Current trends in creation and use of flood maps by the insurance market

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Climate change is increasing the frequency of damage caused by natural disasters, in particular floods. The availability of accurate input data and modern modelling technology helps to produce flood models optimised for use across the insurance market, or, conversely, tailored to the requirements of individual insurers. The deployment of the cloud significantly simplifies and reduces the cost of using the models within the existing systems of insurance companies and enables their continual updating.

Houses destroyed by forest fires. Waterfronts washed away by floods. Foundations of buildings displaced due to subsidence. Climate change damages indicate that insured catastrophe losses in key markets are expected to increase by up to 120% over the next 20 years. The property and casualty (P&C) insurance market is changing rapidly. Global property catastrophe premiums will increase by up to 41% (USD 183 billion) by 2040 due to climate risks, with USD 110 billion coming from developed markets.

As the latest Swiss Re report shows, the P&C insurance is changing, and climate change is a key driver for insurers of a riskier and more complex property portfolio. Economic growth, digitalization and urbanization are also contributing to an increase in risk and a reconfiguration of risk pools that are changing the shape of the industry. Flood damage is a clear example of the consequences of climate change. By 2040, for example, they could lead to a 200% increase in insured losses in the UK, France and Germany, a 235% increase in China and a 145% increase in Canada.[1]

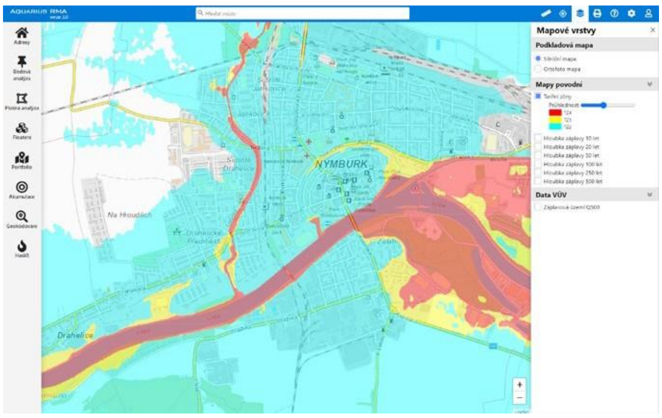
Flood maps

To accurately determine how far the water will recede during a flood event, where it will go and how fast the water will flow, it is essential to use the most accurate and up-to-date input data. In terms of describing the actual terrain, the standard on the Czech market is the fifth generation digital elevation model (DMR 5G), created by the Czech Office of Surveying and Cadastre (ČÚZK), which not only stands out for its accuracy, but also captures the latest changes in the terrain.

To determine the amount of flood water as accurately as possible in simulations that correspond to actual calculations of 20-year or 100-year flows, it is necessary to use an extensive network of n-year flows from more than 200 measuring stations of the Czech Hydrometeorological Institute.

To accurately describe how runoff slows down, accelerates or flows back and how this affects spills, many structures, such as dams and weirs, are included in the modelling.

Modelling would not be complete without the inclusion of flood mitigation measures, such as flood barriers, channel capping, polders, embankments and landscaped edges. A substantial part of flood protection measures is already included in the highly accurate DMR relief model. However, flood protection features such as channel capping, flood walls, mobile dams and reduced DMR accuracy in places where the immediate surroundings are covered with vegetation needs to be supplemented with additional information from other data sources. State-guaranteed and verified data sources, such as the Basin Enterprise, the Flood information system, *Flood Plan of the Czech Republic* and subsidy titles for the construction of flood protection measures can be incorporated into flood models.



Source:Intermap Technologies

Figure 1: User interface of the Aquarius RMA 3.0 risk assessment application with the tariff zones displayed on the background of the CEDA Maps *Atlas of the Czech* Republic

