Natural Hazard and Climate Change Risk Quantification

Software Tools, Analytics & Data for quantification along the whole policy life-cycle:
from Underwriting through Reinsurance to Claim Adjustment

Hrvatski Dani Osiguranja

Opatija, May 2025

Your World. Made Simple.

Knowing means:
Profitability, Cost Effectiveness and Protection

Now more than ever it is true, that understanding **the natural hazards and climate change risks** means along the whole policy life-cycle for the **Insurance**, but also for the **Financial Services** and **Real Estate** markets

- profitable **underwriting**
- cost-effective **reinsurance** and **claims adjustment**

Strong insurance business is a very important **protection pillar** for every country in case of the natural **catastrophic events** which are happening these days

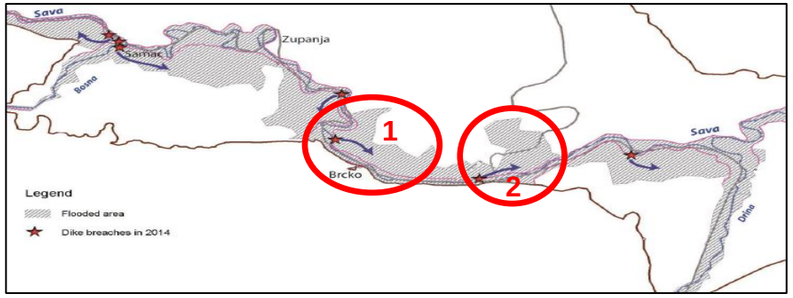
After all, it was the **Czech** and **Austrian** insurance markets that first took up the torch of flood modeling in the continental Europe, right after the **UK**, almost a quarter of a century ago

Understanding **the natural hazards and climate change risks** means the ability to see them within the geospatial context by using the appropriate Software (GIS), Analytics and Data Tools

Natural Hazard Maps

River Flooding

- Floods in the Sava River Basin generally occur in spring, after snow melt, and in autumn, after heavy rainfall.
- **Disastrous floods** occurred in the **Sava** Basin in **May 2014** leading to 79 casualties and economic damages of € 3.84 billion.
- The flood was caused by a strong cyclone over Genoese Bay, together with a strong anticyclone over northern Caspian Sea. Heavy rain was constantly falling over E & N Bosnia, C & W Serbia and E Croatia.
- In Croatia, the rainfall in 5 days was 1.5-1.8 times more than the mean monthly precipitation for May. It caused 3 **casualties**, 15,000 **evacuated** and 38,000 **affected people**, with an **economic damage** of € 300 million, including € 10 million on flood protection, mostly in Vukovarsko-Srijemska County.
- Major damage caused by **dike breaches** at Rajevo Selo and Račinovci in Croatia and 5 others in Bosnia and Herzegovina.



Footprint of the 2014 Sava flood; breaches at Rajevo Selo (1) and Račinovci (2)

Flooded village of Gunja

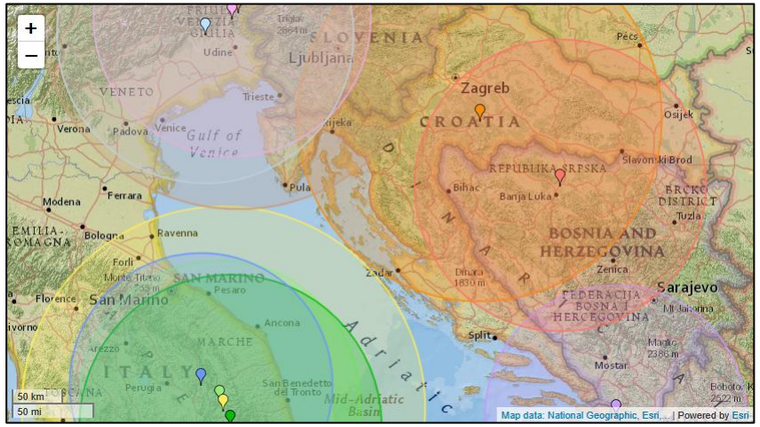
Flood hazard map of the Drava river near Osijek

Dam breach at Rajevo Selo near Brčko

Earthquake

- Croatia is located in a seismically active region, facing frequent earthquakes that threaten buildings and infrastructure, requiring strong building codes and preparedness.

Only in the last 55 years, 7 major earthquakes were felt in the country.



