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Quantum Cities™

Data-centric approaches for resilient, sustainable cities

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University of California Berkeley
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Why cities

Urban development is a huge risk and opportunity

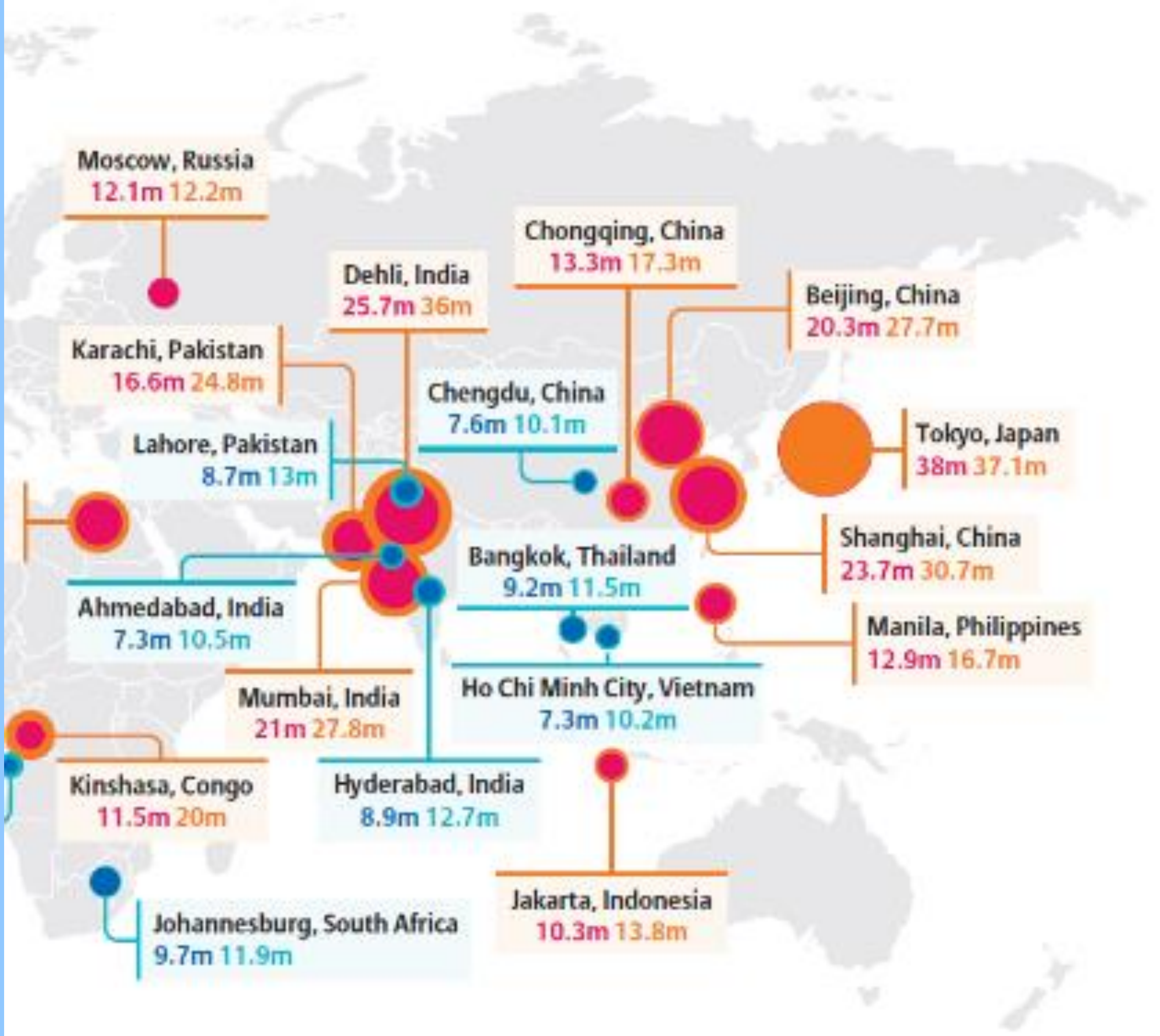
By 2050, **~70%** of the world population will live in cities/urban areas

Today, there are **+35 megacities** with a population of more than **10 million**

The world's 600 largest cities account for **60% of global GDP**

80% of the world's megacities are in **Asia, Latin America** and **Africa**

The world will build an entire **New York City every month for 40 years**



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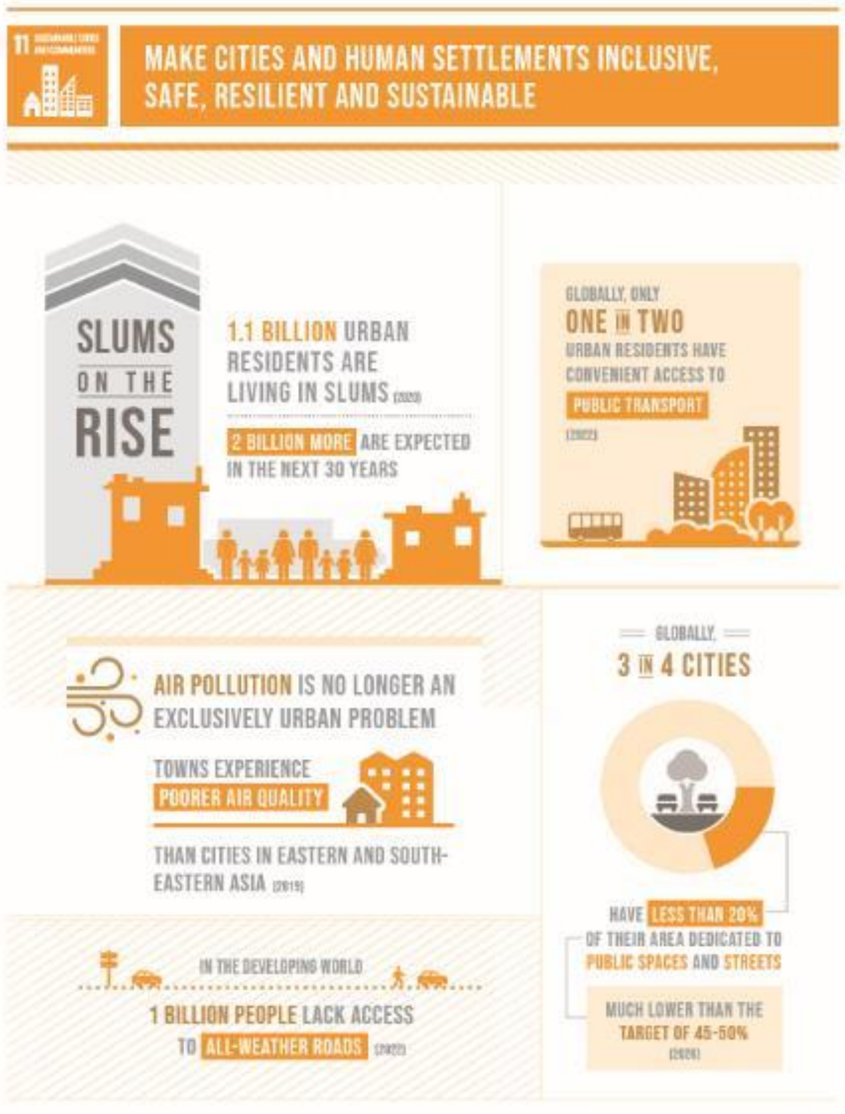
Sustainable Development Goal (SDG) 11:
Sustainable cities and communities

To accommodate for our growing population, and for all of us to survive and prosper, we need intelligent urban planning and solutions that create safe, affordable, green, resilient, and sustainable cities.

By 2030, SDG 11 targets include:

- Provide access to adequate, safe and affordable housing and basic services.
- Provide access to safe, affordable, accessible and sustainable transport systems.
- Significantly reduce deaths / people affected and economic losses caused by disasters, including water-related disasters. Focus on protecting the poor and vulnerable people.
- Reduce the environmental impact of cities, including water, air, waste.
- Implement integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters, and develop and implement, in line with the Sendai Framework for Disaster Risk Reduction, holistic disaster risk management at all levels.

And yet, a recent U.N. special progress report shows we're lagging (see right - infographic).



THE SUSTAINABLE DEVELOPMENT GOALS REPORT 2023: SPECIAL EDITION- UNSTATS.UN.ORG/SDGS/REPORT/2023/

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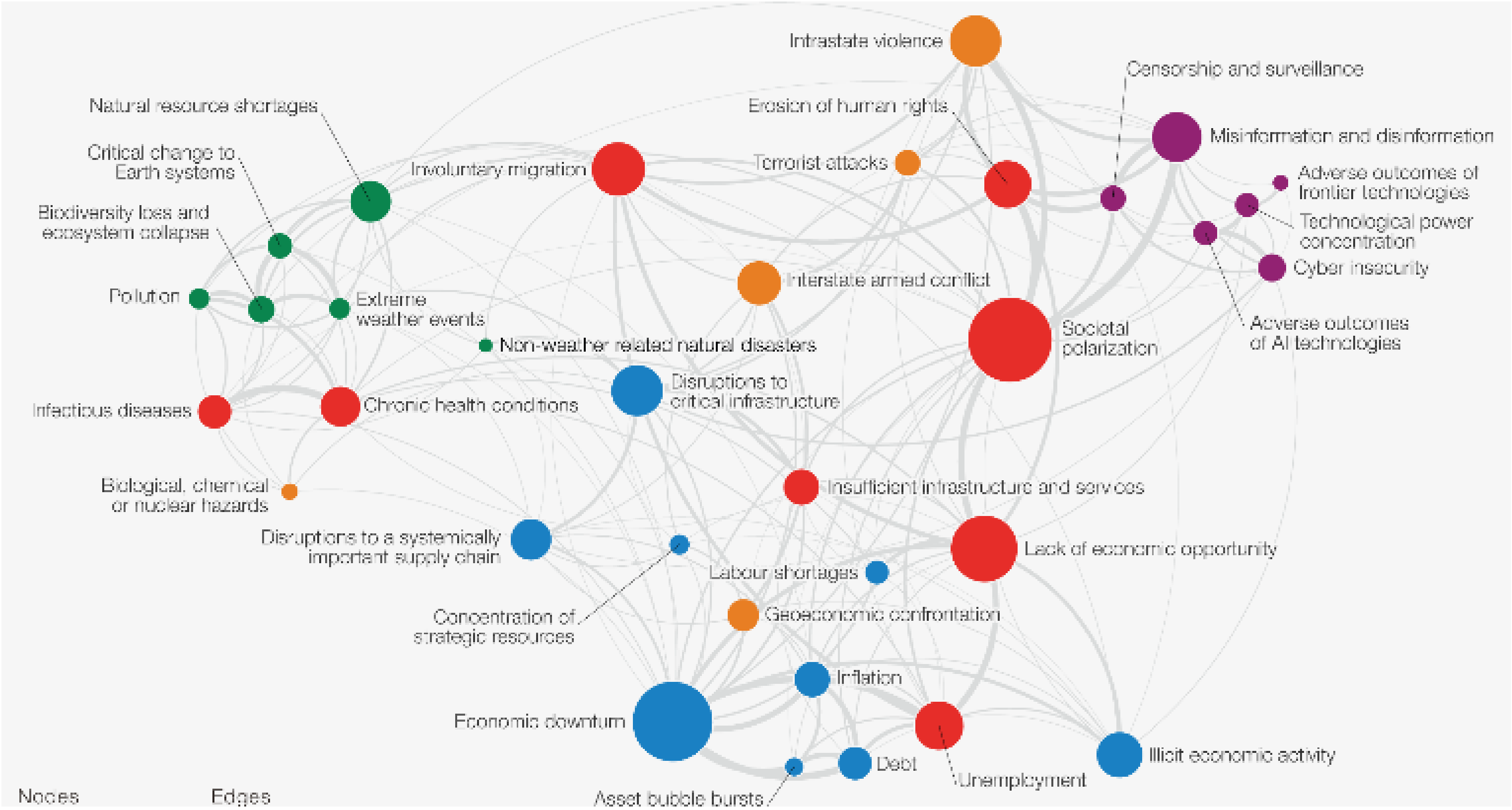
Risks are global, interconnected, accumulating and propagating

WEF 2024 GRR highlights growing technological, social, geopolitical & economic risks



We need new approaches and tools. Data-driven, machine intelligence-enhanced approaches allow us to predict and prevent risks and deliver effective resilience offerings.

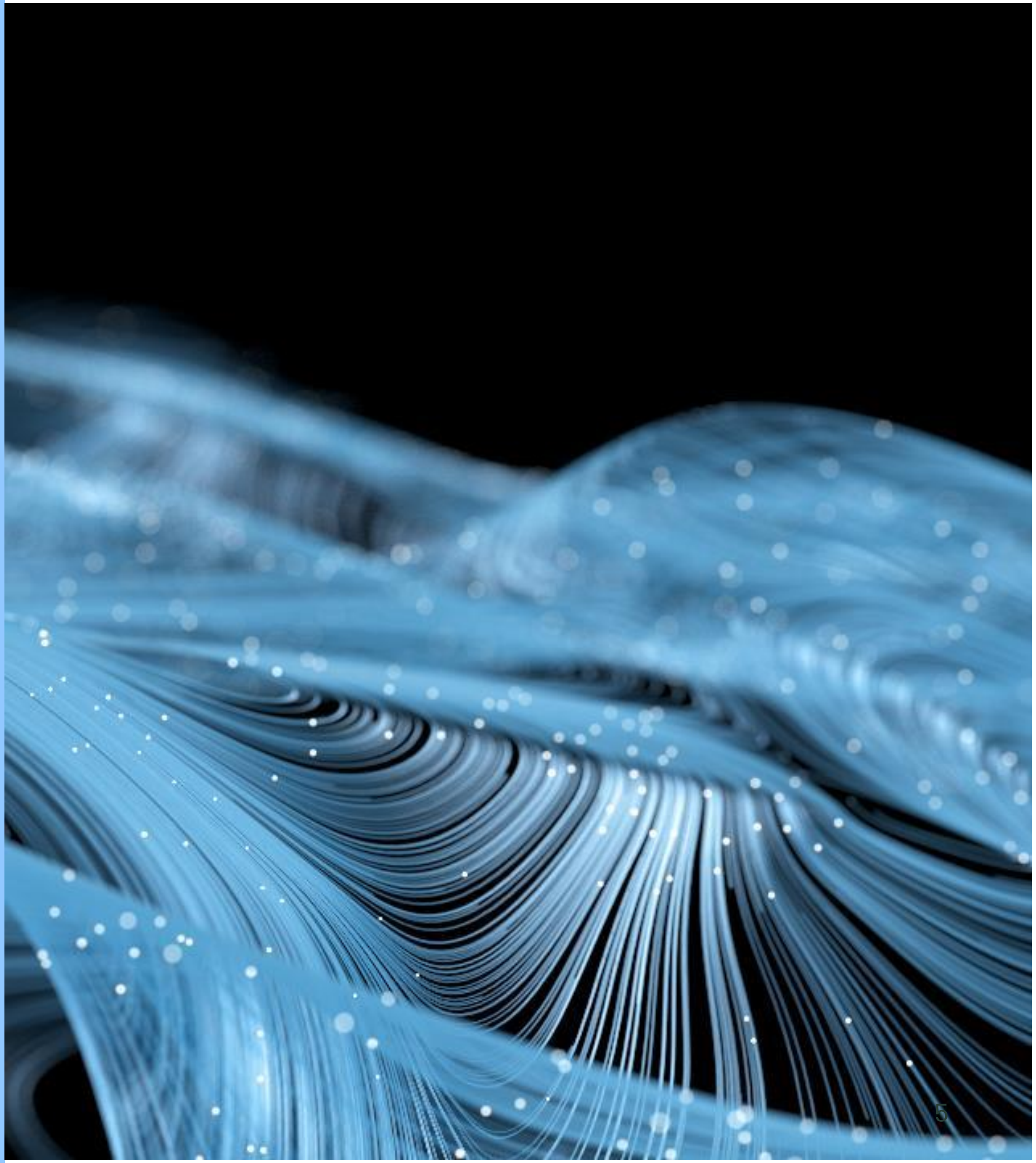
Source: Global Risks Report 2024 | World Economic Forum