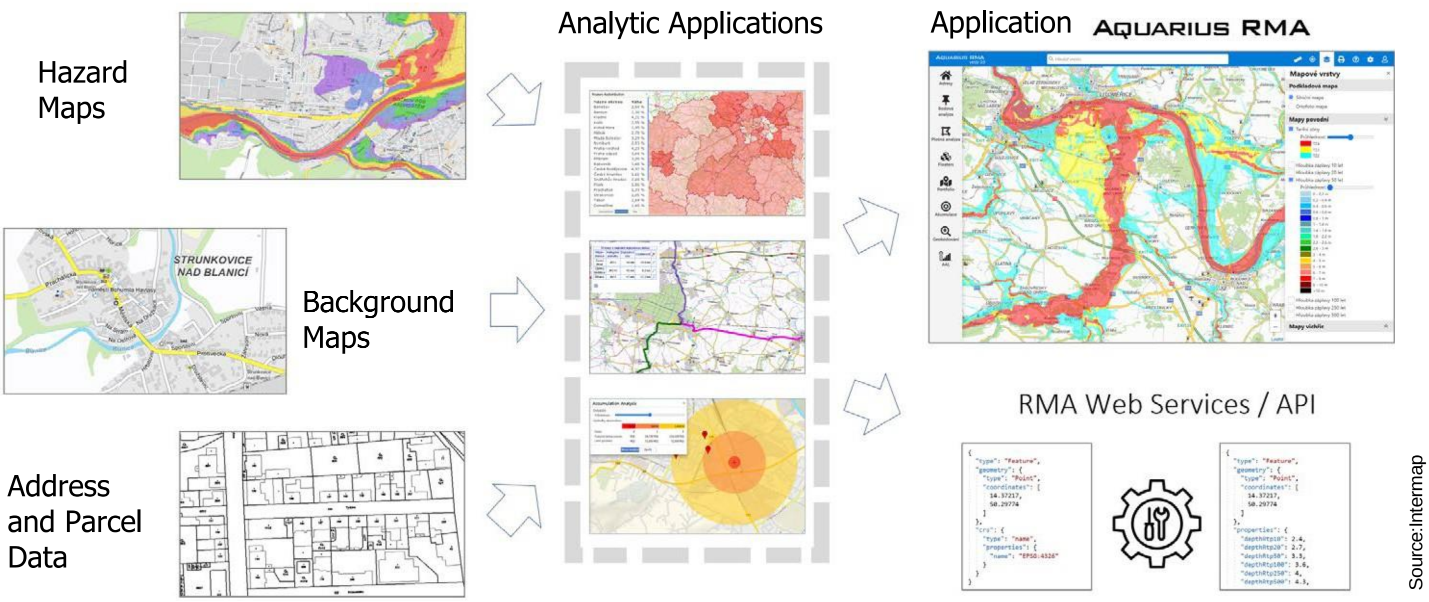


Figure 2: Schematic representation of the risk assessment application. *Center*: analytical tools used to evaluate different aspects of risk by different departments of the insurance company. *Left*: Data that help in the risk assessment process: hazard maps, base (orientation) maps, address and parcel data. *Right*: User interface in the form of a web-based mapping application controlled by an insurance company employee (*top*) or by linking to the insurance company's operational systems via web services (*bottom*)

Due to the considerable decentralization of flood information administered by official authorities, often down to the level of the lowest hierarchical water authorities (municipal authorities), the collection of flood data is extremely labour intensive. For this reason, a suitable solution is to focus on the most important rivers and populated areas, such as the 50 largest rivers plus all towns over the populations of 10,000.

The most widely used systems by the professional public for flood hazard modelling include HEC-RAS, developed by the US Army Corps of Engineers. This system is designed for hydrodynamic modeling of fluvial and pluvial flooding using 2D and 1D hydraulic simulations. It allows for the inclusion of a range of structures that affect the flow of water in the channel itself or in the floodplain.

Automation of geospatial input preparation datasets for modelling and interpretation of model outputs is an important part of the flood hazard mapping process. There is a need to unify datasets from different sources, of different ages, quality and accuracy. The use of tools with artificial intelligence elements simplifies and reduces the cost of creating tailored datasets according to the requirements of the insurance market and allows them to be updated quickly and efficiently.

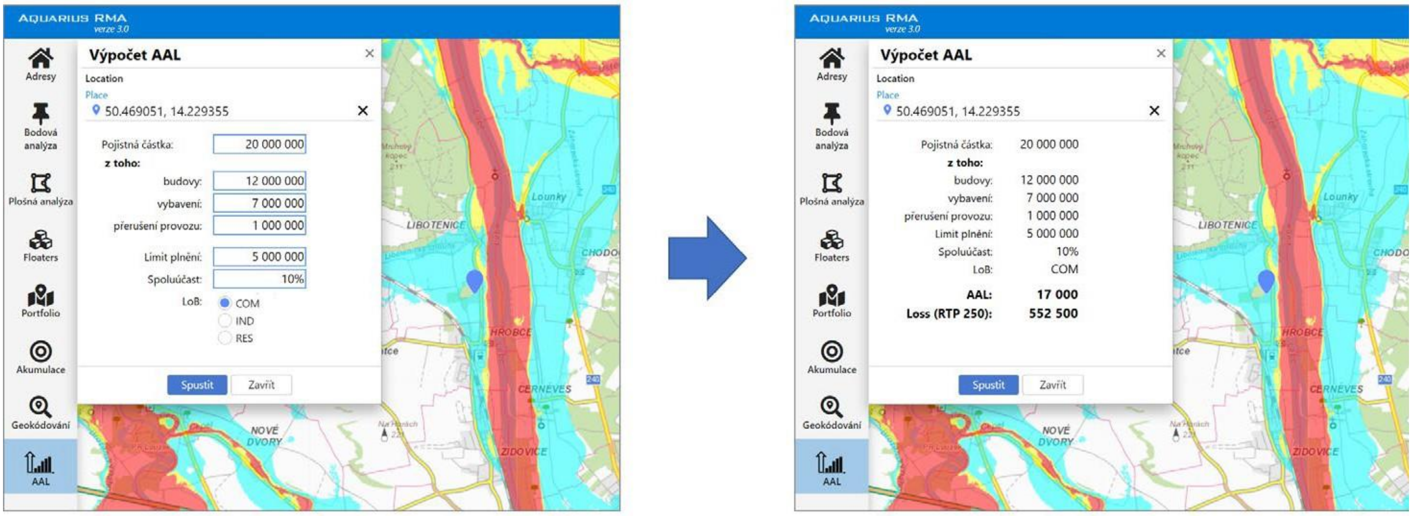
River and flash flood hazard maps consist of a set of several maps of n-year tides as well as maps of maximum flood depths. The much wider use of 2D hydraulic modelling has also enabled the production of maps of maximum flood water velocities and maps of the duration of the flooding.