4 years ago 6.4 magnitude, 10 km depth
Petrinja, Sisačko-Moslavačka, Croatia

8 years ago 6.6 magnitude, 10 km depth
Preci, Umbria, Italy

8 years ago 6.1 magnitude, 10 km depth
Visso, The Marches, Italy

8 years ago 6.2 magnitude, 10 km depth
Accumoli, Latium, Italy

27 years ago 6.0 magnitude, 10 km depth
Nocera Umbra, Umbria, Italy

28 years ago 6.0 magnitude, 10 km depth
Podgora, Dubrovačko-Neretvanska, Croatia

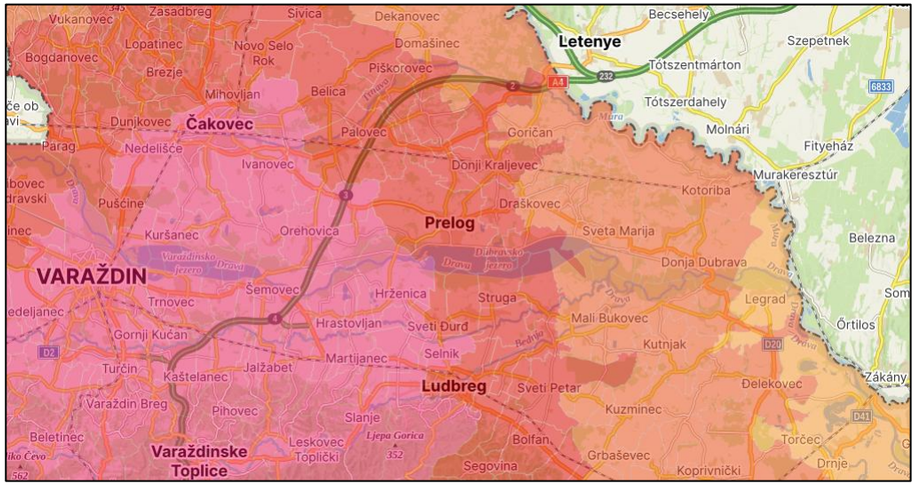
48 years ago 6.0 magnitude, 10 km depth
Isola, Friuli Venezia Giulia, Italy

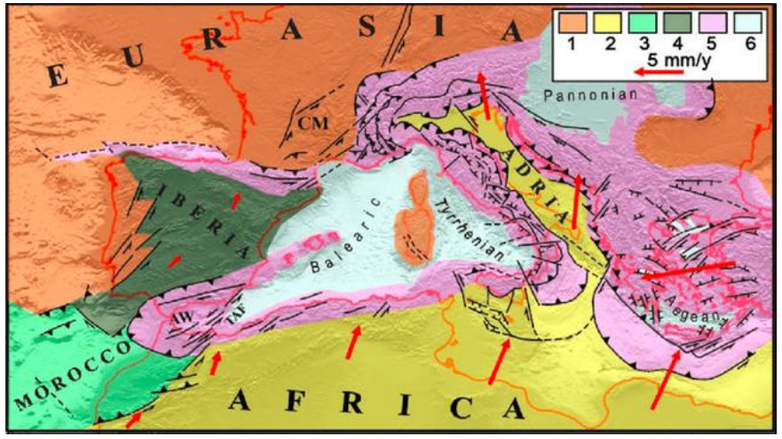
48 years ago 6.1 magnitude, 24 km depth
Lestans, Friuli Venezia Giulia, Italy

48 years ago 6.5 magnitude, 9 km depth
Prato, Friuli Venezia Giulia, Italy

55 years ago 6.1 magnitude, 15 km depth
Trn, Republika Srpska, Bosnia and Herzegovina

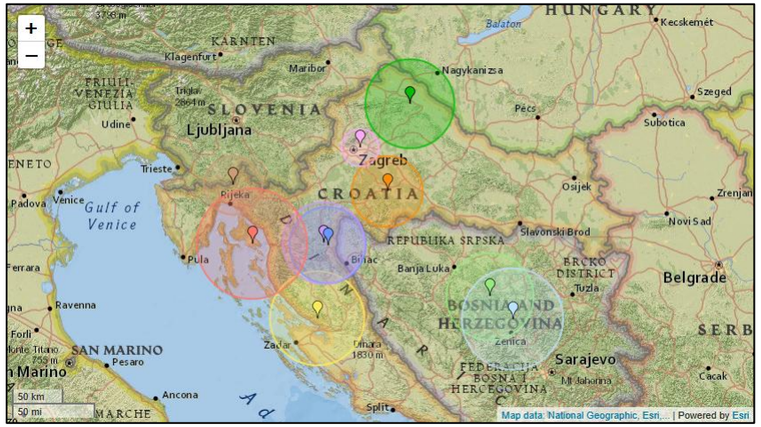
Earthquake intensity maps (EMS-98 scale) help to indicate the hazardous areas.





