Understanding the 2013 European Floods

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Agenda

- Event overview
- Meteorology of the event
- Damage survey
- Creation of ALERT™ loss estimates
- Flood extent maps in Touchstone™
- Summary

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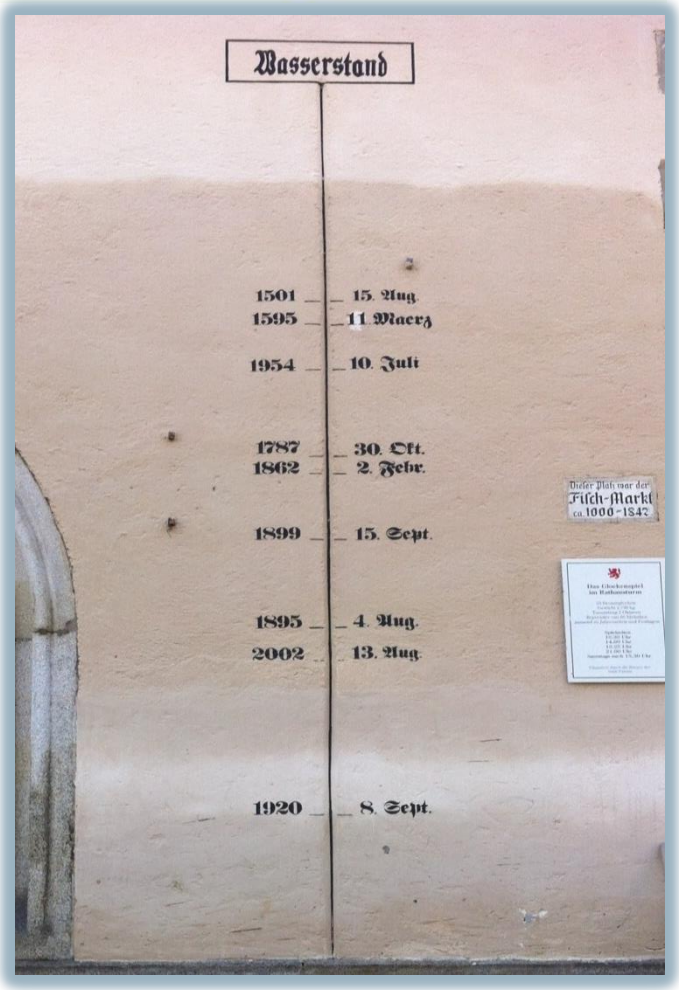
Severe Floods Continue to Affect Central Europe During the Late Spring/Early Summer of 2013

Severe Weather	Heavy Precipitation and Flood
Meteorological Characterization	• Low Pressure Systems Frederik and Günther • V(five)b - Weather Pattern
Event Origin	26/27 May, 2013, Eastern Mediterranean
Maximum Precipitation	31 May – 2 June 2013
Precipitation Amount	403,6 mm/4 Days (30.5.12:00 – 3.6.12:00, Aschau, Bayern)
Affected Countries	Germany, Austria, Czech Republic, Poland, Hungary, Switzerland
Casualties	25 reported



Flood water levels in Passau, June 2013

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Areas Throughout Central Europe Have Been Affected by 2013 Floods

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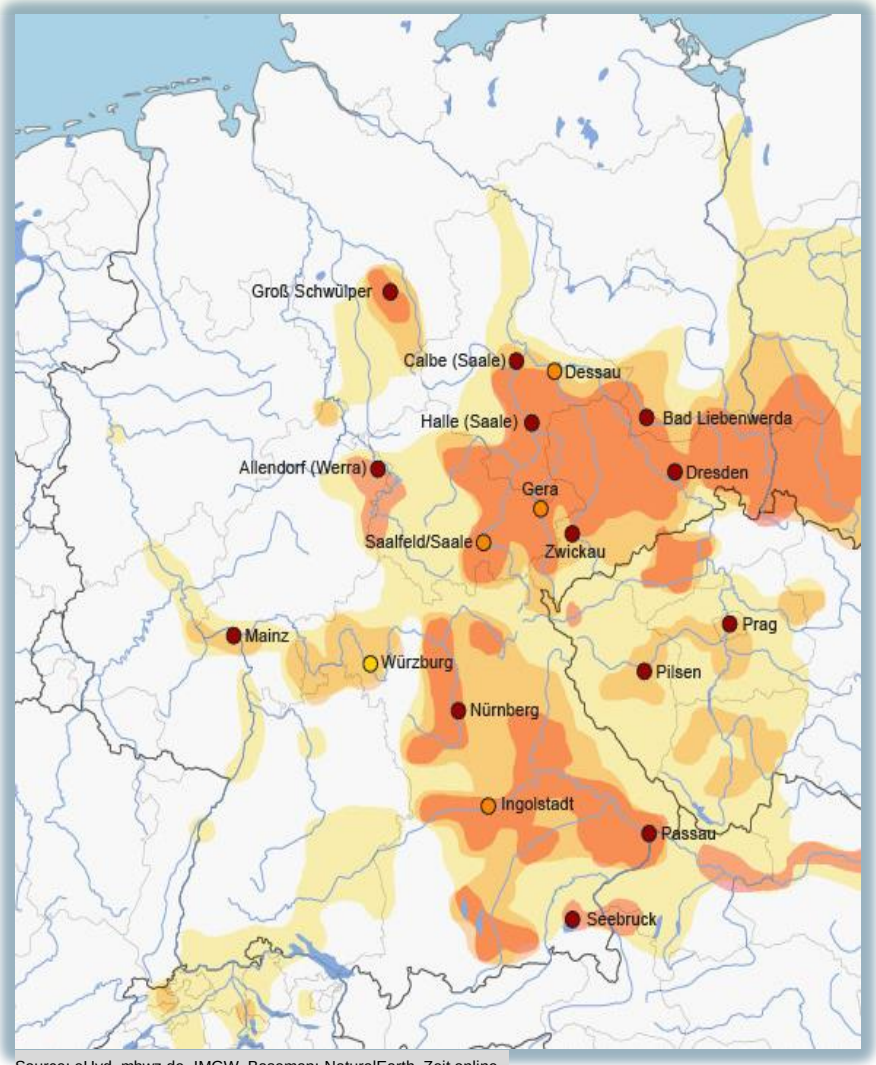
Northeast and Southeast Areas in Germany Have Seen the Most Intense Flooding