While the maps of depths and speeds are an important part of damage estimation in terms of collateral, duration maps will also help in estimates of the length of service interruptions.

Geospatial dataset usage scenarios in the insurance company

Flood maps and datasets described in the previous parts are used by insurance companies in several places, from primary underwriting to risk engineering, product methodology and development, actuarial science, claims and reinsurance. A number of these use cases have a common process: Finding insurance locations by geocoding, assessing risk through hazard maps and using base maps for basic orientation. This information is used through the various analytical tools, resulting in either the display of the insurance location on a map or the sending of the information to the insurance company via web services.

Flood hazard maps can typically be used in two ways: In corporate underwriting and risk management, it is useful to apply as much detailed information as possible about the property to be insured. It is therefore useful to use the Aquarius RMA mapping application to display maps of n-year tides and maps of flooding depths for a given n-value. In contrast, in retail there is limited resources for detailed risk assessment, so it is more practical to use simple zoning values by colors, such as zones 1, 2, 3, 4. For this purpose, tariff zones are used, which includes information from many map layers like n-year tides and depths, river and flash floods, according to a predetermined algorithm. Tariff zones are often hidden in the insurance company's operational system, which communicates with the Aquarius RMA application via web services in the background.



Source:Intermap Technologies

Figure 3: Calculation of the average annual damage and 250-year damage for the retrieved address in Aquarius. *Left:* Entry of inputs (i.e., the sum insured broken down into for buildings, equipment, possible interruption of operations, limit of performance, deductible and LoB). *Right:* Resulting report

As is standard practice, Aquarius RMA supports the combination of flood maps with other natural or social risks. Examples include third-party maps such as susceptibility maps to slope movements on the Slovak market, as well as maps tailored to individual customers, either from their own data of historical damage (e.g., hail maps) or from official data from other agencies (e.g., theft maps or traffic accidents).

To locate the property in primary underwriting, geocoding analytics are used. It is usually a single address lookup, either directly through the Aquarius RMA app or through the insurance company's operational system, which communicates with it via web services. In the case of unlicensed buildings, transport structures or agricultural land, geocoding of parcels is appropriate.

In many cases where the place of insurance lies in several zones, hazard ratings based on the defining points of an address or parcel may be inadequate or misleading. A typical case is a larger industrial site, an agricultural plot, a linear traffic structure or a street next to a river, where individual houses have different risk ratings, even though they are located at a similar distance to the river. It is desirable to use polygon or linear risk analysis to refine the flood risk. This allows a building footprint, parcel or linear structure to be rated in terms of the percentage of each zone. In doing so, the user can either draw their own geometry in Aquarius RMA or use building or parcel plans linked via the iKatastr web services from ČÚZK, or traffic communications via CEDA's StreetNet.

Sometimes it is necessary to locate a larger quantity of insurance locations retrospectively through batch geocoding. In most cases, it is not just a matter of locating addresses or parcels, but primarily for cleaning them of various typos, abbreviations and incorrect, missing or redundant data, and to perform batch risk assessment. The use of batch geocoding, address cleaning and risk assessment is not limited to preparing for NatCat modelling as part of the restoration reinsurance or for cleaning the portfolio during the transition to the new enterprise system.

In the event of a natural catastrophe, the rapid localization of reported damages is a useful tool to assist insurers, both for first estimates of total damage and the amount of unreported damage, for map overviews showing the concentration of damage and for planning the routes of claims adjusters. Locating historical claims, once a year is a way to check the flood risk of a property and to detect insurance fraud in claims handling, to create customized insurance hazard maps, and to calibrate vulnerability functions in NatCat modeling for reinsurance. When underwriting an urban property or a network of retail branches, batch geocoding assists in proper risk estimation. Similarly, when underwriting a portfolio from a broker, geocoding facilitates the assessment of the risk that the broker brings and how it will affect the entire line of business or whether it makes sense to approach a particular client.