It all starts with (entangled) data

quantum entanglement noun

quan·tum en·tan·gle·ment ˈkwän-təm in-ˈtaŋ-gəl-mənt

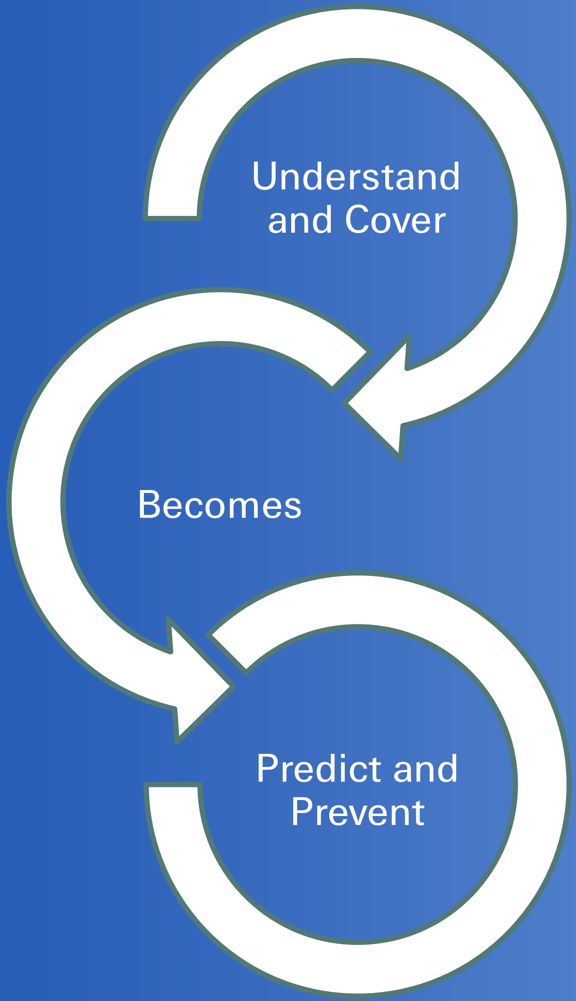
: a physical phenomenon that occurs when a group of entities (and their related data) are generated, interact, or share spatial proximity in a way such that the state of each entity of the group cannot be described independently of the state of the others, including when the entities are separated by a large distance.

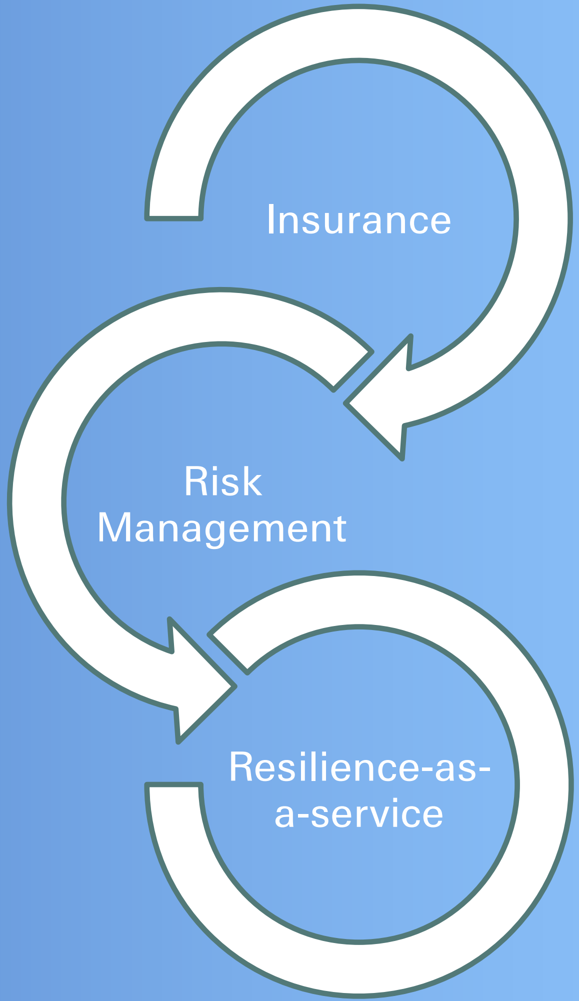


Vision: Ensuring (and insuring) safe, resilient, sustainable cities

To develop modular, data-driven, end-to-end, sustainable urban models, analytics and offerings that enable cities to grow sustainably, better manage their exposures, and for authorities to prevent, manage and quickly bounce back from risks and losses.

Shifts in the insurance industry: From protection to prevention





Quantum Cities™

Enabling sustainable growth and effective risk management

Logistics
Supply chain / trade

Accumulation risk management of complex, interconnected risks

Ensuring supply chain continuity

Enabling seamless, interoperable trade across regions

Automated logistics and cyber

Environment / Natural catastrophes

Coastal city protection (sea level rise). **Urban floods.**

Green infrastructure (coral reefs, mangroves, forests)

Environmental impairment liability (EIL)

Mobility / Green industry

Multi-modal urban mobility

Unmanned Vehicles (UV)

New energy vehicles (NEVs)

De-risking green infrastructure (renewable energy, roads, ports...)

Societal resilience / Health

National Health

Diabetes

Pandemics

Quantified-self

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Fundamental questions and answers

Governments
Municipalities
Enterprises
Citizens

What?	When?	Where?	What if?	How?
What happens when we introduce AVs in cities?	How are global trade flows impacted by climate change?	Where will climate change impact economic development?	What if I get impacted by…?	How can we best manage large scale impacts?
What is the role of regulators in machine intelligence adoption?	When can tech ubiquity reduce risks systemically?	Where are new risks emerging?	How can I qualify the risk of machine intelligence methods?	How can we accelerate infrastructure development?
What is the value at risk of natural resources?	When machines take decisions, who is liable for what?	Where are risks accumulating?	What is the role of insurance in machine intelligence adoption?	How can we model urban floods?
What new risks correlate to tech ubiquity?				How can I make my supply chain more resilient?

Changes

5G DLT Internet of Things Robotics Machine Intelligence

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Systems and solutions to address the growing complexity of risks and society

Governments
Municipalities
Enterprises
Citizens

Risk pools and solutions

- **What?** Risk exposure
- **When?** Forecasting
- **Where?** Accumulation
- **What if?** Simulation
- **How?** Prevention/Solutions

Resilient People | **Resilient Economy** | **Resilient Environment**

Property | Life & Health | Supply chain | Infrastructure | Commercial | Energy | Food | Agro | Climate | NatCat

Risk Knowledge

Regulations | Liabilities | Losses | Risk models | Climate models | Knowledge graph | Behavioural models | Accumulation models

Risk assets and events

Airport | Ship | Truck | Car | City | People | Commodities | Fx/Rates | Social | Weather | Satellite

Airplane | Port | Building | Moto | Plants | Goods | Food | Payments | Orders | NatCat events

Research Projects

5G DLT Internet of Things Robotics Machine Intelligence

Quantum Cities™ exploratory research can create re/insurance opportunities

The risk landscape of urban centers is changing. This changes current risks and coverage gaps. Re/insurers can tap into these new risks pools, offering targeted products and services to close protection gaps and build urban resilience.

Quantum cities risk landscape: Traditional and new risk pools

Traditional urban risks

Urban P&C risks

Property and liability risks (of buildings, infrastructure…) due to natcat

Urban people risks

L&H risks, climate change (higher injury/death from natcats, growing exposures due to heat/cold/pollution), epidemic risks

New Quantum Cities™ risks

Increase in interconnected systems and dependence on tech results in efficiencies but also greater exposures, e.g., supply-chain business interruption risks and propagation

e.g., Connected trade

Increase in AI-powered algorithms, connected devices, and digital health services results in better L&H offerings but also increased exposure to systemic risk like algorithmic, cyber risk, etc.

e.g., Connected services

Resilience-as-a-Service: Potential data-driven offerings (examples)

- Risk products and services
  - Risk scores & indexes
  - Structuring risk transfer mechanisms
  - Data services
  - Solvency services
  - End-to-end risk platforms
  - Real-time supply chain track & trace services
- Risk analytics
  - Predictive risk analysis
  - Real-time NatCat monitoring / early warning systems
  - Risk management tools
  - Risk resilience analytics platforms
- Risk studies
  - Feasibility studies
  - Economics of climate adaptation & climate impact studies
  - Risk outlook and transition scenarios

Modeling cities:
Challenges and opportunities

Data deluges, advanced algorithms, and powerful computational tools enable physical and natural system modeling like never before.

Data

IDC forecasts worldwide data to grow by CAGR of 23% to 181 ZB till 2025. A third of these data will be real-time.

Advanced algorithms

Hybrid algorithms can lead to better data curation by addressing issues related to data quality and lack of compute power.

Better processing

Synchronized edge and cloud computing can ease data processing by on-demand access to computing resources.

Computational tools

Modern computational tools' ability to study complex systems enable extreme events analysis at multiple levels.

Source – Swiss Re Institute

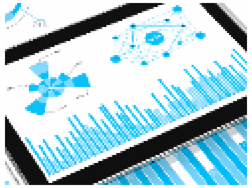
Simulating physical phenomena is evolving from component design to systems assembly to developing *digital twins* of physical assets

Early steps in modelling

Timeline

- Development of basic models
- Better understanding of phenomena

3D component design



~ 1985

- Rapid advances in 3D modelling from computers
- Use of computer aided technology (CAD) in product component design

Holistic systems assembly

~ 2000

- Advances in model-based systems engineering
- Holistic approach to systems assembly

Physics aware digital twin

~ 2015 onwards

- Hybridisation of ML by combining the virtual and physical world
- Creation of reduced order models (ROM) to bridge value chains

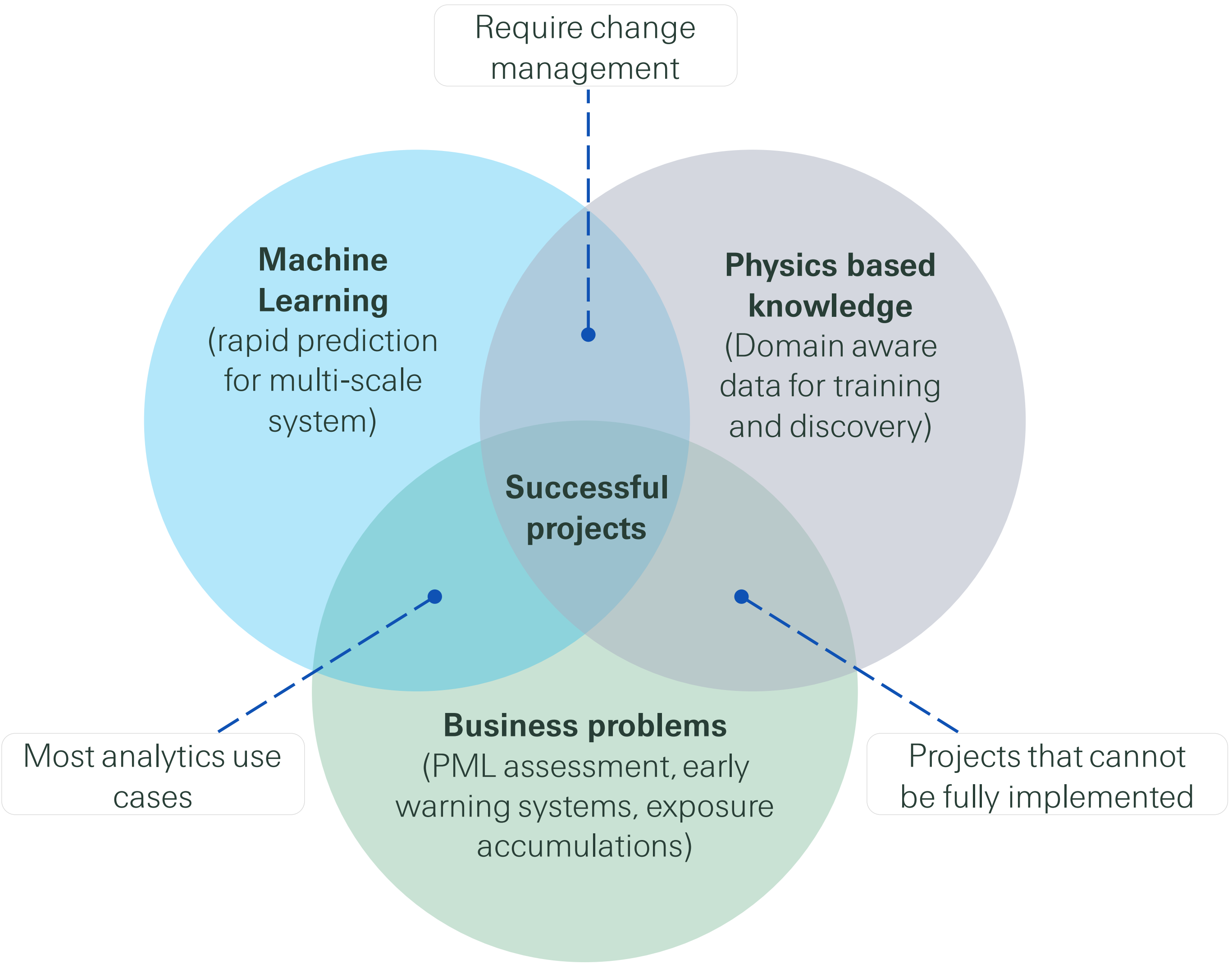
Key challenges in physics aware ML implementation

- Parametrisations of complex real-world processes
- Keeping physical and digital worlds 'in sync' easily
- Closing the data loop from operations back to design
- Generating knowledge from distributed models
- Overcoming expertise-limited scalability of use
- Applying novel simulation technologies and convergence with data analytics and IoT

Source: 1) Connecting physics based and data driven models: The best of two worlds, Siemens AG, 2018
2) Swiss Re Institute

Careful selection of physics-based machine learning projects can enable productive enterprise scale transformation at insurers

- **Physics-based** reduced order models of complex assets and processes combined with **machine learning** can allow re/insurers to **uncover hidden entanglements** between insured assets and the external world.
- **Solutions can be made available to clients** via scalable SaaS platforms for better monetisation. Internally, these can be applied to synthesise exposure data, claims data and physical models to better quantify and monitor risks.
- **Successful** physics aware machine learning **projects need** substantial investment and **cross-industry collaboration** for alignment of interest between insurers, governments and other stakeholders.