There is a still ongoing activity: events in the last 2 years.

Drifting of the Adriatic plate is a major factor.



1 month ago 4.2 magnitude, 10 km depth
Sisak, Sisačko-Moslavačka, Croatia

2 months ago 4.6 magnitude, 10 km depth
Starigrad, Zadarska, Croatia

6 months ago 4.5 magnitude, 14 km depth
Pribinić, Republika Srpska, Bosnia and Herzegovina

8 months ago 4.5 magnitude, 10 km depth
Ludbreg, Varaždinska, Croatia

11 months ago 4.3 magnitude, 15 km depth
Tržačka Raštela, Federation of Bosnia and Herzegovina, Bosnia and Herzegovina

11 months ago 4.4 magnitude, 10 km depth
Sluni, Karlovačka, Croatia

1 year ago 2.9 magnitude, 5 km depth
Dubrava, Grad Zagreb, Croatia

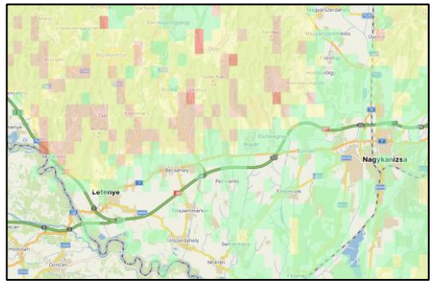
1 year ago 4.7 magnitude, 11 km depth
Željezno Polje, Federation of Bosnia and Herzegovina, Bosnia and Herzegovina

1 year ago 3.9 magnitude, 8 km depth
Klana, Primorsko-Goranska, Croatia

2 years ago 4.8 magnitude, 10 km depth
Punat, Primorsko-Goranska, Croatia

Landslides, Wildfire, Drought

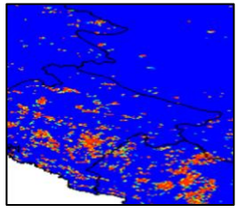
- Hilly and mountainous regions of Croatia experience a prevalence of **landslides**, often triggered by heavy rainfall, seismic activity, or human activities.



Landslide in H. Kostajnica near Sisak

Landslide map of Hungary near Varaždin

Wildfire in Dalmatia in 2017



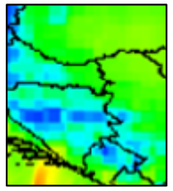
Wildfire hazard map of SE Europe

- **Wildfires** are a major seasonal hazard in Croatia, especially along the coast, spreading rapidly through dry vegetation in hot, windy conditions and increasingly intensified by climate change, threatening ecosystems and communities.

- Croatia faces increasing **drought** hazard, particularly during summer months, characterized by prolonged periods of low precipitation and high temperatures that stress water resources for population, industry and nature, impact crop yields, and elevate wildfire risk.

Drought near Orljava river, Požega-Slavonia County

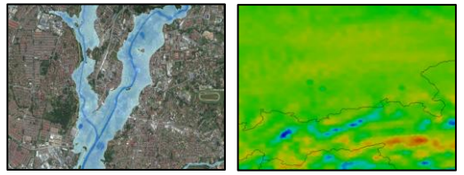
Drought hazard map of SE Europe

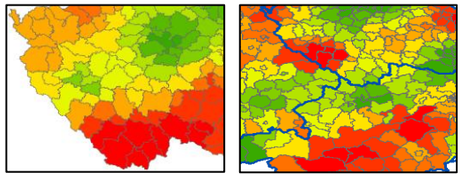


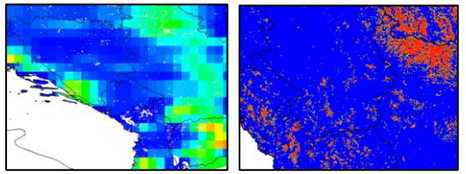
Present Day Natural Hazard Maps

Acute Meteorological:

- River Flood
- Windstorm
- Hail
- Lightning
- Fire Weather
- Wildfire
- Pluvial Flood
- Surge Flood
- Tropical Cyclone / Hurricane / Typhoon

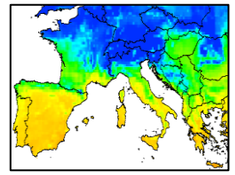
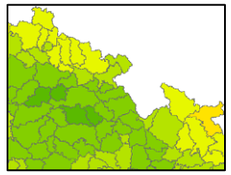
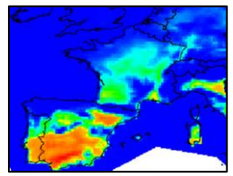






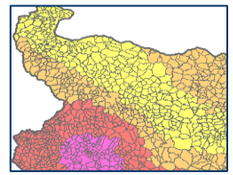

Chronic:

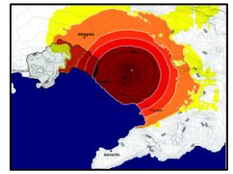
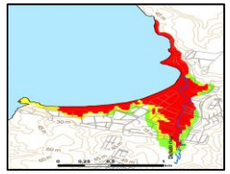
- Drought Stress
- Precipitation Stress
- Heat & Cold Stress

Geo-Physical:

- Earthquake
- Landslide
- Volcano
- Tsunami

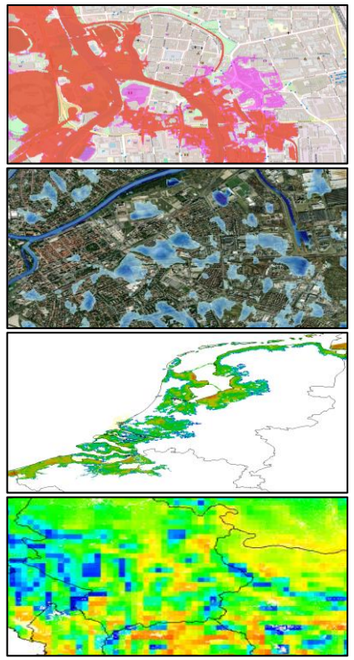


Forward-looking Natural Hazard Maps

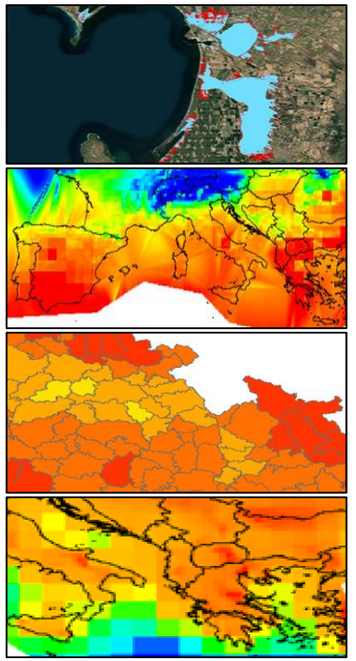
Acute:

- River Flood
- Pluvial Flood
- Surge / Tidal Flood
- Fire Weather



Chronic:

- Sea Level Rise
- Drought Stress
- Precipitation Stress
- Heat & Cold Stress



- Simulations are made and different maps are created according to several climate change scenarios and target time horizons:

1. Climate change scenarios:

SSP / Shared Socioeconomic Pathways defined by the Intergovernmental Panel on Climate Change 6th Assessment Report (IPCC-AR6) in 2021. Radiative forcing [W/m^2] in brackets:

- **SSP 1 (2.6)** Sustainability (Green Road)
- **SSP 2 (4.5)** Middle of the road
- **SSP 5 (8.5)** Fossil-Fueled Development (Highway)

2. Time horizons used for modeling:

- **Near** (2030's-2040's)
- **Medium** (2050's-2070's)
- **Far** (2080's-2100)

Decoding the Maps:
Interpreting Hazard Information for Risk Quantification

Return Periods and Probabilities

- a 100-year return period of flood has a probabilistic interpretation as a 1% chance of flood occurrence in any given year
- a 475-year return period of earthquake means a 10% chance of earthquake occurrence within a period of 50 years
- **These are probabilities, not guarantees of when an event will occur**

Flood Extent, Depth and Velocity

- Flood maps often show not just the extent of an N-year flood but also the potential depth and flow velocity of floodwaters, which are crucial for assessing damage potential