Line structures, distribution networks, branch networks, municipal property and multiple locations often do not contain specific locations of individual insurance sites, but they need to be distributed for risk estimation or reinsurance purposes. This is done by using the asset disaggregation method or floaters redistribution, which allows assets to be allocated to territorial units or territories by postcode using selected weights, such as population or land area.

As a guide in determining the minimum technical premiums so that the contract is not a long-term loss, the value of the average annual loss for a given peril such as flood, can be used. The calculation considers information on the location of the property, the corresponding values of the perils, the vulnerability and the financial attributes of the specific contract, such as sums insured, limits and deductibles for the whole portfolio or for individual locations.

Similar to locating historical damage, another tool insurers can use in the underwriting process is an analysis of the terrain profile between the river and the insurance site. This can clarify possible terrain obstacles or, depressions that could allow flooding to occur in and around a building.

Similarly, it can help identify critical locations in terms of flood propagation within a particular industrial site. Querying building heights and other parameters using iKatastr web services is a useful tool for listing urban assets.

Better orientation of underwriters or liquidators in the field is also accomplished by using background maps within the Aquarius RMA application. In addition to the traditional base maps from CEDA and basic maps from ČÚZK, it is also possible to use cadastral maps from ČÚZK or aerial photographs from Seznam.cz using web services.

The Aquarius RMA application allows you to use web services to connect to a wide range of third-party map layers, such as state-designated floodplains from the HEIS portal of the Water Research Institute or protected areas and sources of emissions from the CENIA portal, which are useful for risk assessment in terms of environmental liability insurance. Tracking tools based on CEDA's StreetNet web services also have their place in the Aquarius RMA application. For fire risk assessment, they calculate firefighter travel times from several nearby fire stations to decide on the best locations to distribute resources from.

Finally, there is also a price map calculator, which is connected to the Price Map Society's service. The price map clearly compiles the most extensive database of information on the actual selling prices at which flats and family houses are currently being sold and sorts the information in a clear form according to the individual property types and locations. With the sales price map, insurers can find out the real value of a flat or house and work with this information.

New in Aquarius RMA is the ability to work on mobile phones or tablets. The user interface is optimized for use on mobile devices directly in the field during underwriting, loss adjusting or routing of loss adjusters. Cloud-based online services make it easy and secure to use the Aquarius RMA app anywhere a signal connection is available.

Use of the cloud

Cloud computing is used across many applications and models. It provides services or programs by servers accessible from the internet, with users being able to access them remotely via a web browser or mobile phone. Cloud deployment greatly simplifies and reduces the cost of using advanced tools and datasets within existing insurance companies' systems and allows for continual updating. For large group insurers, cloud deployments make it easy for these tools to become a group platform for regional use by simply adding country-specific data.

The main advantages of the cloud solution include no investment in software and hardware (CAPEX) and eliminating internal operation and maintenance costs systems. The simplicity of the user interface, together with the availability of services and data from anywhere, including mobile devices, ensures productivity growth. The ability to quickly adapt cloud IT facilities to the growth and needs of the users, such as the ability to instantly increase the performance of the data center during natural disasters is critical.

Source: Intermap Technologies

Figure 4: The Aquarius RMA 3.0 application supports the connection of third-party risk maps using web services. In this case, the Q500 floodplain from the HEIS database of the Water Research Institute (*background:* orthophoto map)

The world's leading cloud service providers computing are Amazon, Microsoft, Google, IBM, etc. The cloud variant of Aquarius RMA uses the Microsoft Azure cloud, which is optimized for hybrid interconnection with insurers' existing IT systems.

Aquarius RMA can be deployed in a private architecture (software and data are installed and managed by the insurer's IT department), hybrid (some modules and data are hosted on the cloud and managed by the vendor), or entirely in the cloud (everything is hosted in the cloud and managed by the supplier).

Conclusion

Climate change is a key factor for insurers of a riskier and more complex property portfolio. Economic growth, digitalization and urbanization are also contributing to an increase in risk and a reconfiguration of risk pools, changing the shape of the industry. Modern tools and accurate data allow insurers to optimize decision-making processes and significantly reduce risks arising from the changing market situation. Mobile technologies ensure that a complete solution is available anywhere in the field. Cloud deployment greatly simplifies and reduces the cost of using advanced tools and data sets within the existing systems of insurance companies and enables their continual updating.

1 Source: SwissRe - In a world of growing risk the insurance industry has a crucial role to play; 6 September 2021; https://www.swissre.com/risk-knowledge/building- societal-resilience/growing-risk-insurance-industry-crucial-role.html.