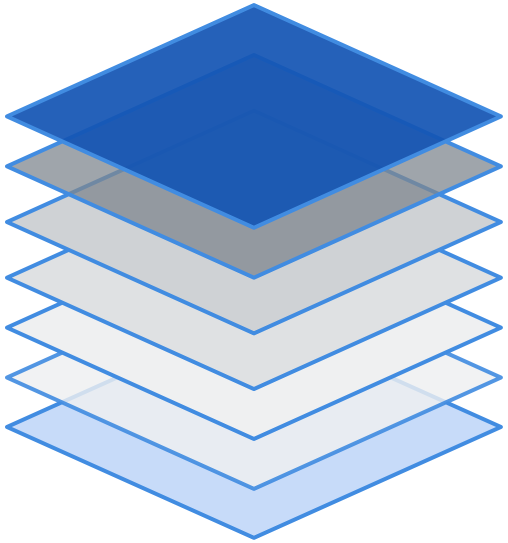
Source – Swiss Re Institute

Physics-based modelling of cities can allow insurers to use a systems approach to assess the impact of extreme events on each layer

Physical footprint of a city

- Transit system data
- Water system data
- Utility system data
- Critical infrastructure & hubs (CIH)
- CIH dependencies
- Asset footprint data
- Natural environment data

Digital footprint of a city

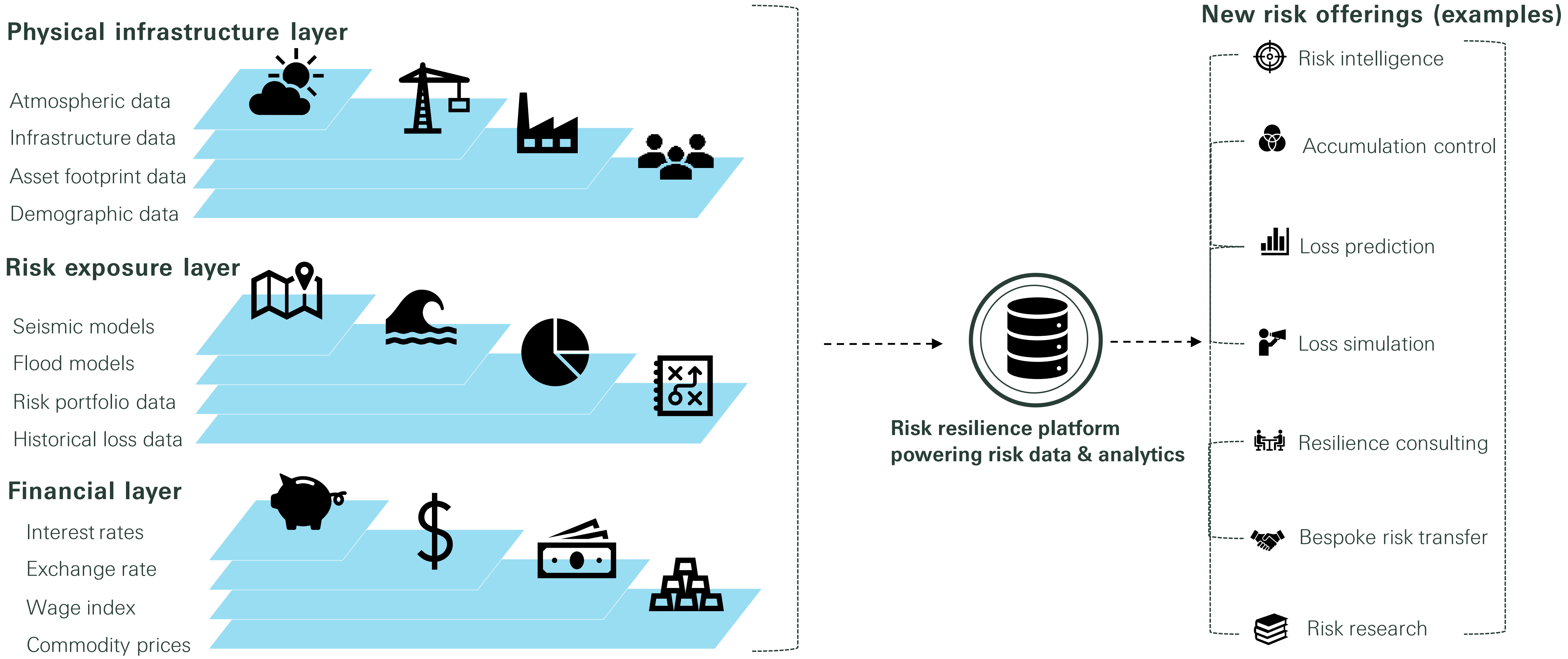


Risk footprint of a city

- Seismic impact analysis
- Flood impact analysis
- Wildfire Impact analysis
- Supply chain vulnerability

Source – Swiss Re Institute

Physics-based resilience models can help insurers develop new risk offerings and improve their portfolio view for pricing, reserving and large event losses



Source – Swiss Re Institute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Urban floods

Urban Flood as an Antiselection Tool

Addressing localised pain points of underwriting business units

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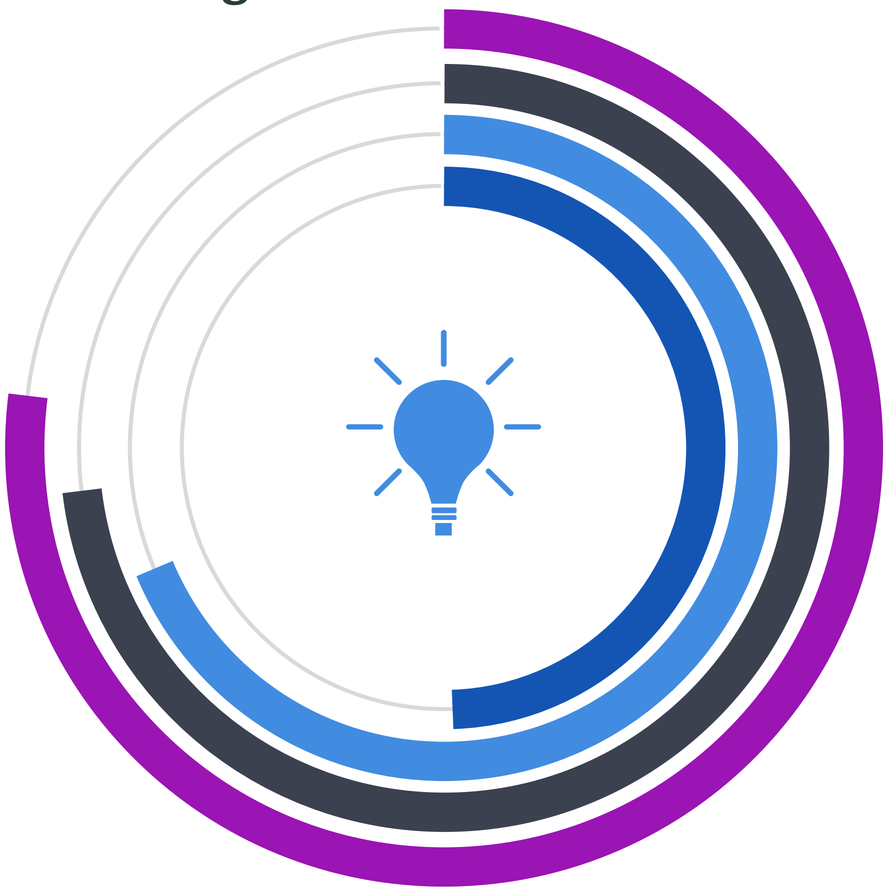
Projected Goals of urban flood as antiselection tool

Inform and facilitate statistics for portfolio analysis and exposure for underwriting units.



A scalable local approach

that can be streamlined and transposed to other cities and eventually other perils

Natural factors

including several topographical, hydrographical and climatic aspects, including extreme patterns in rain due to climate change

Human factors

affecting urban environments specifically, such as urban land use (urbanisation), vegetation index and road network

With a hazard index look up

defined to the level of accuracy requested by the stakeholders, and on which anti-selection can be performed in an informed manner.

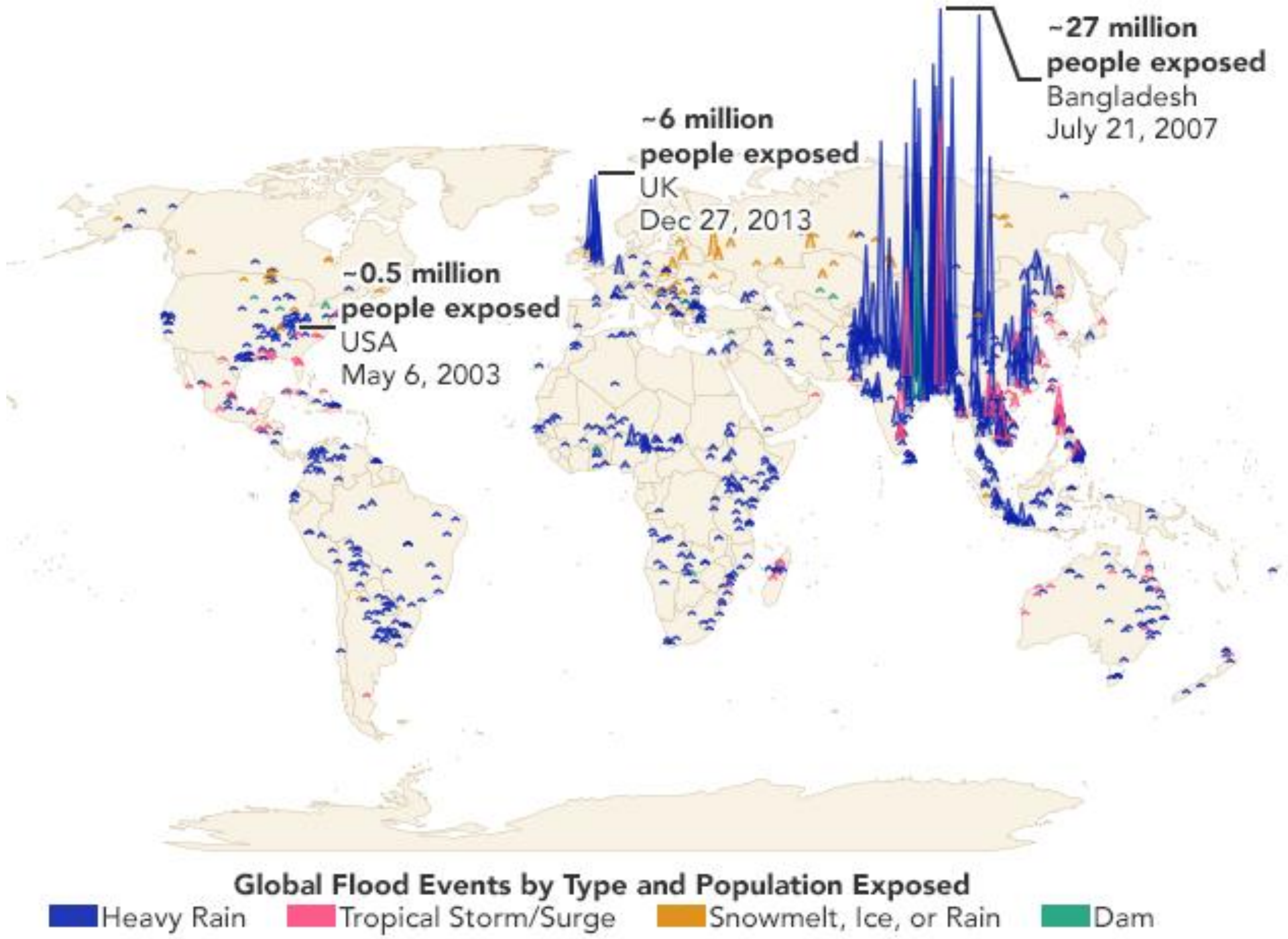
Flooding represents 20-25% of all secondary peril insured losses between 2011-2020.