Earthquake Magnitude vs Intensity

- Magnitude is a measure of energy released
- Intensity is a measure of the shaking experienced at a specific location: intensity is what directly impacts structures

Landslide Susceptibility

- Susceptibility identifies areas prone to landslides based on geological and topographic factors

Average Wind Speed vs Wind Gust

- An hourly (daily) average wind speed is easy to collect but may hide the real damage caused by a windstorm
- Wind Gust measurements (e.g., 3 second gusts) better represent the damage force of a windstorm

Number of days with extreme weather

- Cumulative number of days with hot / cold / rainy / dry weather identifies how frequent the extreme weather is
- Number of consecutive days with rainfall deficit identifies the severity of the drought

Risk Quantification Analytics

How to Quantify Risk: Single Asset or Bulk Geocoding

Map pinning

- Clicking on the site in the map

GPS coordinates

- Entering the GPS coordinates of the site

Address geocoding

- Roof-top or door-step localizing of the house number (street address)

Parcel geocoding

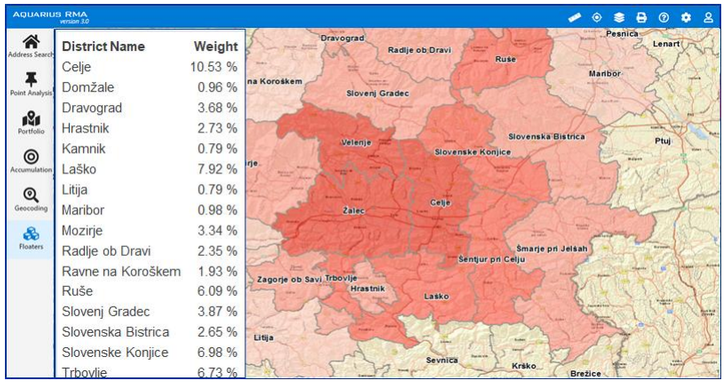
- Finding the centerpoint of a cadastral parcel

Area or Line analysis

- Drawing an industrial area or a linear construction in the map
- Selecting parcels of an industrial plant or agricultural land from the map

Disaggregation & Redistribution

- Disaggregation of property insured without exactly specified location (floaters) and its weighted redistribution to administrative or postal areas



Leveraging Hazard Data & Analytics for Enhanced Insurance Practices along the Policy Life Cycle

Product Management

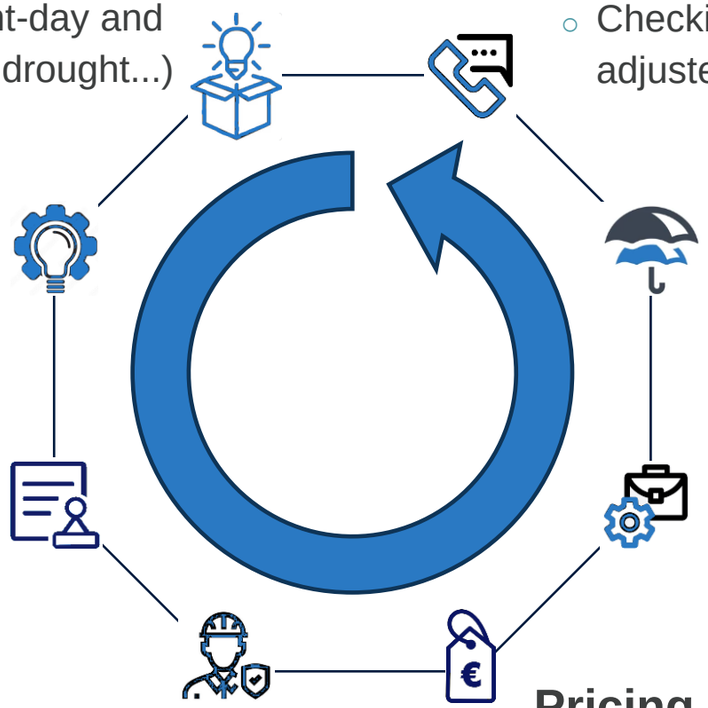
- Designing products according to present-day and future hazards (trends in flood, wildfire, drought...)

Claim Adjustment

- Checking for insurance fraud, optimizing of claim adjusters, estimation of yet unreported claims

Methodology

- How to combine information from hazard maps with historical claims, media resources etc.