Source: eHyd, mhwz.de, IMGW, Basemap: NaturalEarth, Zeit online

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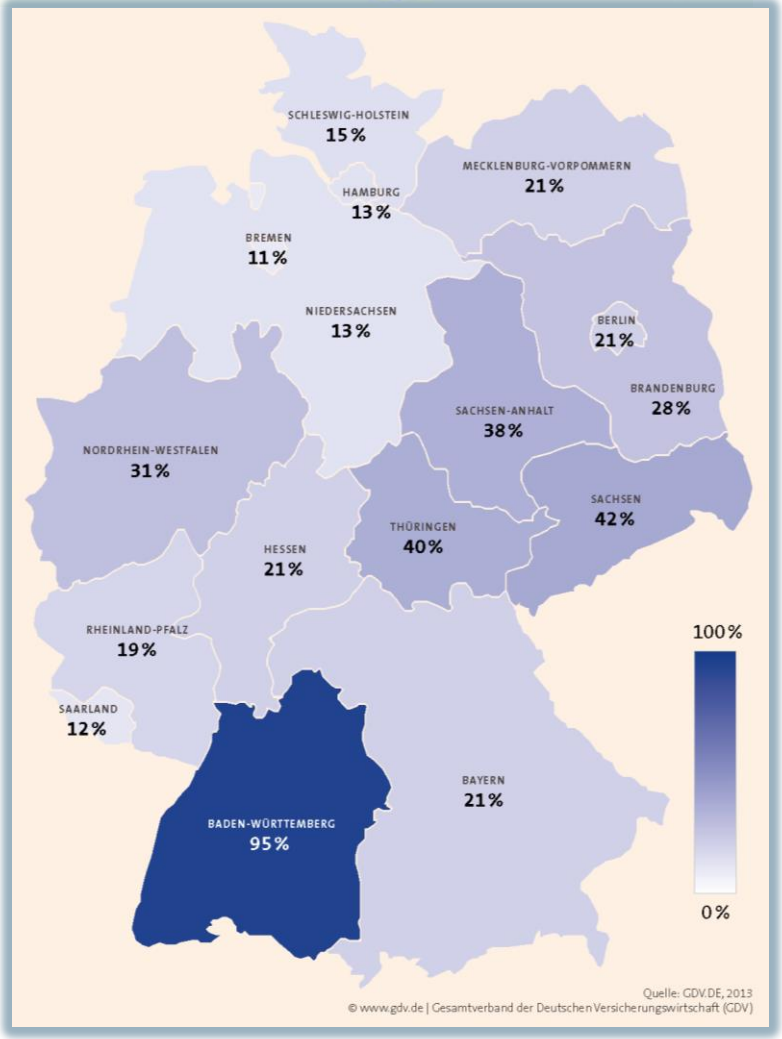
Key Facts About Flood Insurance and Reinsurance in Germany

- Flood risk is covered by **non-obligatory** extended elementary risk policies
- Residential take-up rate in Germany is about **32%** (with large regional variations) → Tendency: Increasing
- **ZÜRS** flood zoning system in place. Even for the properties in the highest risk zone 4, the take-up rate remains high at 25% on average
- Commercial/Industrial take-up rate is higher at about **40%**
- Market generally uses standard policy conditions, deductibles, and limits. Event loss limits in proportional reinsurance treaties are common after the 2002 flood event
- Reinsurance market generally applies a **504 hours** clause introduced after the 2002 flood event, which is accounted for in AIR's flood models