Sigma report,
Lucia Bevere, Dr Andreas Weigel

A drastically increasing proportion of urban areas will be exposed to flood

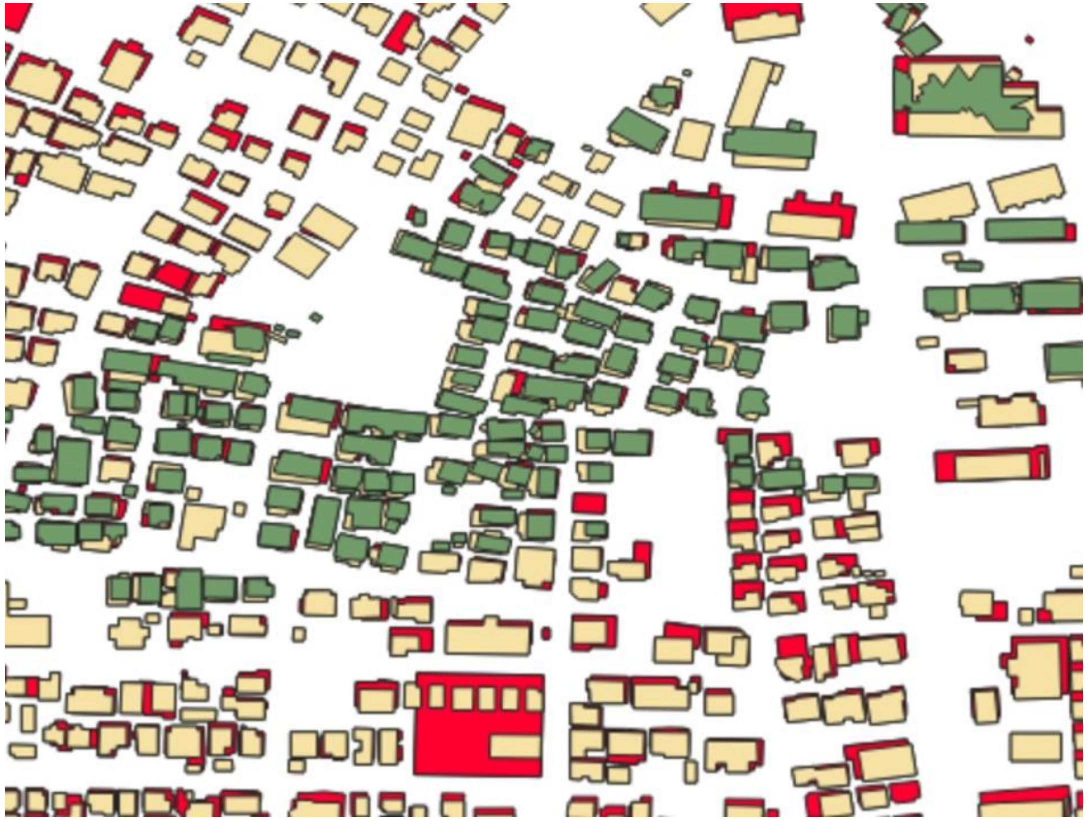
In a study published in Nature in August 2021, scientists found that the proportion of the world’s population exposed to floods grew by 20 to 24 percent. Although researchers expected an increase in the number of people living in flood-prone areas, the new estimates were ten times greater than what previous models predicted.

Map and chart imagery created by Benjamin Cooley, Cloud to Street, and provided courtesy of Tellman, B., et al. (2021). Story by Emily Fischer, NASA Earth Science News Team, with Michael Carlowicz.

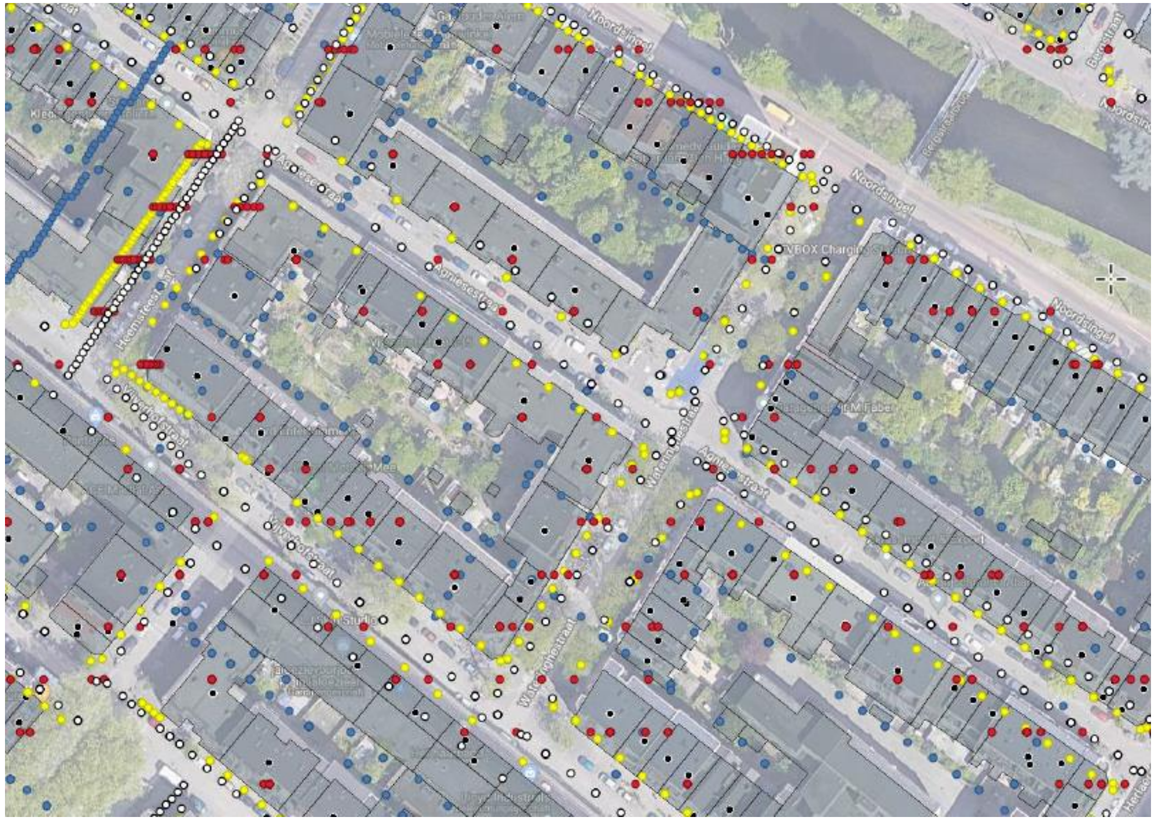


Source: https://earthobservatory.nasa.gov/images/148866/research-shows-more-people-living-in-floodplains

Accuracy issues



(left) three commercial building footprint providers. Each of them guarantees a 30cm accuracy.

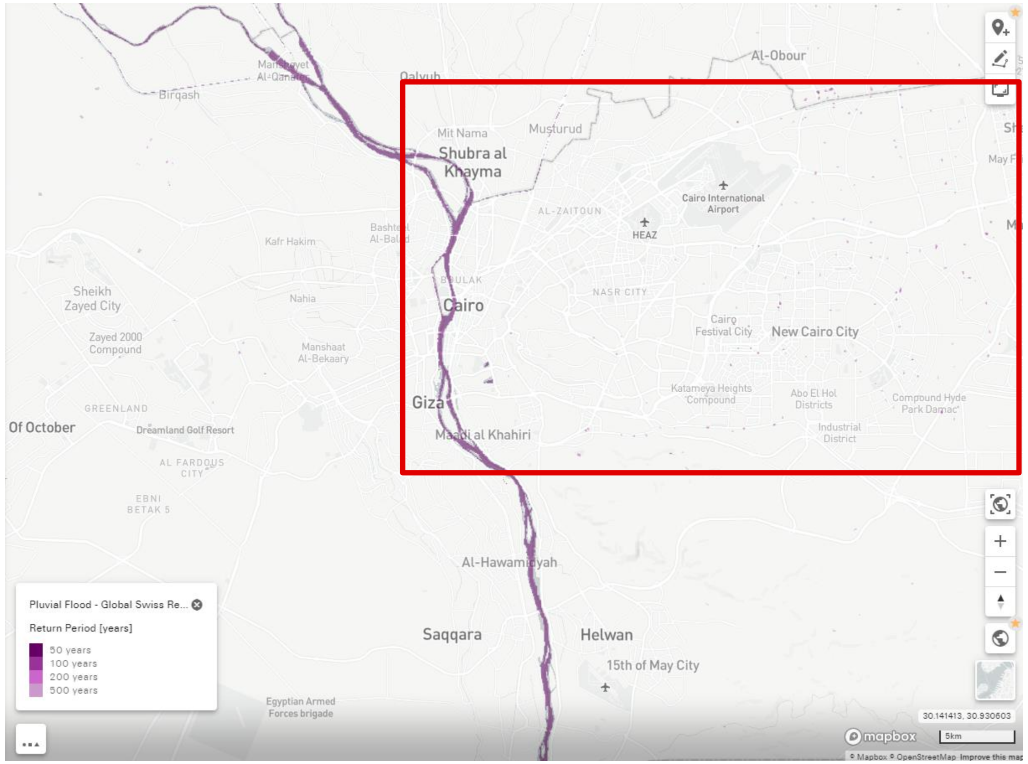


(left) 5 different geocode providers. All describe the same objects, none of the geocodes are the same.

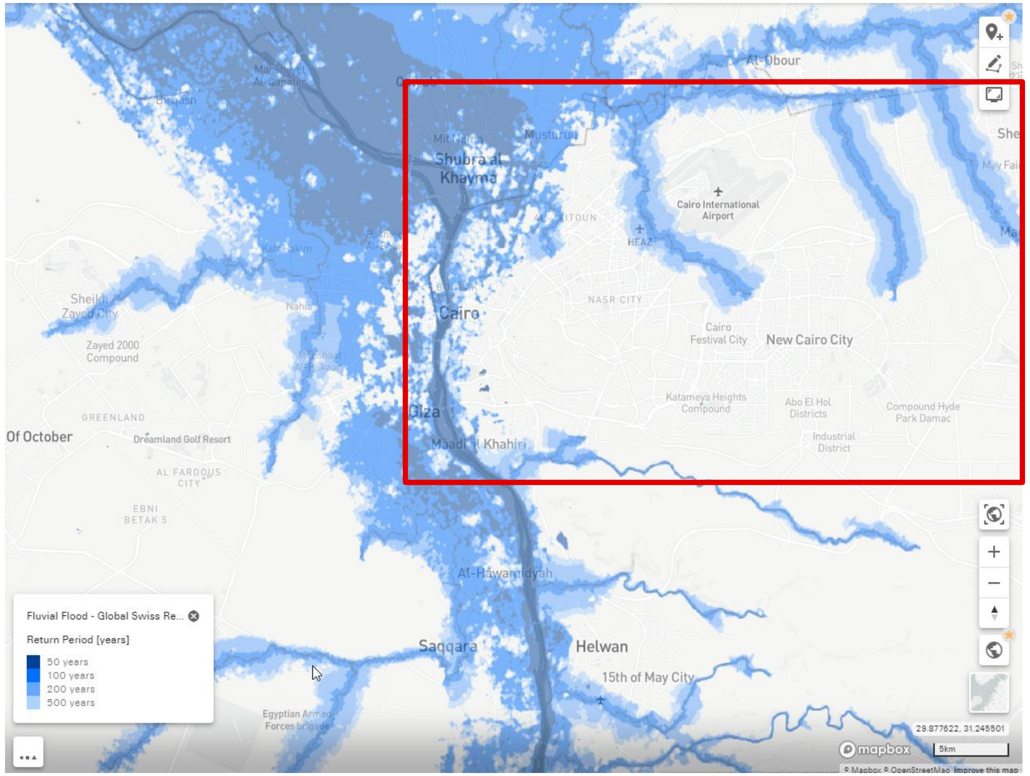
Current global fluvial and pluvial zones in Cairo (CNP)

Global flood zones, are layers accepted by the insurance industry as reliable risk layers. They are used for risk estimation and insurance. They do not take loss into account. They are based on observations and physical modelling of natural processes. They do not take human impact into account.