Reinsurance Management

- Renewal NatCat modeling, property localizing, vulnerability calibration based on historical claims, Solvency II modeling, transfer pricing benchmarks

Underwriting

- Retail: automation with pre-defined UW rules
- Corporate: multi-risk & multi-source evaluation

Portfolio Management

- What is the space for negotiations on re-setting deductive, limits etc. based on the risk? How risky portfolio is brought by a broker? Is addressing of a specific client in accordance with insurer's policy?

Risk Engineering

- Spatial context (geo-location, hazard maps),
- Structural context (price maps, building & roof material),
- Historical context (historical claim maps, future hazards)

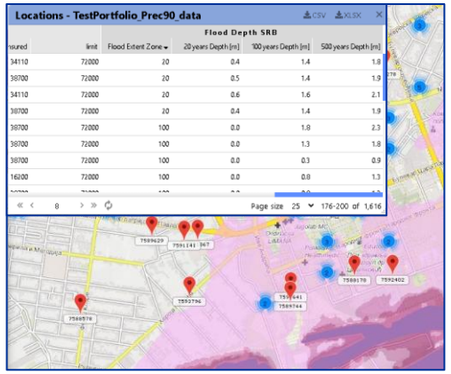
Pricing

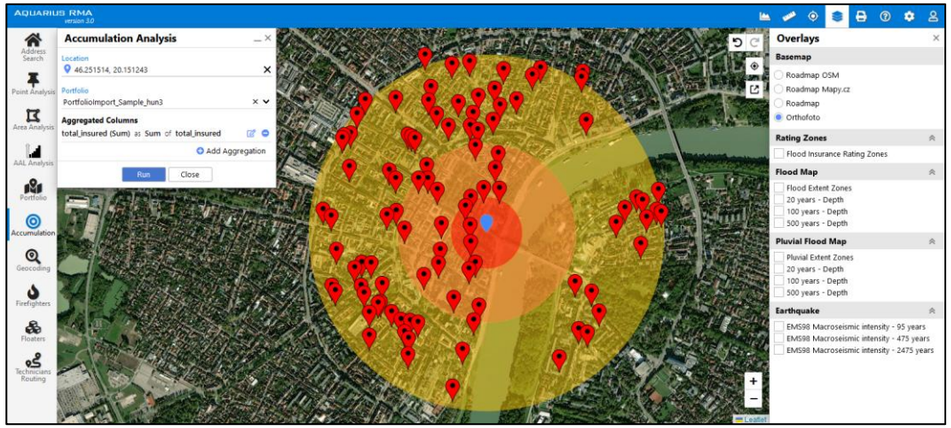
- Technical price vs UW adjusted price vs Average Annual Loss