Residential Take-up Rates

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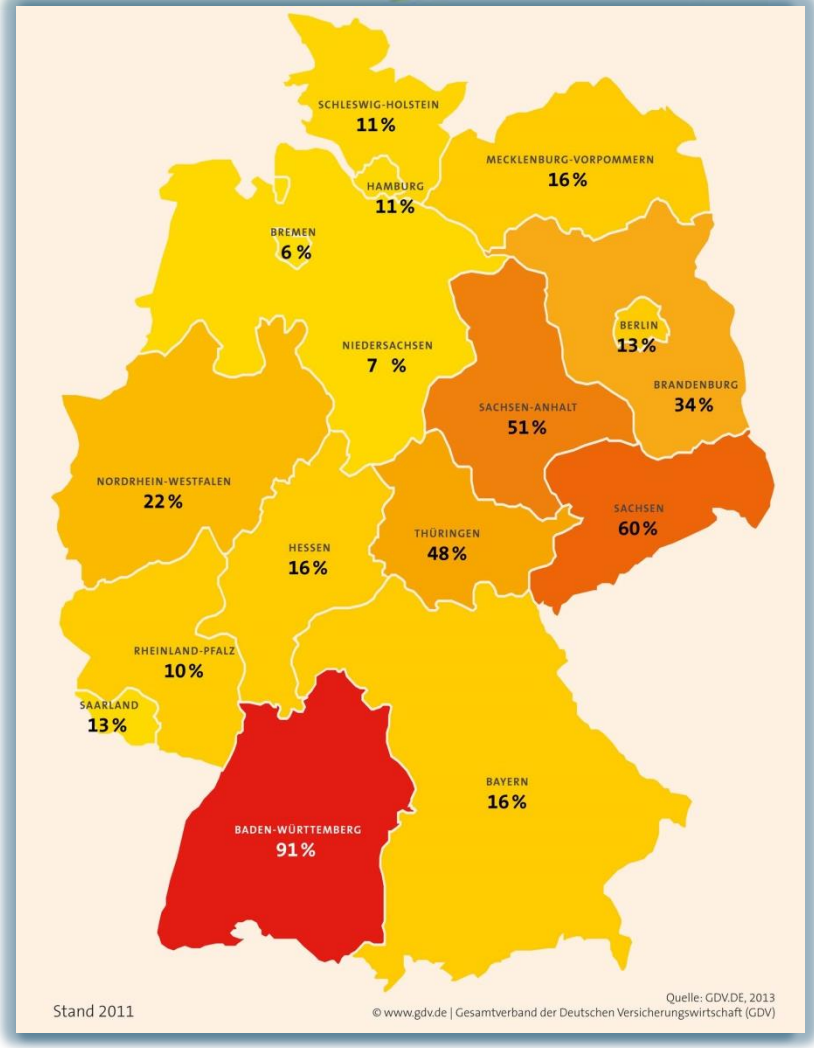

Residential Take-up Rate in highest Flood Risk Zone 4

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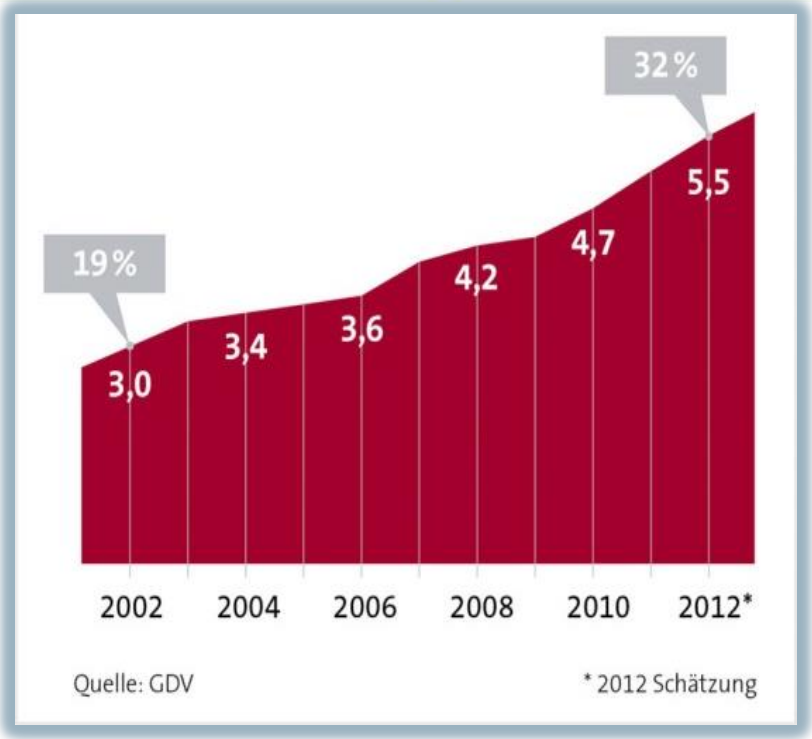
Key Differences Exist Between the 2002 and 2013 Flood Events