Global Pluvial Flood Layer

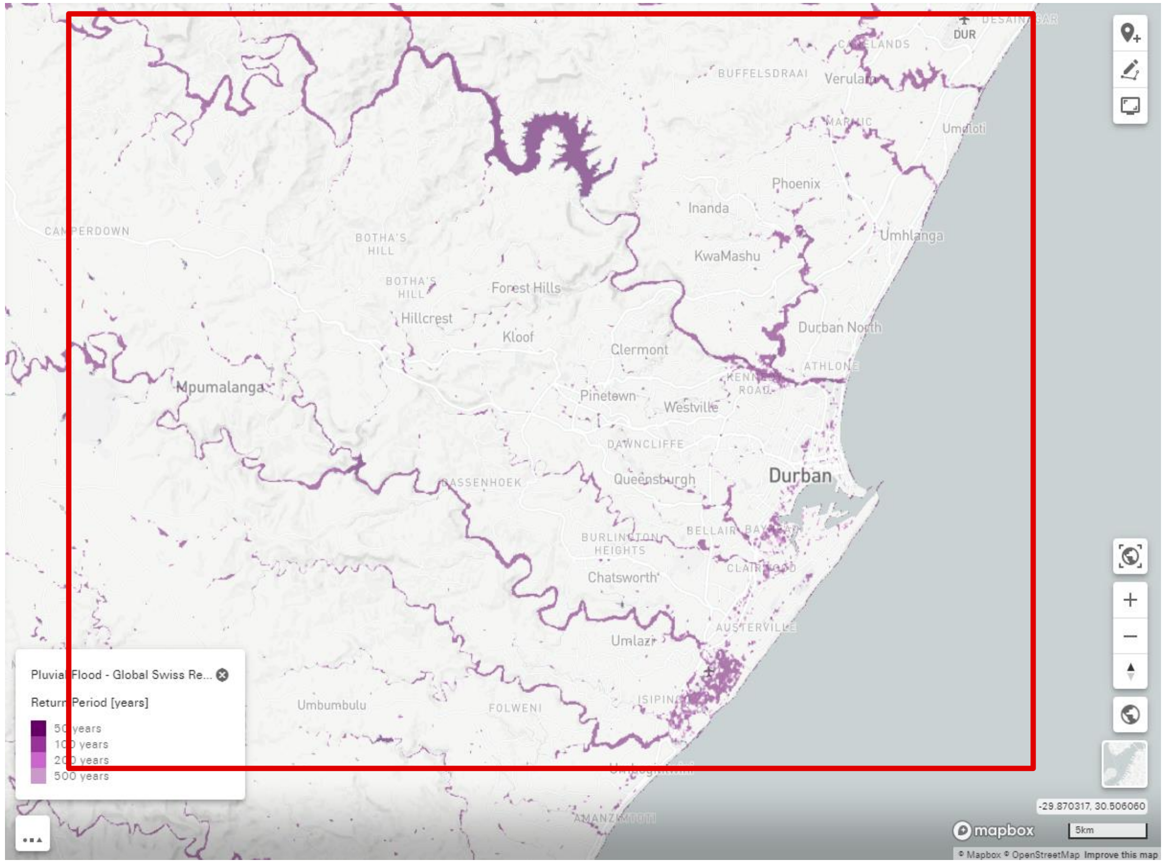


Global Fluvial Flood Layer

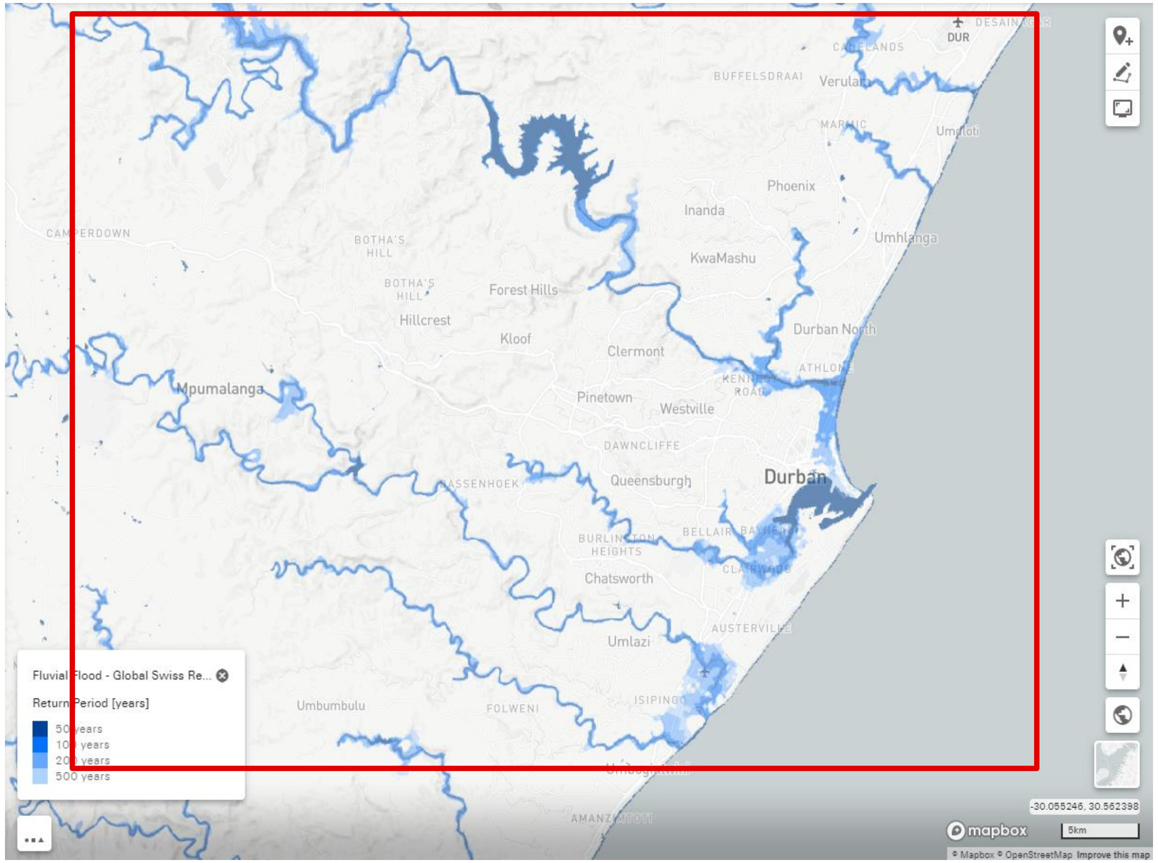


Current fluvial and pluvial zones in Durban (CNP)

Global Pluvial Flood Layer



Global Fluvial Flood Layer

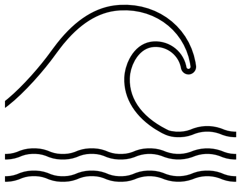


Methodology

- **Flood risk** is usually determined by the product of **hazard** (the statistical and physical aspects of the actual flood) and **vulnerability** (the exposure of people as well as assets to floods) [1,2].
- It can also be described as the coupling of possible damage and flood probability [3], or more specifically, as **the product of hazard and vulnerability** [4].

Flood Hazard
(probability of flood in space)

- Elevation
- Slope
- River network
- Distance to river
- Drainage density
- Potential Runoff
- …



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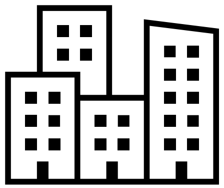
Flood Vulnerability
(susceptibility to flood damage)

- Specific socio-economic sectors
- Built and population densities.
- Building usage.
- TBD by stakeholders.



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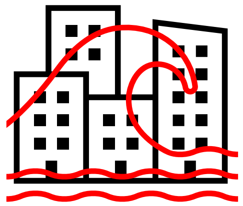
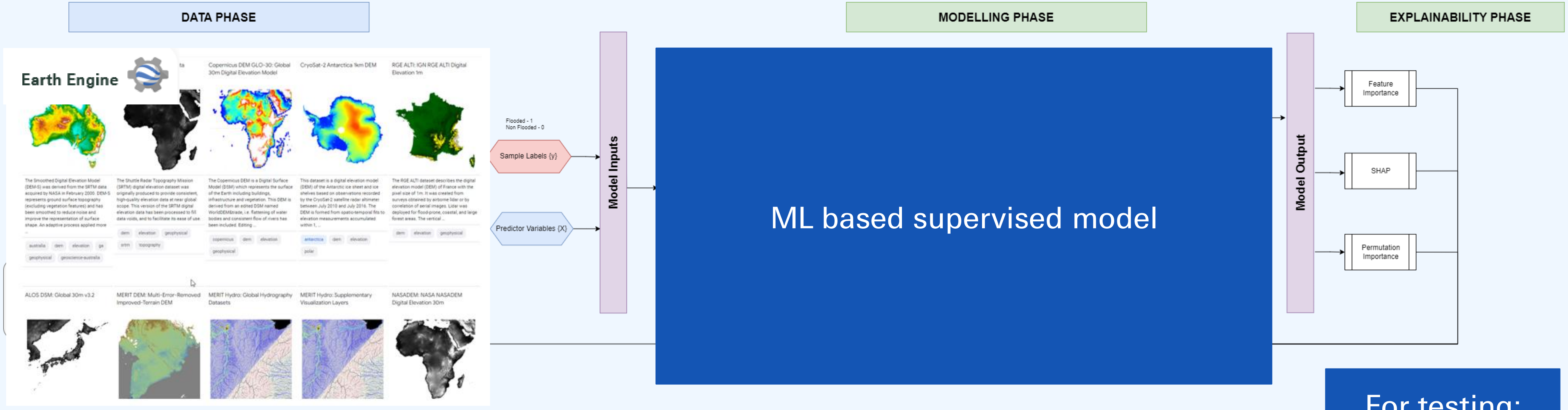
Flood Risk
(chance that a hazard will actually cause harm)

Flood Hazard
Flood Vulnerability



Sources:
1. Merz, B.; Kreibich, H.; Thieken, A.; Schmidtke, R. Estimation uncertainty of direct monetary flood damage to buildings. Nat. Hazards Earth Syst. Sci. 2004, 4, 153–163.
2. Apel, H.; Aronica, G.; Kreibich, H.; Thieken, A. Flood risk analyses—How detailed do we need to be? Nat. Hazards 2009, 49, 79–98.
3. Förster, S.; Kuhlmann, B.; Lindenschmidt, K.-E.; Bronstert, A. Assessing Flood Risk for a Rural Detention Area. Available online: https://hal.archives-ouvertes.fr/hal-00299508/ (accessed on 9 January 2020).
4. Ologunorisa, T.E. A review of the eects of gas flaring on the niger delta environment. Int. J. Sustain. Dev. World Ecol. 2001, 8, 249–255.

Urban flood hazard: Complete pipeline



Open Source Loss/Damage Data

For testing: Own loss data

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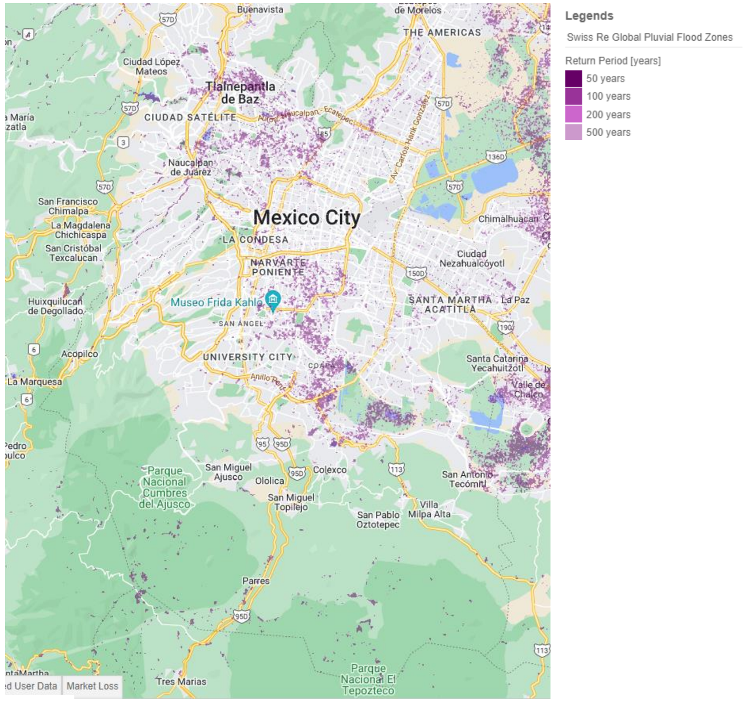
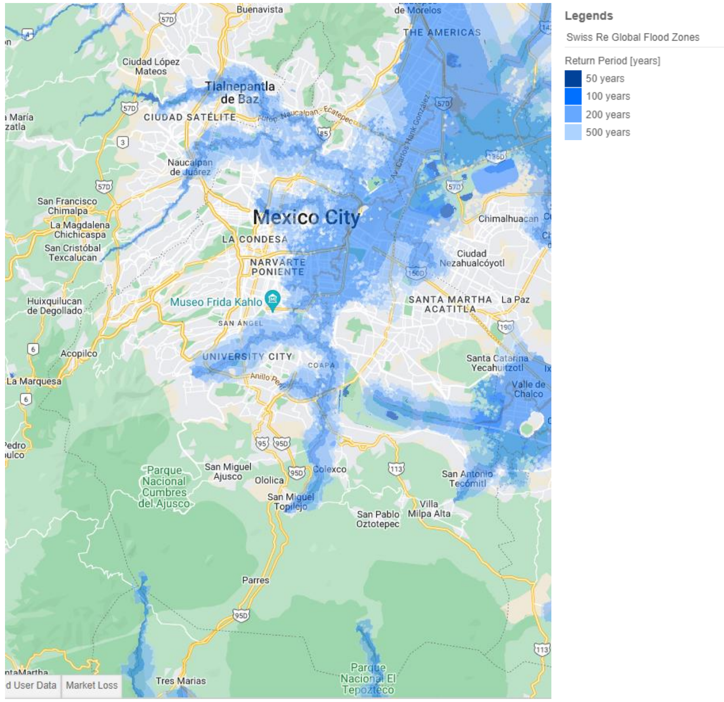
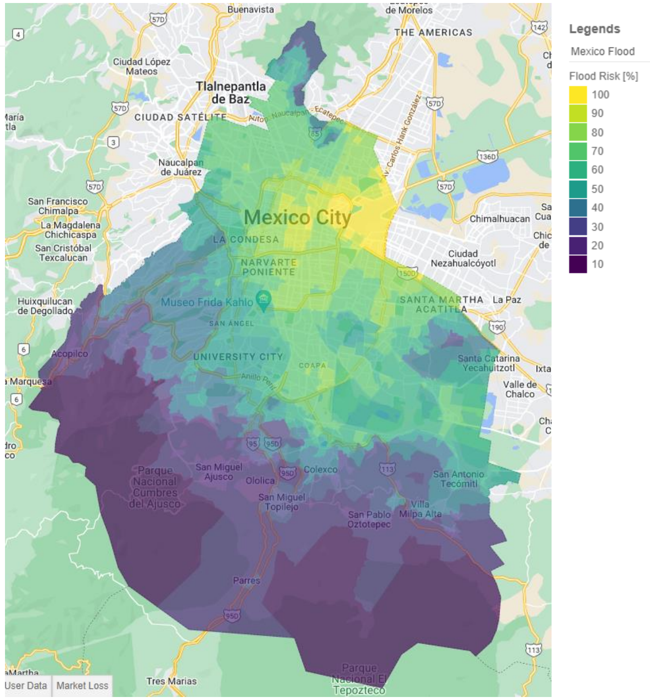
Where it all started: Urban flood anti-selection for Mexico City



Global Pluvial Flood Layer



Global Fluvial Flood Layer



Urban Flood Layer for Mexico City

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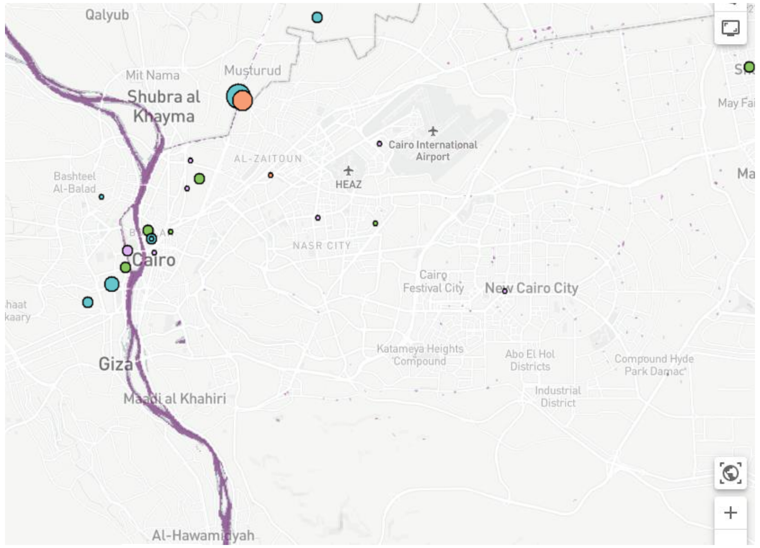
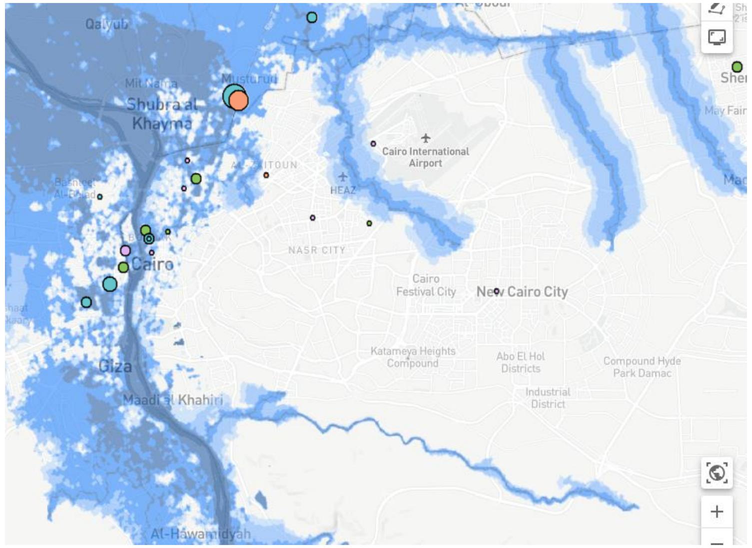
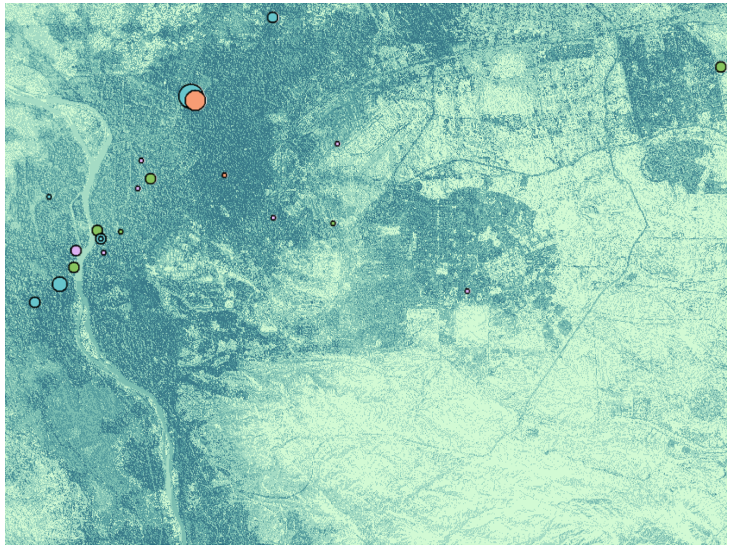
Urban flood is not a replacement for the Global Flood Zones: it complements them by addressing gaps in the coverage of flood hazard in cities, where modeling processes is hard due to complex situations.