Underwriting & Reinsurance Analytics: examples

Portfolio analysis

- Uploading, geocoding and analyzing custom portfolios



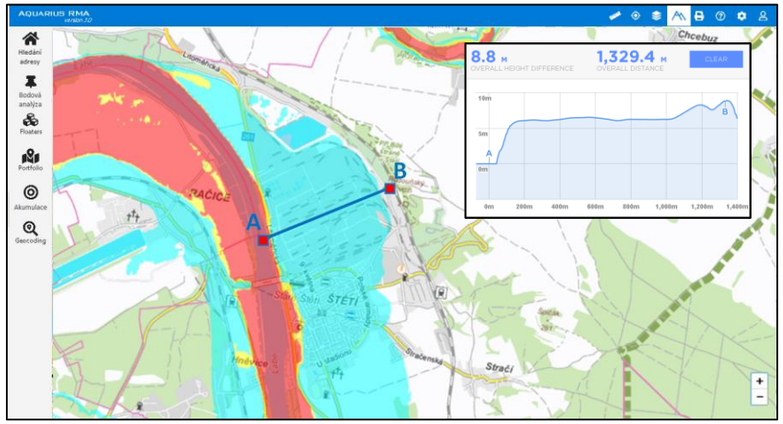


Accumulation analysis

- Analyzing the portfolio's accumulation in a radius

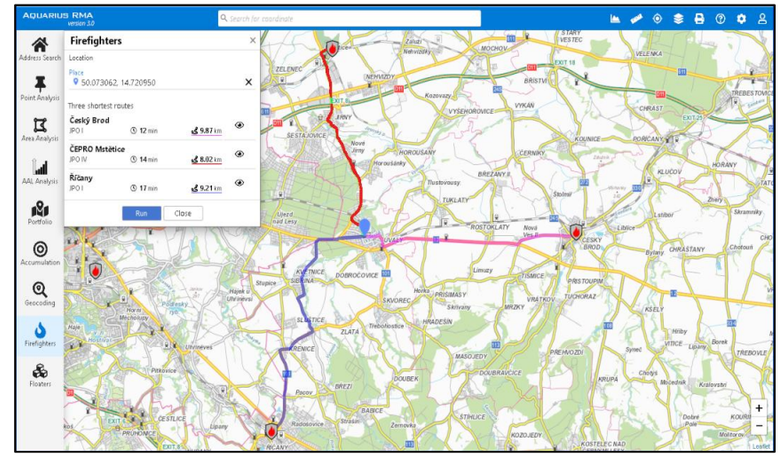
Terrain profile

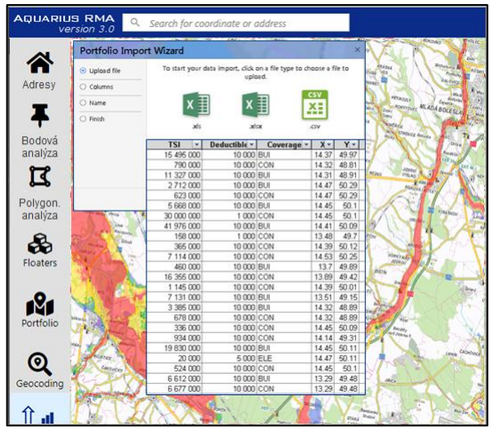
- Finding local hollows or humps within a site