Event	Cause	Intensity (I) Aerial Extent (A)	Casualties
1954 - Summer Flood	Excessive Precipitation	I = 42.4 A = 28.2%	N/A
1999 - Pentecost Flood	Excessive Precipitation	I = 24.4 A = 18.7%	7
2005 - August Flood	Excessive Precipitation	I = 19.2 A = 16.9 %	N/A
2002 - August Flood	**Excessive Precipitation**	**I = 35.9 A = 22.4%**	**27**
2013 - June Flood	**Excessive Precipitation and antecedent Soil Saturation**	**I = 56.9 A = 35.1%**	**25**

Source: CEDIM



Number of Insured Residential Buildings and Take-Up Rate

The affected area and the severity of the 2013 event is higher compared to 2002

The residential take-up rate in 2013 is significantly higher compared to 2002

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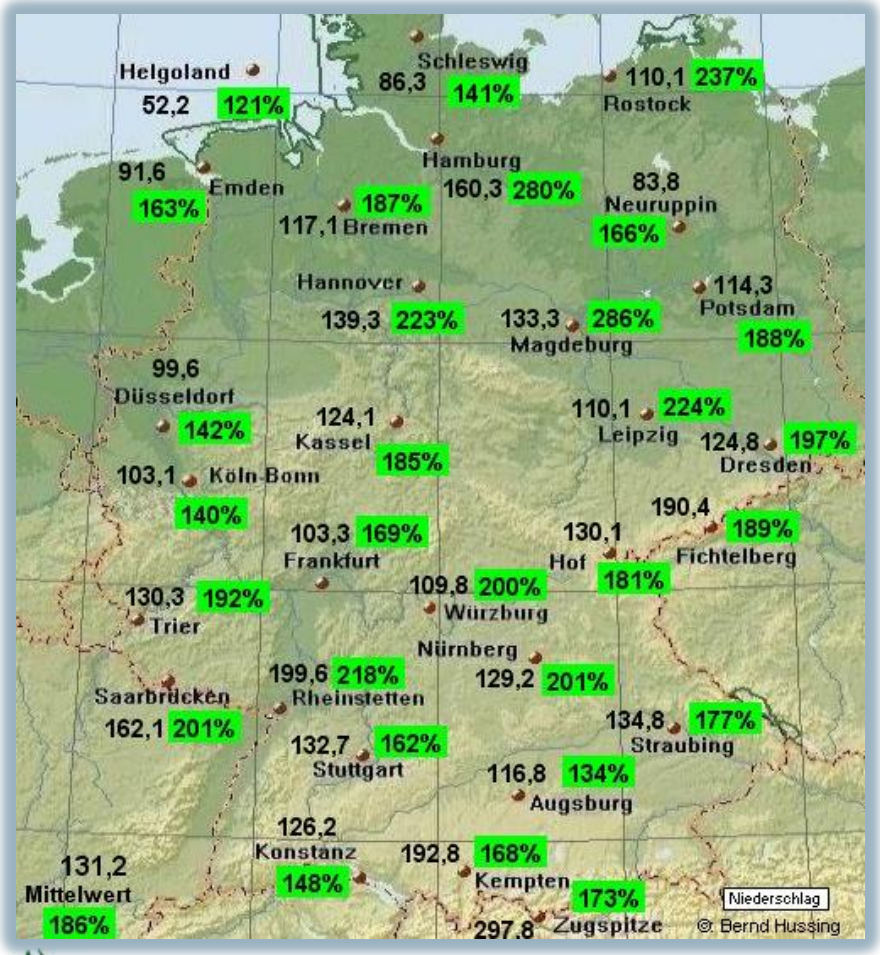
Meteorology of the Event

Prior to the Floods, a Wet Spring Had Saturated Soils Throughout Germany

Monthly precipitation rate during May 2013 compared to the yearly average from 1961-1990



- Every rain gauge shows a high precipitation rate
- Magdeburg shows the highest precipitation rate, with 286% above average
- May 2013 was the wettest May in 50 years