Global Pluvial Flood Layer

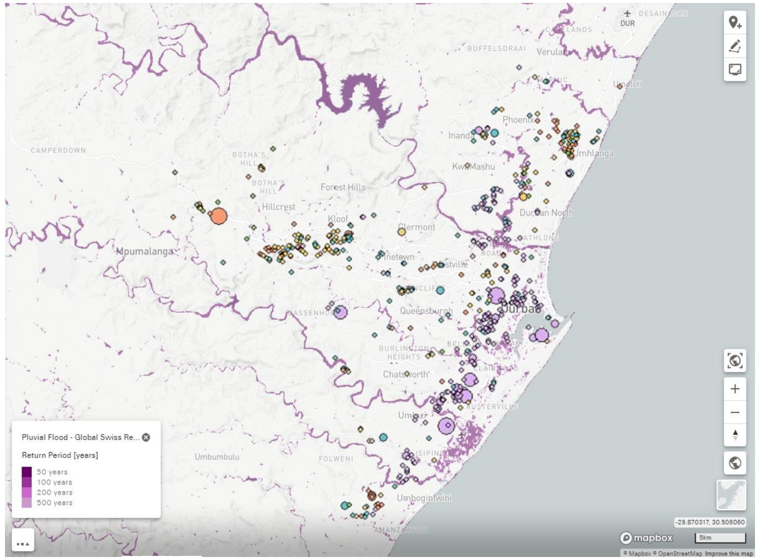


Global Fluvial Flood Layer

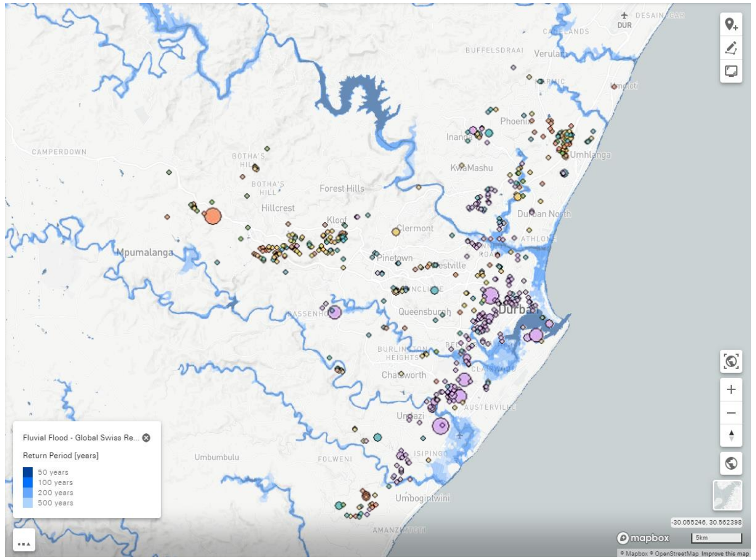


Urban Flood Layer for Cairo

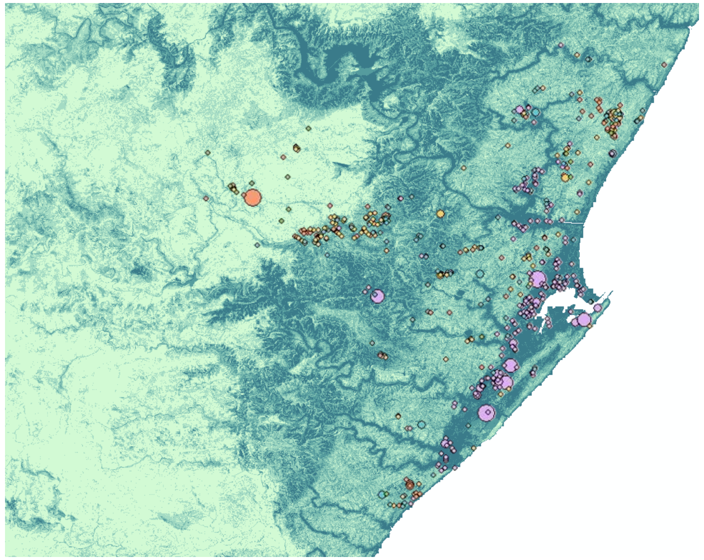
Urban flood is not a replacement for the Global Flood Zones: it complements them by addressing gaps in the coverage of flood hazard in cities, where modeling processes is hard due to complex situations.



Global Pluvial Flood Layer



Global Fluvial Flood Layer


Urban Flood Layer for Durban

Transposability to other cities and perils

Bringing complementary insights where needed

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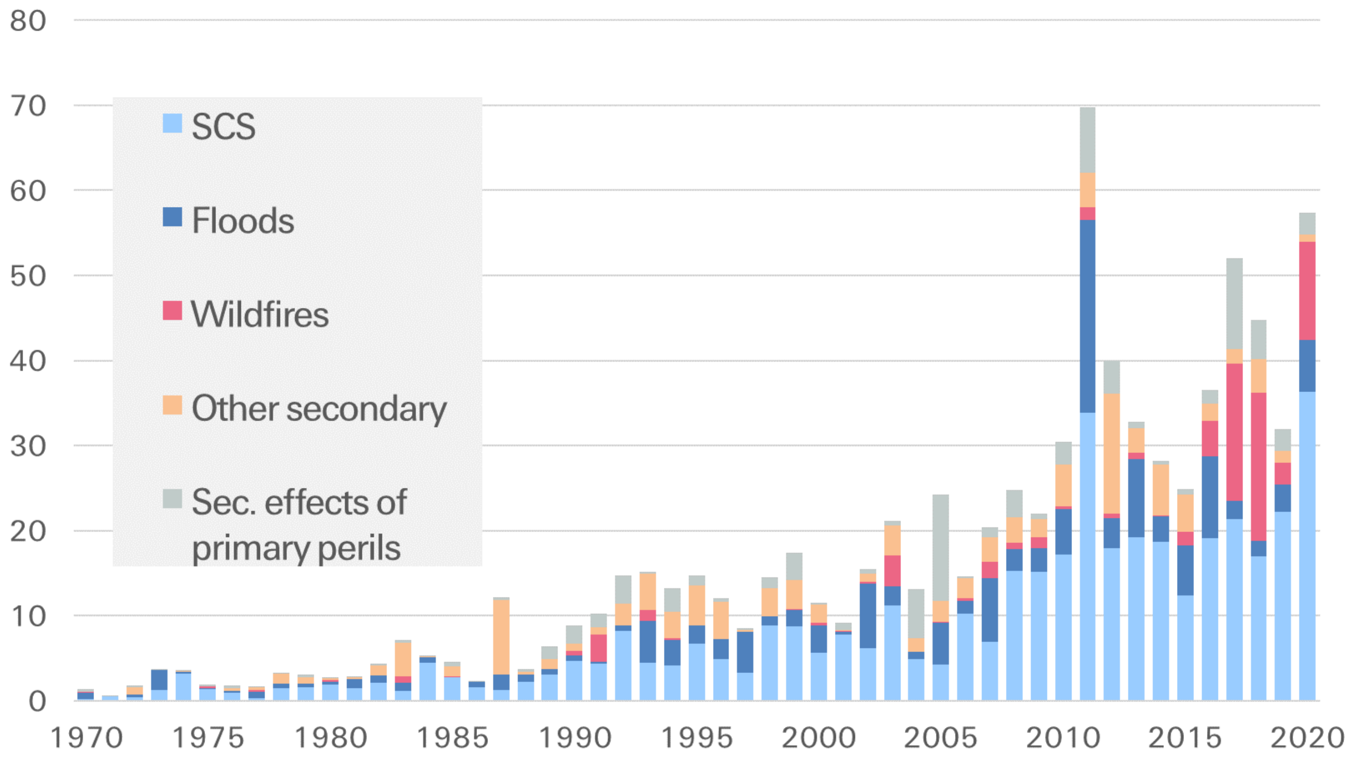
Insured losses from secondary perils from sigma 1-2021

Since the 1970s, **severe convective storms** (SCS) have been responsible for **more insurance damage** than any other secondary peril

Losses from **wildfire** have been **increasing faster** than any other peril, fuelled by an intricate interplay of man-made and natural factors. Climate change is likely an important driver

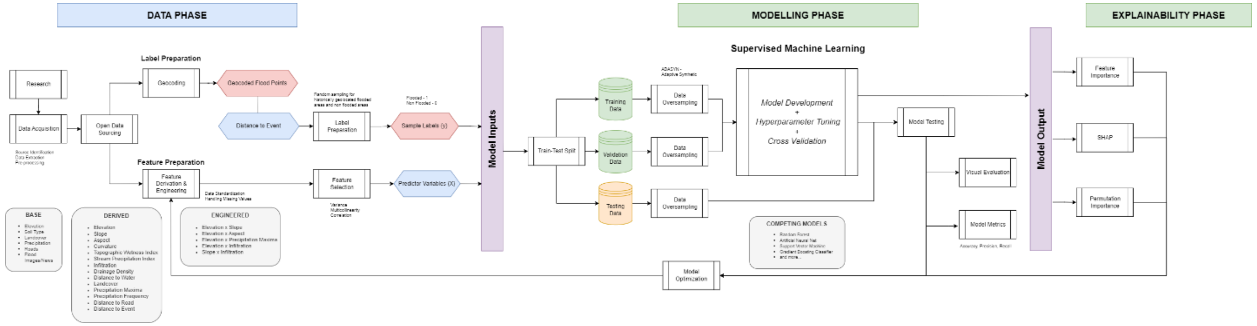
Floods from precipitation and storm surges make up **a quarter of insured secondary peril losses**

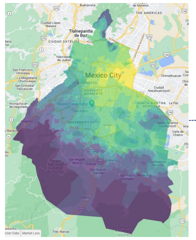
(Sigma 1/2021)
Lucia Bevere
Dr Andreas Weigel

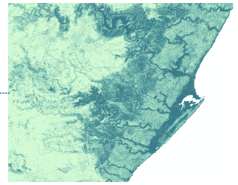


*All losses in 2020 prices

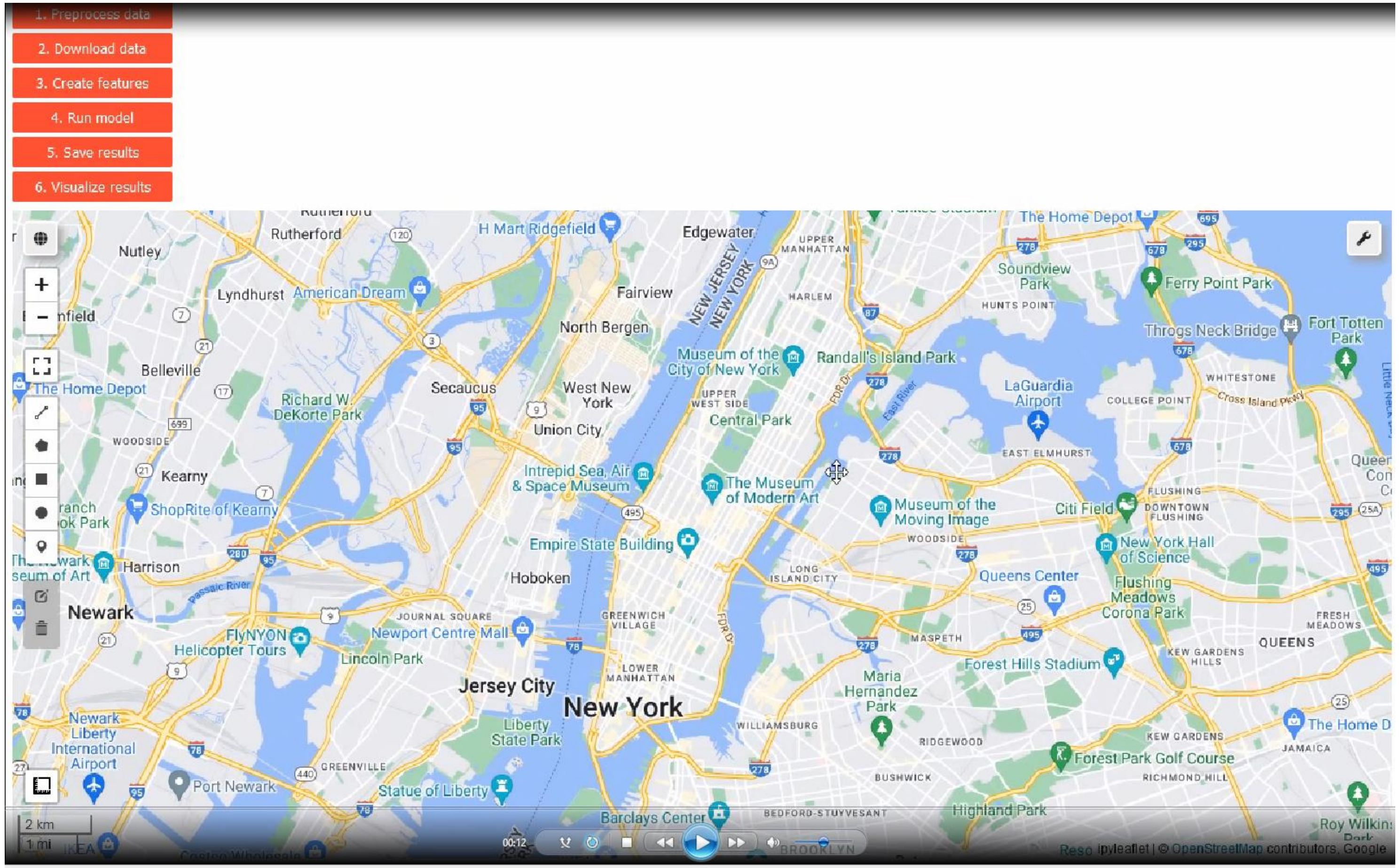
An agnostic model enabling a safe transfer to other contexts and datasets







Demo of urban flood model



Quantifying business interruption for supply chain resilience

Global supply chain risk landscape is changing rapidly: Technological, political, social and environmental risk drivers are evolving and causing **risk accumulation**

Supply risks

Supply chain unpredictability is a business continuity risk, and it arises due to **high degree of specialisations** and separations between tiers of suppliers.