Firefighters' arrival times

- Distance of site insured to the fire stations



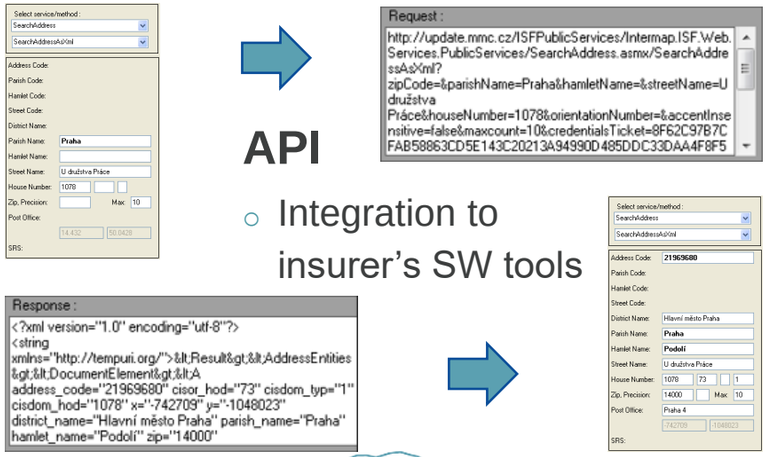


AAL

- Annual Average Loss calculation

API

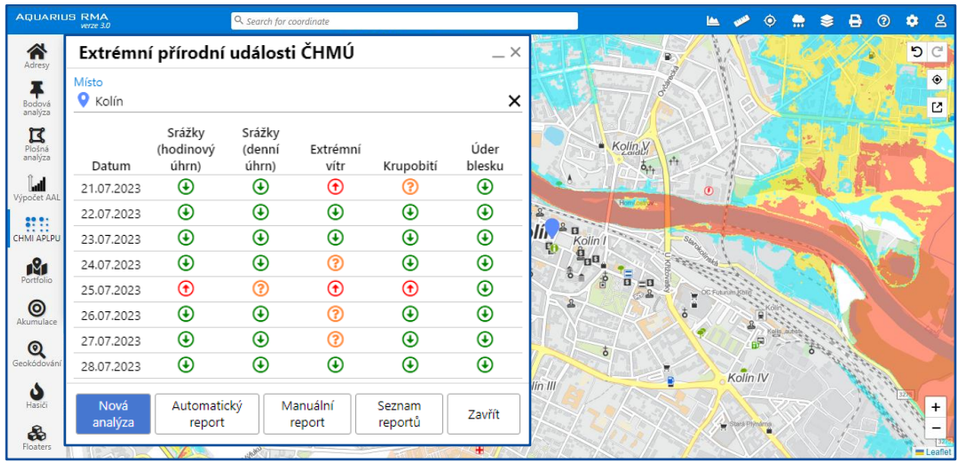
- Integration to insurer's SW tools

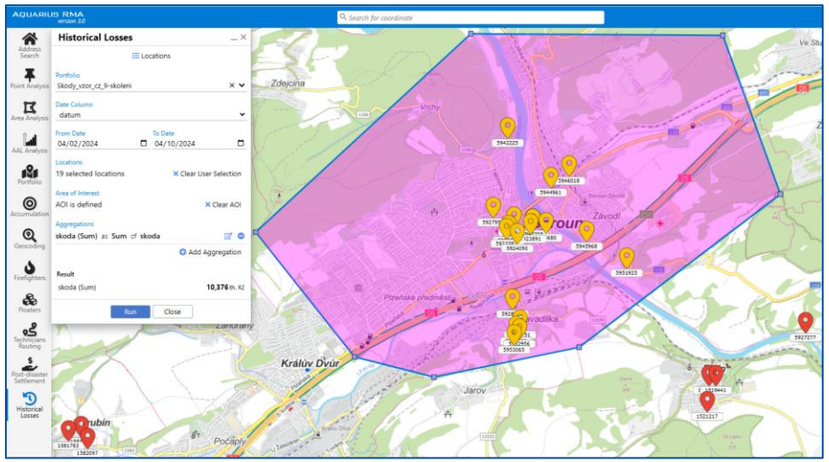


Claim Management Analytics: examples

Extreme Natural Events

- Near real-time check for disasters



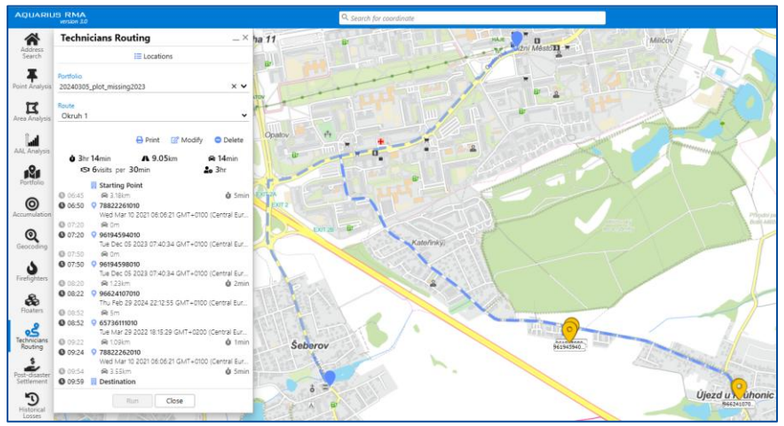


Historical Claims

- Working with historical losses within a user-defined time interval and area

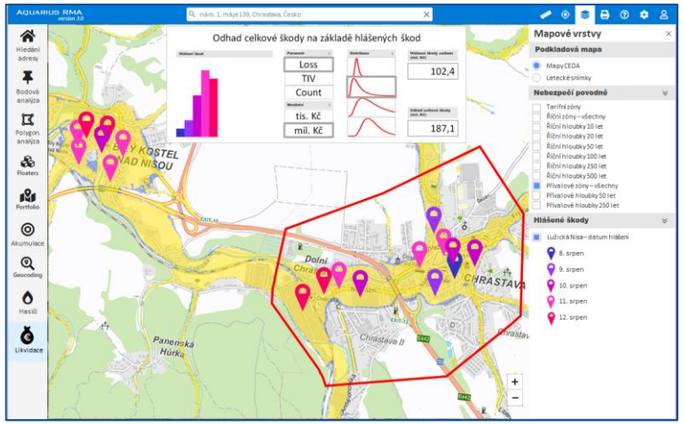
Routing of Claim Adjusters

- Route optimization among inspected sites insured



Claim Estimation

- Estimating of total loss based on ongoing reported claims



Thank you for your attention!

Richard Šálek

Regional Director, Business Development & Sales – Europe
Cell: +420 724 316 382
rsalek@intermap.com

Vojtěch Hlavatý

Head Flood Modeler and Climate Change Expert
vhlavaty@intermap.com

Intermap Technologies, s. r. o.

(EU operation of Intermap Technologies, Inc.)

Zelený pruh 95/97
140 00 Praha 4
Czech Republic
www.intermap.com
www.intermap.com/european-solutions