Source: http://www.bernd-hussing.de/Archivdateien/Klima052013.htm

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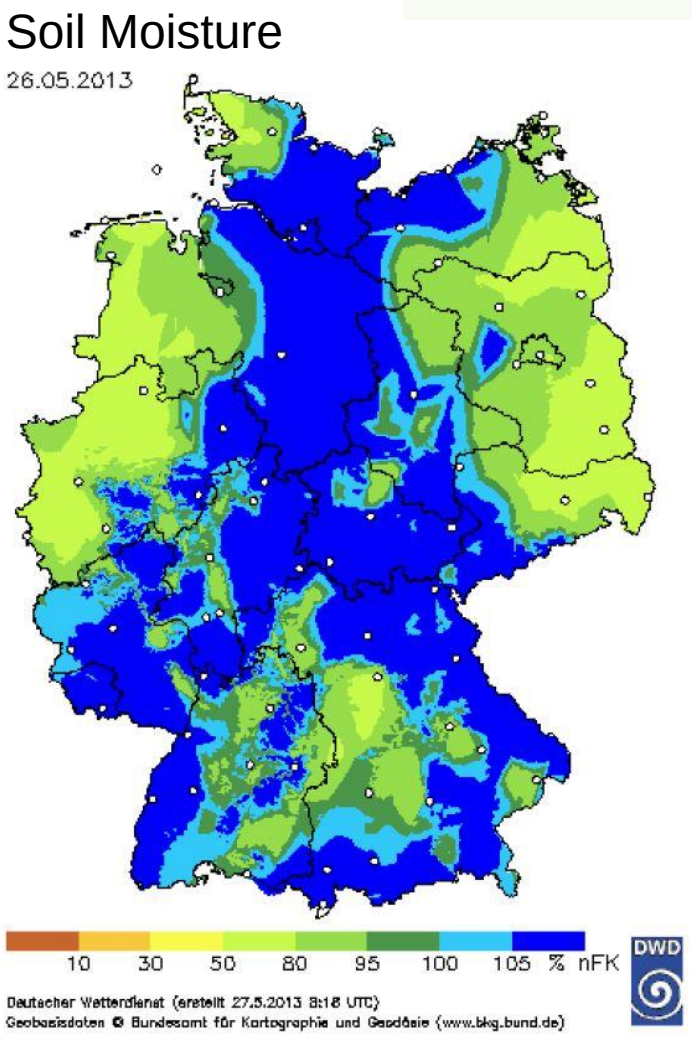
Soils Throughout Much of Germany Could Not Absorb Any Further Precipitation



- Soil saturation exceeded 80% virtually everywhere
- Soil saturation for two-thirds of Germany exceeded 100%, including all affected areas
- Any additional precipitation would result in surface runoff and/or additional stream flow

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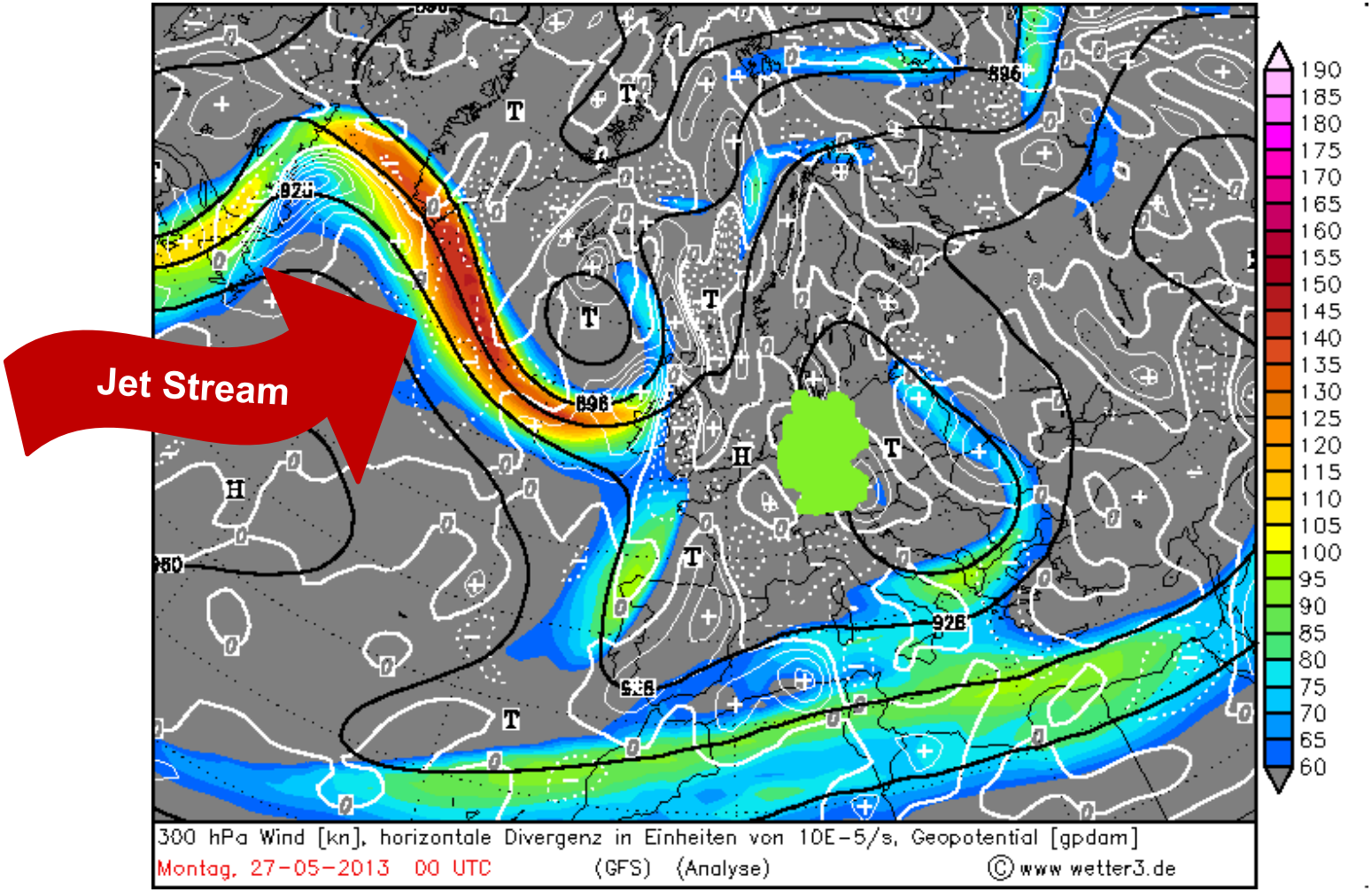
Disruption in the Jet Stream Enabled a Low Pressure System to Drench Much of Central Europe