Operational risks

Process & control risks are major operational risks. Process risks relate to disruptions in a firm's manufacturing, and distribution process. Control risks refer to the compromise of governance processes.

Network risks

Failure of transportation and communication networks restrict the access to information, people and assets. These risks increase with length and complexity of the supply chain.

Financial risks

Financial risks are related to the probable **interruption in the flow of financial resources** like credit, working capital, lending, banking services etc. between urban areas and other business centers.

Socio-political risks

Political risks (wars, coups), **regulatory risks** (sustainability) **economic risk** (trade disputes) and **social risks** (civil unrest) may result in business interruption and reputational damage.

Emerging risks

Internet vigilantism, cyber risks and algorithmic risk (biases and errors in algorithms) are prominent emerging risks with financial consequences for supply chain actors.

Non-systemic risks (Supply risks, Operational risks, Network risks)

Systemic Risks (Financial risks, Socio-political risks, Emerging risks)

Supply chain resilience requires new data-driven approaches and network models

Supply chains are increasingly global, digital, and operating in an interconnected, volatile and climate-challenged world. These increased risks and interdependencies mean events can quickly propagate globally, driving large and sometimes catastrophic losses.

Supply chain disruptions cost organizations around an average of USD 184 million per year[1]. Weather events, geopolitical instability, pandemics and climate change are examples of events that can severely disrupt corporates' business.

The average business interruption (BI) loss is more than one third higher than the average property loss[2]. But costing BI/CBI can be extremely challenging due to lack of connected, reliable data. Often overestimated BI exposure assessments and loss costing can hamper underwriting performance and/or lead to coverage exclusions.

Supply chain resilience requires understanding of supply chain nodes, networks and interdependencies to calculate business interruption risks and the potential risk propagation and accumulation.

Supply chain disruptions cost organisations USD 184 million/ year[1] on average

[1] Supply chain disruptions - cost by country 2021 | Statista
[2] Business Interruption Exposure – An Underwriter's Guide to Getting It Right | Gen Re

Supply chain BI/CBI quantification: Key questions to estimate financial losses

01 **Which locations in a portfolio are dependent on others?** Portfolios can contain sites of a company without their suppliers (BI) or include suppliers (CBI). The data source for location information is exposure (submission data) and for suppliers' locations and relationships can come from supply chain relationship or shipment datasets.

02 **Which products (raw material/parts) are supplied to the dependent locations? Which companies supply those products?** e.g., product description (e.g., HS code). Our main data source is the shipment dataset.

03 **What is the relative scarcity or risk of those products/suppliers?** Scarcity can be defined based on availability of materials in one or several regions/countries, number of suppliers, already established relationships with suppliers, and tier-n single sources of raw materials (e.g., silicon).

04 **How can business interruption propagate? What is the probability and intensity of the propagation?** Given an interruption at a location (either at an insured corporate company or their suppliers) how can it propagate to other connected locations? What are the metrics to use? If the products are not single source, how much time would it take to find alternative suppliers?

05 **How can we estimate financial losses at a dependent location? How much is the interdependent CBI/BI exposure at each location?** The total assigned exposure can be more than the initially estimated exposure due to the propagation effect.

06 **How can we develop a model for a parametric cover?** For example, we can use business metrics such as business downtime (e.g., 2 days business interruption) as a trigger instead of a more classical approach using event intensity (e.g., hurricane strength x)

Risk aggregation in automotive supply chains

Automotive supply chain risks

Insurance accumulation losses

Supplier aggregation

Bottleneck in typical multi-tier supply chain system

Geographic aggregation

Concentrated manufacturing
Automotive industrial zones

Industry aggregation

More overarching factors also bring in uncertainty to auto industry.

- Shipping
- Finance
- Manufacturing

Physical loss

Property Loss under Property Policy

Vehicles loss under Marine Policy

Loss of profit

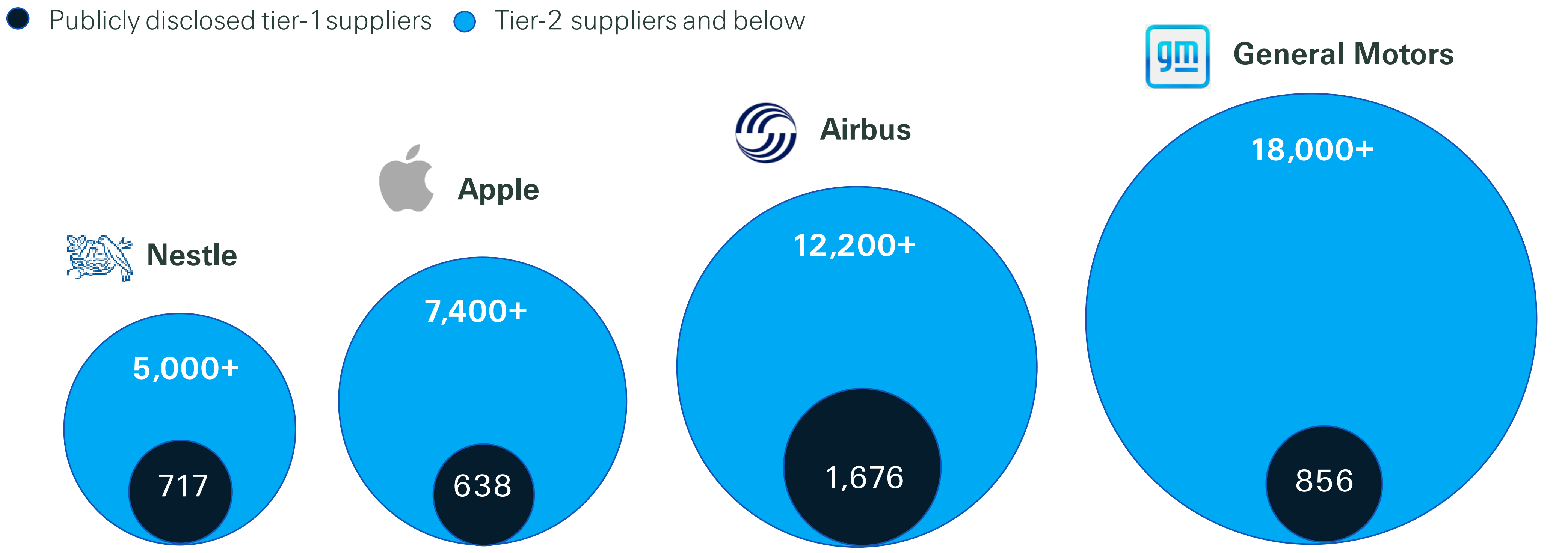
Business Interruption (BI)

Contingent Business Interruption (CBI)

Non-Damage Business Interruption (NDBI)

Supplier aggregation: We can't avoid the risk we can't see

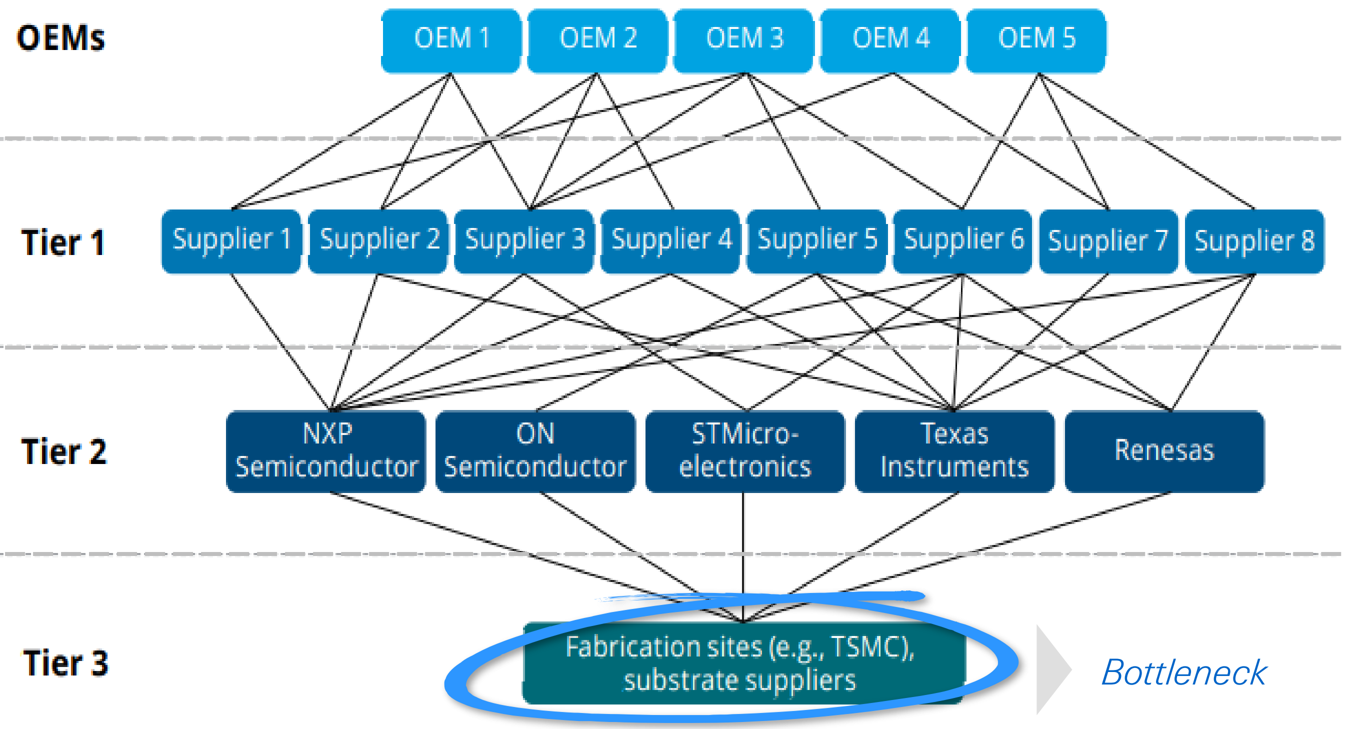
Beyond tier 1, manufacturers rely on a network of thousands of suppliers



Source: McKinsey

Bottlenecks in lower tiers can delay/suspend production

Illustrative automotive chips supply chain



Source: Deloitte Analysis

Products

Automobiles

Components & modules

MCUs / PCBs

Wafers & chips

Supply chain risk propagation model (co-developed with CDAR)
Overview

Data: We curated external datasets (containing import and export transactions data) and built a global supply chain digital twin that encompasses around 60% of global trade. The supply chain data contains company hierarchies, their manufacturing locations, and supply networks between locations. This provides information like product category, product value, weight and volume to enable tier-1 to tier-n supply chain analytics and the development of a BI/CBI risk propagation model.

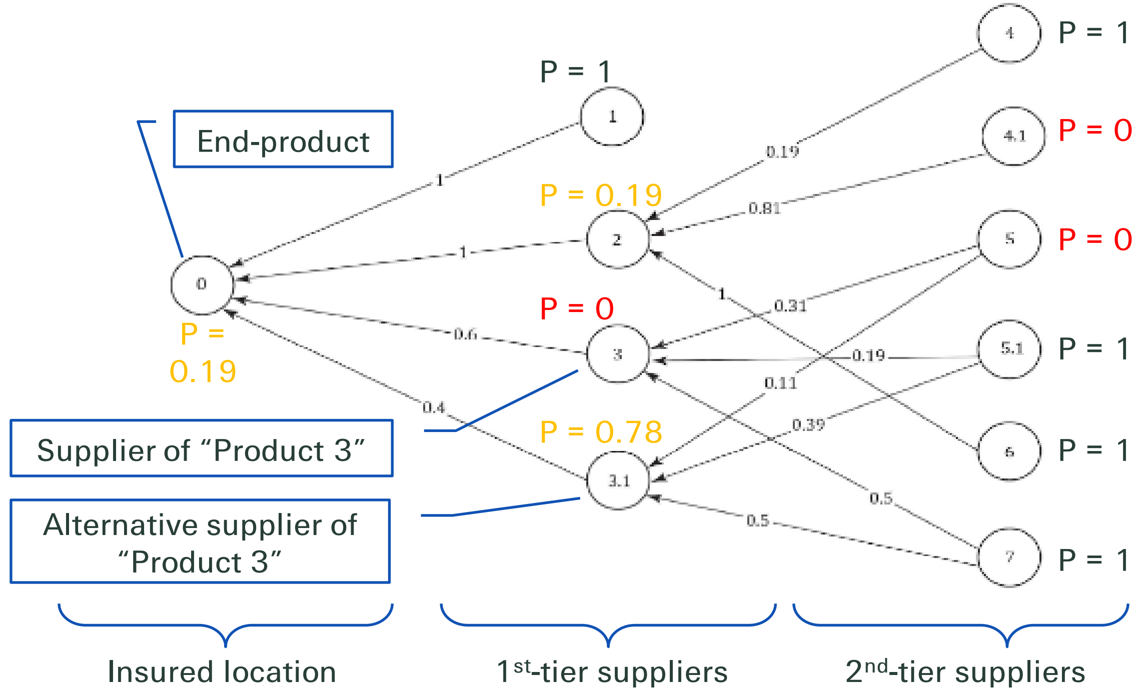
Model: The new supply chain risk propagation model quantifies BI/CBI losses at each insured location, taking into account product dependencies, single source suppliers, and supply chain relationships for given interruption at the any location in the supply network. The input of the model is the interruption ratio and duration at the location(s) affected by event. The model is peril-agnostic and can estimate interdependent BI/CBI for any peril (man-made or natural catastrophes).

