geopolitical Conflict, Scenario Phases**

**Table 9: Southeast Asian Geopolitical Conflict**

| | S1 | S2 | X1 |
|---|---|---|---|
| **Civilian Deaths** | 100,000 | 250,000 | 500,000 |
| **Civilians Hospitalized** | 230,000 | 575,000 | 1,150,000 |
| **Property Damage** | $120 Bn | $300 Bn | $500 Bn |
| **Conflict Duration** | 9 Months | 24 | 60 |
| **Trade Disruption Duration (Months, In Addition to Conflict Duration)** | 3 | 24 | 36 (triggering a Recession) |

## 8.3 Estimated Impacts

The geopolitical conflict is anticipated to trigger losses from a wide number of classes of business. This is due to both the scale and duration of the scenario. Property and contents in the areas subjected to the strike are heavily damaged, and a proportion of these buildings have political risk property coverage in addition to their regular property cover. Life and health claims are triggered for those who are privately insured in the conflict area. Privately insured pension products are also heavily impacted due to the loss of employee contributions. Marine ports are targeted during the strikes, damaging cargo, hull, and port equipment. Yachts and private vessels moored at city harbours are also damaged in the strikes, amplifying personal marine claims. Cyber warfare between the two countries also escalates to cyber attacks on United States and results in large Cyber insurance losses, a predicted escalation for 21st century warfare. The high number of casualties and business interruption due to upset supply chains leads to large companies to default on their loans, triggering trade credit insurance losses. Casualty liability lines are stressed following environmental damages and worker compensation claims at targeted areas. Further incidents such as acts of terrorism, the kidnap and ransom of

high-profile individuals, and the repatriation of travellers, trigger losses in various other insurance lines. Calculated losses for each scenario variant are outlined in Table 10.

**Table 10: Total Loss Estimates, South East Asia Conflict**

| Class of Business | S1 Loss Estimates (Billions) | S2 Loss Estimates (Billions) | X1 Loss Estimates (Billions) |
|---|---|---|---|
| **Political and Security Risk** | $ 8 | $ 38.31 | $ 168.39 |
| **Trade Credit** | $ 19 | $ 24.40 | $ 40.99 |
| **Marine** | $ 3 | $ 7.98 | $ 16.80 |
| **Aviation** | $ 0.3 | $ 0.62 | $ 6.32 |
| **Life** | $ 0.03 | $ 0.16 | $ 0.48 |
| **Health** | $ 0.06 | $ 0.28 | $ 0.82 |
| **Travel Insurance** | $ 0.5 | $ 2.36 | $ 6.98 |
| **Cyber** | $ 1.4 | $ 2.60 | $ 4.63 |
| **Specialised Underwriting Classes (Specialty Insurance)** | $ 0.08 | $ 0.17 | $ 0.23 |
| **Surety** | $ 0.5 | $ 0.75 | $ 1.00 |
| **Casualty and Liability** | $ 14 | $ 30.56 | $ 58.53 |
| **Total** | $ 47.7 | $ 108.18 | $ 305.17 |

**Geopolitical Conflict**

**Class of Business:** Political and Security Risk

**Type of Insurance:** Security Risk/Crisis Management

**Sub-Type of Insurance:** Political Violence

**Coverage:** Physical Damage, Contents and Business Interruption

**Coverage Trigger Pathway:** Air strikes target key commercial facilities causing significant property damage in the conflict zone.

**Historical Precedent:** The 2003 Baghdad bombing saw complete destruction of government and military infrastructure. During WWI, the bombing of Dresden saw 23% of industrial buildings damaged, 1 million homes were destroyed during the Blitz in London and 50% of Tokyo city were destroyed.[1]

**Coverage Trigger Pathway Variables:**

- How many buildings are in the conflict zones?
- How many of these are likely targets for the air strikes due to the commercial and economic importance?
- How many of those are likely to have political risk insurance?
- What is the average value of buildings in the conflict zones?

# Part IV: Defining Insurance Exposure Data

## 1. Definitions for $500 Trillion of Exposure

The Data Definitions Document developed during this two-year project is broad and covers a wide range of classes of insurance. It provides a consistent method of managing exposure that can be applied across an estimated $500 Trillion of insurance exposure worldwide, making this one of the most ambitious attempts to catalogue and standardize exposure since the development of property catastrophe risk management approaches in the 1980s.

### 1.1 Breadth vs Depth

The consensus of the project Steering Committee and the community that was involved in supporting this effort, was that the strategy for developing the schema should be broad – as close to comprehensive as possible – to help insurance companies apply uniform assessments of their exposure across diverse international portfolios in many classes and lines of business. The other point of principle generally agreed was that the schema should be as simple as possible, and to align with current practice, terminology, and systems already in use. This was to minimize the amount of effort that an insurance company would need to undertake to implement the schema.

To provide breadth of coverage across this universe of exposure, the level of detail is necessarily limited. The data definitions provide a hierarchy of categories for descriptions of the exposure and limit the categories (to around 10) for each level of the hierarchy. In most dictionaries that have been specified in this version 1, we have proposed two levels of hierarchy – around 100 subcategories for any one type or attribute, and only on rare occasions where it seemed most significant, have we gone to a third level. There will be areas where specialists in the exposure types will feel that the schema is insufficiently detailed to capture all the important nuances of exposure. Detail can be added in the future, by expanding to provide more granular information at extra levels of hierarchy.