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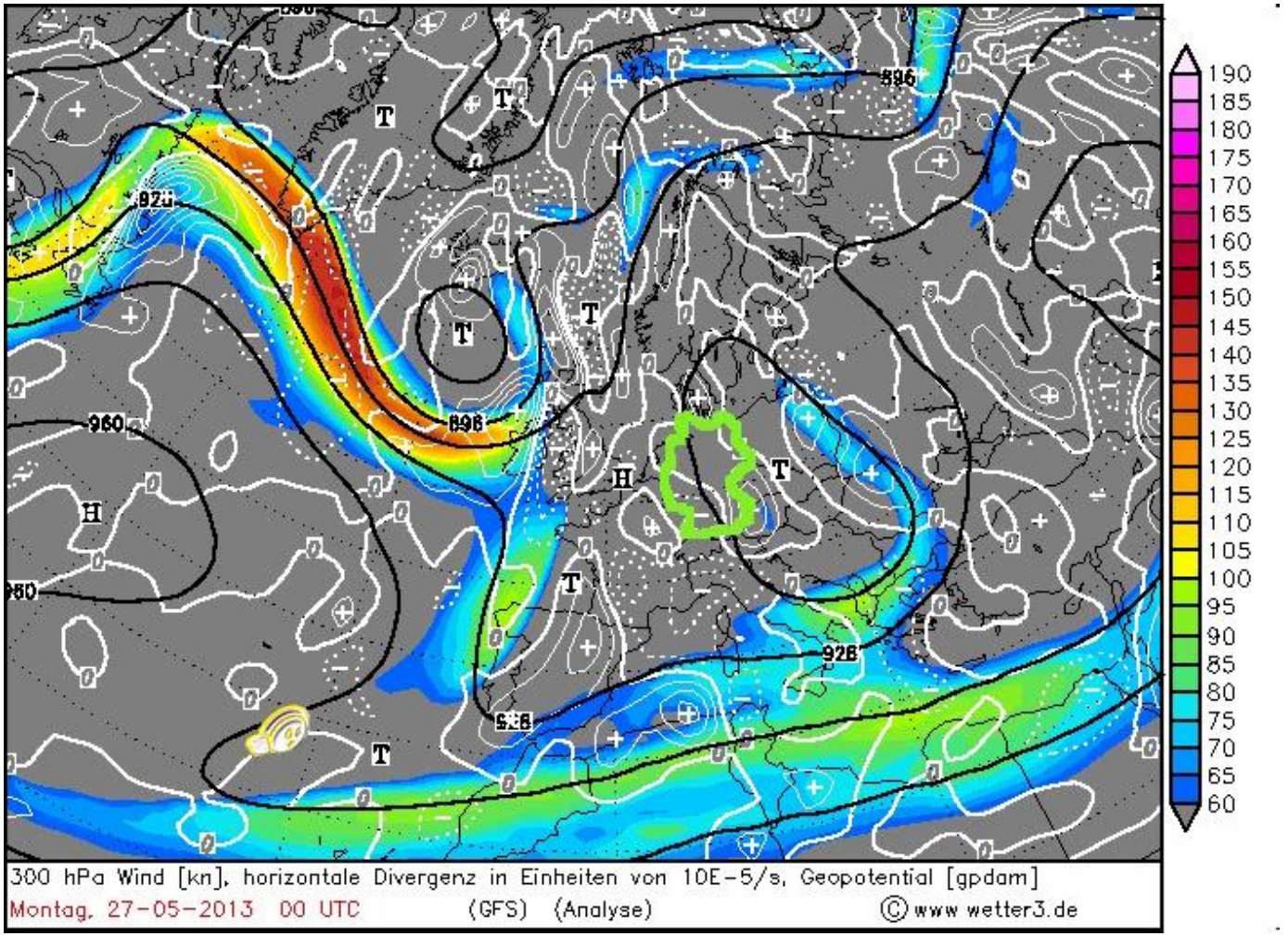