Potential extensions: The current model can be integrated into current natural catastrophe models and effectively applied to large portfolios for accumulation management. In addition, the model can be extended to take into account reserved stock at locations (redundancy), probability of finding alternative suppliers, and lead time to securing new supplies.

Supply chain risk propagation model (co-developed with CDAR)

Enabling supply chain interdependency analytics to improve BI and CBI costing.

- Re/insurers have **limited information about their clients' supply chains.** This **limits our ability to accurately quantify the risks** stemming from interdependencies between insured locations.
- **Actual BI losses can be 2.5 times more than modelled losses and half of total property losses.**
- Swiss Re Institute's new BI/CBI risk propagation model[1] enables better **quantification of BI/CBI losses** by considering product dependencies and supply chain relationships for better risk selection and costing.
- The BI/CBI propagation model can be extended. Using global trade data we can model the **probability to find alternative suppliers and lead times for goods**.



[1] 2022-02_a_propagation_model_to_quantify_business_interruption_losses_in_supply_chain_networks.pdf (berkeley.edu)

The challenge

Automotive supply chain networks are global and complex. Companies lack full visibility. **Quantifying BI/CBI losses requires using new datasets and new risk models** that can help companies understand and quantify risk propagation across entities, taking into account supply chain interdependencies).

To quantify and assess BI/CBI risks in an automotive property portfolio, companies need to estimate the **overall accumulation in different scenarios**.

The R&D

Data: Automotive manufacturers' location data extracted from curated supply chain datasets to understand supply chain network and dependencies.

Modeling: BI/CBI risk propagation model across entities, identifying interdependencies and critical nodes and risk drivers (e.g., product scarcity, geographic supplier concentration). Financial quantification of interruption by local entity and at Group level.

The results

Out of 401 locations* in Japan, 58 were impacted by the Osaka 2018 earthquake, causing BI losses.

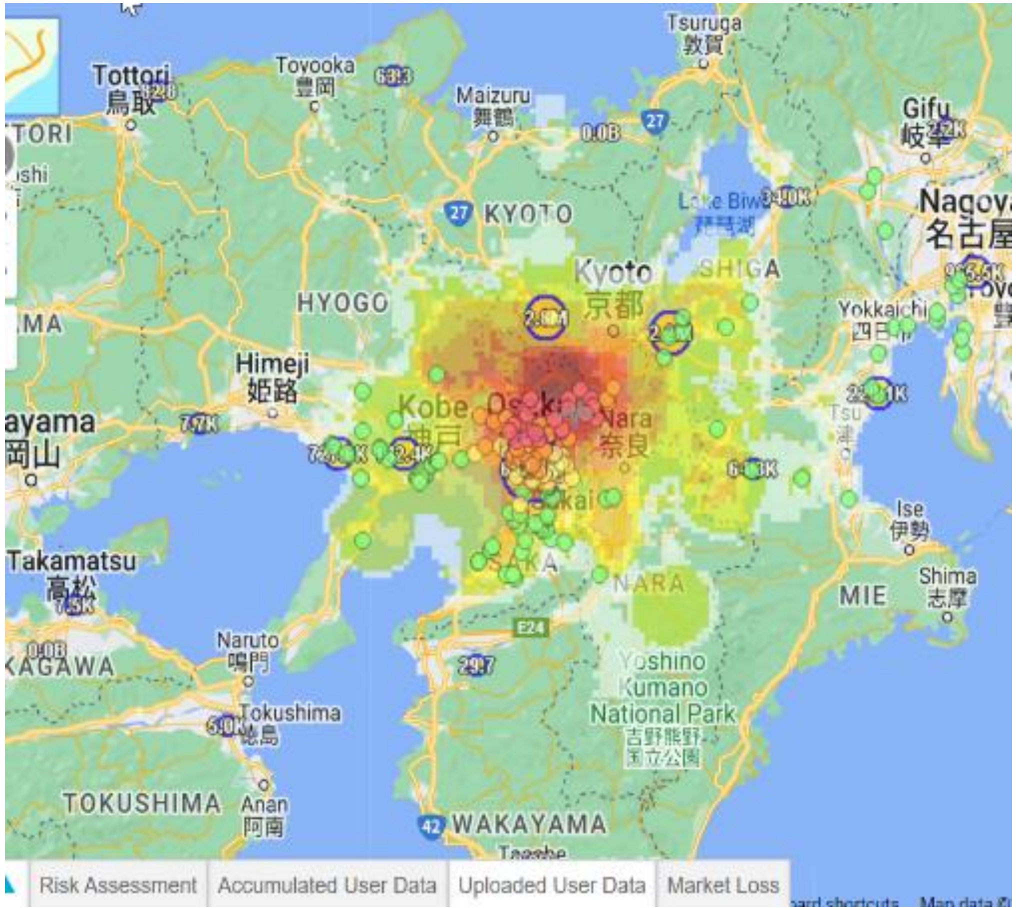
The 58 impacted locations in Japan caused interruptions at **9 other locations** across the automotive industry, causing an additional (CBI) loss of **approximately 11%.**

* Based on purchased shipment data

Modelled example: Risk propagation can cause an additional 11% CBI loss (synthetic data)

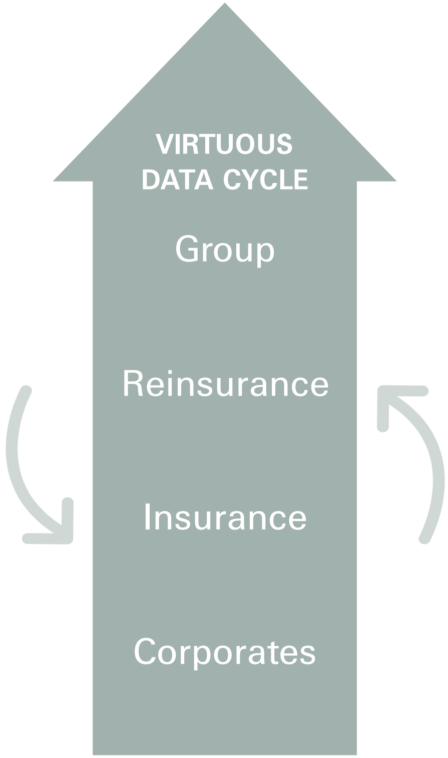
- **Assumptions**: Automotive locations data are extracted from purchased shipment data. The locations' insured value is **assumed to be USD 60m per building, USD 40m per content and equipment, and USD 50m of annual gross profit** (12 months indemnity period).
- **Results**: Out of 401 locations in Japan, Osaka EQ scenario impacted 58 locations. Swiss Re Nat Cat models estimate the BI loss at ~USD 118m. The interruption of impacted locations in Japan causes interruption to 9 other locations with an estimated additional ~USD 13m in losses, which is about 11% more than the BI estimated.

Japan 2018 Osaka EQ - scenario losses				
Model	Number of locations	Property (PD)	BI (Swiss Re Cat Model)	CBI (incl. Supply Chain)
Insured values	401	40,100 mn	20,050 mn	+1st-tier customers
SRI Nat Cat Losses	58 (direct) + 9 SC indirect impact	136.8 mn	118.5 mn	**13.4 mn**



Better data can help solve for underwriting performance pain points across a re/insurance company

Objectives: Achieve end-to-end supply chain visibility for improved supply chain risk quantification and management



- Qualitative and quantitative NDBI risks
- Map NDBI exposures metrics
- Property BI and CBI quantification (interdependent losses)
- UW relevant metrics (dependencies, redundancies, emissions)
- Internal data enriched with client, partner & vendor data integrated into common ontology

Pain points to solve for within a re/insurance company

- Unknown supply chain interdependencies can cause CBI and NDBI losses for clients which can then lead to re/insurance exclusions and/or losses
- Interdependent worker liability risks, cyber risks, credit risks, geopolitical risks and reputational risks (e.g. sustainability including scope 3 carbon) can lead to NDBI losses.
- Interdependent BI/CBI modelling is required to avoid inaccurate estimation of financial losses due to interruptions at tier-N suppliers or lifeline (e.g. bridges) interruptions.
- Lack of qualitative and quantitative metrics for underwriting to assess BI exposures. Without full visibility of supply chain network, it is challenging to estimate aspects like interdependencies and scope 3 carbon emissions
- Lack of common data ontology to enable full integration of SC data from different sources. Very limited information regarding supply chain relations between corporate clients lead to inaccurate BI exposure assessments.

Integrating and enriching internal supply chain-relevant data with external data to power supply chain analytics

Data sources

Re/insurer data

- Property exposure data (insured values per address, occupancies etc.)
- Property claims and loss adjustor reports
- Risk engineering data (BI rating per location)
- Hazard maps
- etc

Third-party data

- IHS vessel location data
- Marine Benchmark vessel emissions
- Ship recycling
- Global shipping data (S&P Panjiva)
- Company Database (S&P Global) or Factset RIBICS
- Supply chain data (Factset)
- News feed (Factiva)

R&D

Data sourcing & curation

Find and assess data sources, get access, control data quality and completeness, data validation, feature extraction, data structuring, building data ontologies

Models

Cat models including BI (direct losses)
Macro models
Credit
Etc

Model gap

Indirect BI modelling
News sentiment analysis (e.g. for credit risk signals)

Analytics (examples)

- Interdependent exposed BI analytics services
- Supply chain network visualisation and analytics
- Real-time risk insights (e.g. natcat warning signal for risks impacting suppliers)
- Location-level indirect BI risk scores

Partnerships (examples)

University of California Berkeley CDAR: Review and compare state-of-the-art supply chain network risk models. Develop network risk propagation model.

Re/insurance use cases (examples)

Underwriting

- Enable improved high risk location identification. Plug data gaps for better risk selection and costing.
- Better assess risk interdependencies and more accurately quantify BI risks in portfolios.
- Avoid bad risks and accumulations related to BI interdependencies.

Risk engineering

- Perform detailed on-site risk assessments at high-risk locations based on risk dependencies.
- Enable improved estimation of exposed BI and loss estimates.
- Grow fee-based services
- Foster stronger client relationships through improved risk insights and mitigation plans

BI / CBI modelling

- Integrate new/improved BI/CBI modelling reflecting risk dependencies into costing models linked to claims data

Re/insurance covers

- Offer improved indirect BI loss estimates
- Enable development of NDBI parametric covers.

Bottom up, enhanced data enables better risk selection and costing at single risk level, steering of portfolios, and accumulation management at company level

Company-level: Identify accumulation drivers. Manage risks globally. Effectively allocate underwriting capital.

Portfolio level: Steer portfolios. Balance upside, downside, impact. Portfolio growth. Implement risk management strategies.

Single risk level: Improve costing and risk selection. Develop new products. Expand insurability.

Examples of personas who benefit from supply chain resilience offerings

Personas	Needs	Benefits
Risk / insurance manager Responsible for managing risk and buying insurance covers and services	**Key needs** • Identify / assess / quantify risk landscape and drivers • Purchase insurance covers • Lead risk mitigation strategy and investments • Estimate Property and BI insured values in sites (BI allocation)	**Key advantages** • Identify risk drivers and vulnerabilities / accumulation potential • Structure insurance coverages for the actual risks considering vulnerabilities and redundancies. • Manage risks at key locations with the highest financial impact • Quantify the portion of revenue at risk at each location considering interdependencies.
Supply chain manager Responsible for supply chain strategic planning & KPI management.	**Key needs** • Understand company supply chain tier-1 to tier-n • Manage supply chain risk mitigation measures • Propose mitigation strategies supporting financial targets	**Key advantages** • Interlinking supply chain risks and their network-effects to establish the basis for decision making • Quantifying risk impact to identify best available options considering different KPIs.
Procurement manager Responsible for managing supplier network to ensure business continuity.	**Key needs** • Identify upstream single source products. Find reliable alternative suppliers • Source goods at reduced costs • Optimally manage stocks to ensure business continuity within financial targets	**Key advantages** • Managing single source suppliers and find alternatives to reduce risks • Identifying best available supplier considering different KPIs including risk impact and costs. • Integrating risk insights capabilities to enable to anticipate adverse risk events & take action

Steps towards improving a company’s supply chain risk resilience

1. Map company x tier-n supply chain
   → Company x insurance manager uses analytics tool for supply chain visibility to tier-n
2. Identify critical locations and natcat events
   → Company x Tokyo location gets hit by typhoon. The production of base chemicals used for drug generation in company x India gets interrupted. This propagates to the supply of company x end products in Italy.
3. Quantify location loss and risk propagation across dependent locations
   1. BI allocation (revenue at risk) per location (India, Italy)
   2. Post-event impact quantification: By production ratio (in%) and duration (and therefore production loss) of impact per location
4. Resilience analytics & products
   1. Supplier alternatives → Company x selects alternative suppliers based on production volume, location, etc
   2. Product uniqueness (single source supplier) → Company x reviews single source products to inform their supply chain and product development strategies.
   3. Storage (stock redundancy) options
   4. Offer BI / CBI / NDBI indeminity covers. Offer new products (e.g. parametric covers for fast payout, complementing indemnity covers).

Potential re/insurance offerings for supply chain resilience

360° capabilities	*Potential products and analytics features*
Visibility	• **Digital twin**: Visualise end-to-end supply chain mapping down to tier-n across all industries globally.
	• **Risk insights**: Explore supplier and product dependencies and overlay historical and live e.g., weather risk data.
	• **Alternative suppliers**: Find alternative suppliers (and customers) by country and products.
	• **Supplier risk hotspots**: Identify suppliers risk hotspots and concentration.
	• **BI allocation of revenue at risk:** Quantify the portion of revenue at risk at each site considering supply interdependencies.
Mitigation	• **Resilience analytics (including revenue impacted)**: Advanced supply network analytics and what-if scenarios e.g., simulate disruptive events and quantify loss of revenue across supply chain.
	• **Risk mitigation insights:** Effective risk mitigation investments on resilience measures by simulating impact of mitigations e.g., buffer of key material stocks for strategic products, investment on site protections.
Protection	• **Insurance covers:** Insurance covers including new products e.g., parametric BI covers based on business downtime.

Quantum Cities™
Takeaway

At the nexus of technology, economic and societal changes lie untapped opportunities. The breadth and depth of **challenges** require new **approaches** to sustainably accelerate **growth** and manage **new risks**

Swiss Re´s **Quantum Cities™** is a strategic response enabling **innovative risk approaches and offerings** to increase **resilience** and close **protection gaps**

Working in strategic partnerships with research applied to large-scale transformational projects, re/insurers can support urban and national **strategic visions** that enable **resilient, sustainable economies and societies**

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