We have chosen to optimize breadth over depth, providing a balance of sufficient detail for the first-order uses of exposure management, while enabling the practical implementation of the schema to maximize its chances of being adopted by the insurance community.

### 1.2 Demonstrable use of data definitions for loss assessment

The proposed data schema has been tested in several ways. It has been used in the loss analysis of three different clash scenarios, to derive estimates of insurance claims that would arise from each of the range of classes of insurance that could potentially be triggered by large catastrophic events. The schema has performed well in these loss-modelling exercises, providing a framework for identifying and prioritizing potential ‘coverage trigger pathways’ and enabling a logical loss assessment process to be applied. Loss assessment has been performed to useful levels of detail in each class of insurance in the schema, as part of the scenario development exercise. In each of these examples, the loss was estimated for a total industry value, in terms of how many companies could suffer a loss that would be covered under the terms and conditions of a policy if they had purchased coverage, with unlimited cover and no deductible, so a potential ‘insurable’ ground up loss.

### 1.3 Value in clash risk management

It is worth noting that in these ‘super catastrophe’ events, selected for the test scenarios, the resulting losses are widespread, triggering significant losses in as many as 10 different classes of insurance in the same event. Although these events have loss drivers in one or two main classes of insurance – the scenarios estimate 30 to 50% of the total losses being in their largest class of insurance – significant proportions of the total loss are contributed by multiple other classes. As insurance penetrations increase across the world, and as each class grows in significance and value of exposure, the clash potential will increase. Even moderate catastrophes will incur loss across multiple classes of insurance.

# 2. Adoption

The testing of the schema has also involved implementing sample insurance company portfolio data into the data definitions structure. This has principally involved adding data tags of the dictionary values for the characteristics of the exposure. This has demonstrated that existing data sets being used by insurance companies can be aligned with the proposed data definitions within reasonable and acceptable levels of data manipulation and tagging. In most cases, applying category tags from the data dictionaries entailed database queries with equivalent translations being applied for factors that were mainly captured already or those that could be relatively easily inferred.

## 2.1 Minimizing effort of implementation

However testing with insurance exposure portfolios has not been extensive. As with other data schemas that we have developed before, we know that the real test will be when large numbers of different insurance companies apply the schema structure to their data. The effort involved to apply and adopt the data definitions more generally will ultimately depend on the complexity and exception cases of exposure data. The adoption of a data standard is critically dependent on the amount of effort required by each company to enhance existing data structures to conform with the proposed definitions. One of the main principles of the design of the data definitions was to minimize this effort, and the concept of a ‘data budget’ – the effort required to implement a schema – was proposed to guide the design to avoid requesting resource-intensive attributes.

## 2.2 Value from implementation effort

Ultimately companies need to see useful returns in terms of improvements in exposure management and reductions in uncertainty in their risk assessments, to make it worthwhile to expend effort in implementing this data standard. As we work with companies in the future to help them implement the schema in their own exposure data, we will get a clearer idea of whether we have succeeded in developing a schema that is simple enough to implement and that will give benefits for exposure management to individual companies, that will also benefit the market. There will no doubt be areas where the data definitions will need further refinement as real-world examples test the structures of the schema.

We hope that reporting requirements, regulators, intermediaries, and market counterparties will also add to the value of implementing the schema by requesting data information in formats that are compatible with the data definitions.

## 2.3 New Modelling Analytics

A standard description of exposure data is a requirement for analytics that can be offered to multiple users. The proposal of a set of exposure data definitions is a pre-requisite for broader applications of models. Many companies today carry out their own modelling analytics, using their proprietary internal data structures or consultants adapt their models to deal with the individual way each company holds their information. There are categories of exposure today that have limited analytics available to assess them, and for which a broad set of insurance companies could benefit. There are obvious benefits to providers of models, including modelling vendor companies, in having a broader market of insurance companies using similar methods of categorizing their exposure data, to enable a wider potential uptake of any specific new analysis. This makes the economics of developing models more attractive. We hope that the data schema will facilitate a broader ecosystem of model providers that will develop analytics in less-well-modelled classes of insurance, to improve the sophistication of exposure risk management across the industry.

# 3. Conclusion to the project

The project summarized within this report was dedicated to developing a standardized Data Definitions Document for recording and analyzing exposure data across multiple classes of insurance in a consistent way. As the project concludes, we are confident that this task has been accomplished. The project demonstrated that the data definitions provide a useful and standardized process for monitoring and reporting multiline exposure and are useable for loss modelling by demonstrating its use in three clash scenarios. The industry review and consultation echoed this confidence through the various consultation documents, interviews, and workshops

held in the process. We hope that the data definitions will evolve, adapt, and increase in detail in the future, as they are used.

We hope that the Data Definitions Document proves to be of value to the insurance industry as a whole. We hope that it demonstrates its value in adoption, and in facilitation of new methods of exposure risk management, and a new ecosystem of analysts who can make their models more broadly available to a broader market. We hope that this contributes to a broader interest in managing exposure more rigorously across the industry and improves the profitability and risk management capabilities for a new generation of insurers, benefiting society as a whole.

# Part V: Bibliography

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Consultation documents for each round of the data definitions development. These can be accessed at the Cambridge Centre for Risk Studies publications page for the Project on Global Exposure, Accumulation and Clash: https://www.jbs.cam.ac.uk/faculty-research/centres/risk/publications/multi-threat/

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Global Exposure Accumulation and Clash Project

# Challenges and Solutions for Enterprise Exposure Management

September 2018


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