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Radar Animation of Frederik Shows the Storm Unable to Move Away from Central Europe

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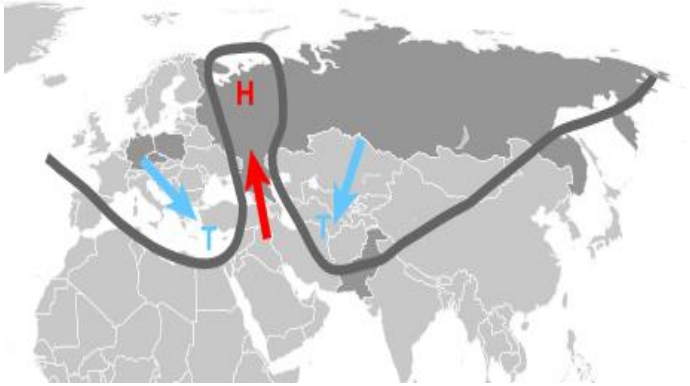
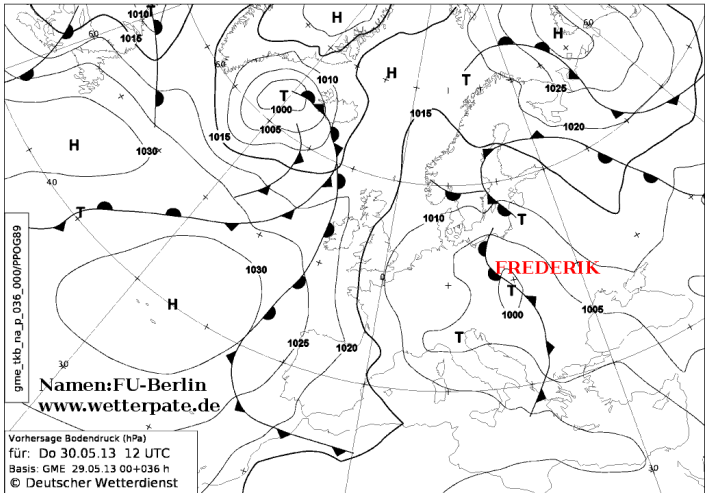
A Diversion of the Zonal Jet Stream Caused a Storm Loaded with Precipitation to Stall over Germany

- Frederik developed over the eastern Adriatic Sea and it moved northwards towards the Eastern Alps, carrying warm, moist air from the Black Sea
- As the warm air masses collided with the colder air over northern Europe, it was lifted up and rain clouds developed
- The low remained over Central Europe for several days due to a very stable track
- As the result of this meteorological phenomenon, heavy precipitation occurred over a duration of 90 hours in Central Europe





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Storms that Take Historical 'Vb' Tracks Often Lead to Catastrophic Flood Events

Year	Affected Region/Event
1993	Brig flood
1997	Odra flood
2002	European floods
2005	Switzerland, Austria floods
2009	Danube, Austria flood
2010	Odra, Black Elster flood

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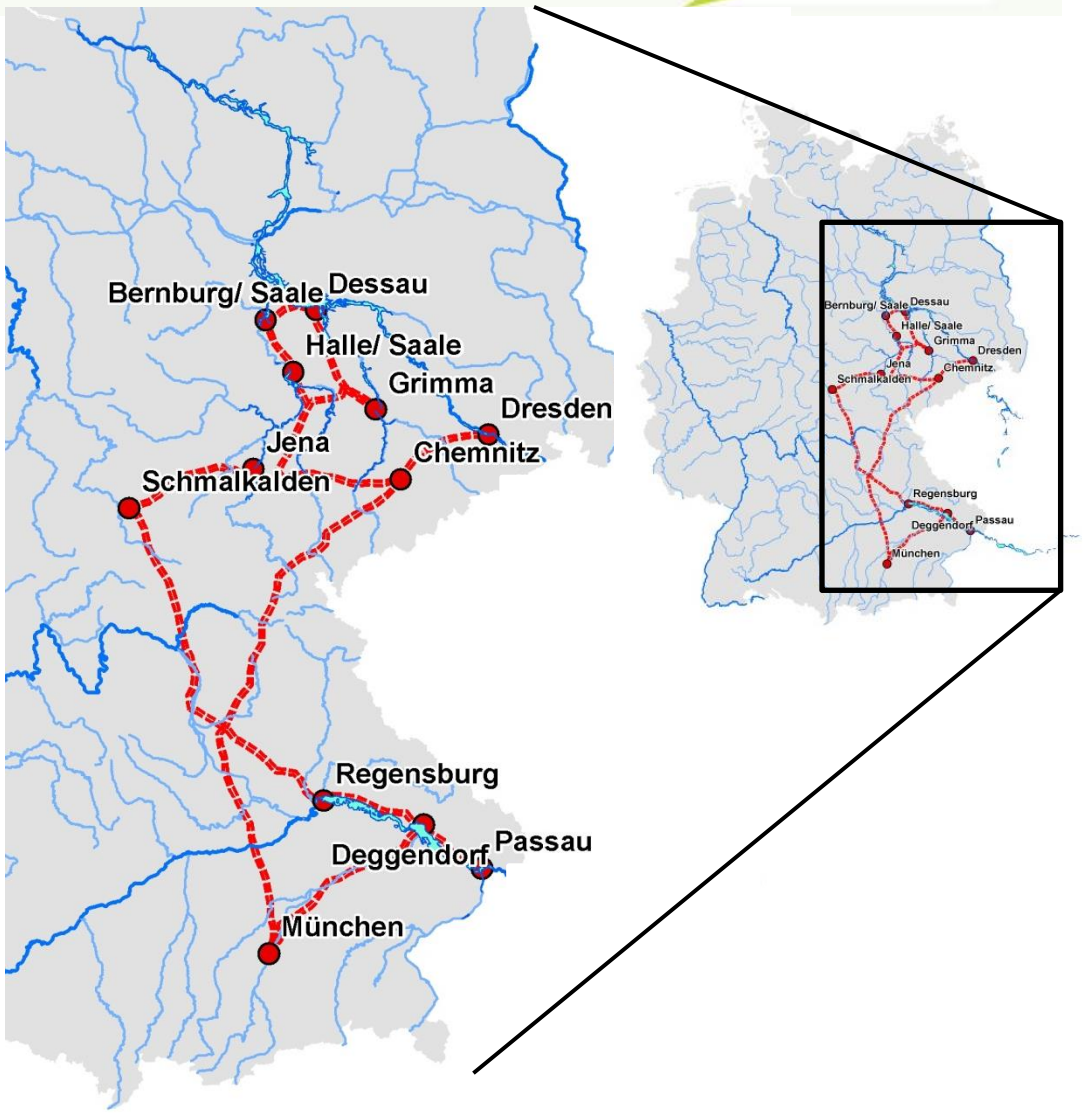
Damage Survey
6 – 12 June 2013

AIR

AIR Conducted a Damage Survey to Assess the Impact on Affected Areas

- Motivation for damage survey is to consolidate knowledge for:
  - Affected area
  - Loss patterns
  - Types of damage observed
  - Register water hight levels
  - Observe cleanup efforts
  - Impact on infrastructure
    - Highways, railroads
  - Impact on Commercial and Industrial Facilities (BI)
- AIR covered more than 2500 km in 5 days between 6 – 12 June



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Record High Flood Water Levels Were Observed in the Most Severely Affected Areas

Water marks in Grimma (Saxony-Anhalt) and Passau (Bavaria)

- The two cities were affected with different flood heights from the 2013 flood

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Significant Damage to Residential Buildings Was Observed

- Interior and exterior walls were damaged
- Interior and exterior wall insulation was contaminated

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For Ground Level Dwellings, Residential Contents Were a Near Total Loss

- Contents, like furniture and cupboards, were contaminated
- Contents from cellars were affected
- Main part of the kitchen, like refrigerators, microwaves and ovens, had to be replaced

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Industrial Facilities Experienced a Combination of Physical Damage and Losses from Business Interruption

- Several large industrial facilites were submerged along the Elbe River
- In addition to physical damage, large business interruption losses are expected in these areas

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Losses to Commercial Contents Also Account for Damages to Structural Components

- Electrical installations have to be replaced due to contaminated water seeping into electrical equipment in the walls
- Flooring, such as hardwood floors and carpets, have to be replaced in almost every commercial facility

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Automobile Losses Were Significant as Many Dealerships and Parking Lots Were Submerged

- Several car dealerships suffered complete losses of their automobile stock
- The region around Deggendorf in Bavaria was especially hard hit
- One dealership alone suffered a loss of several million Euros

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Damage to Infrastructure Caused Additional Business Interruption Losses

- Several highways were completely submerged for more than a week, severely disrupting traffic, especially in Bavaria
- Railroads were also affected, especially in eastern Germany
  - This caused business interruption to large motorworks such as Volkswagen in Zwickau and Porsche in Leipzig

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Water Contaminated with Oil and Gas Will Necessitate Waste Cleanup Efforts

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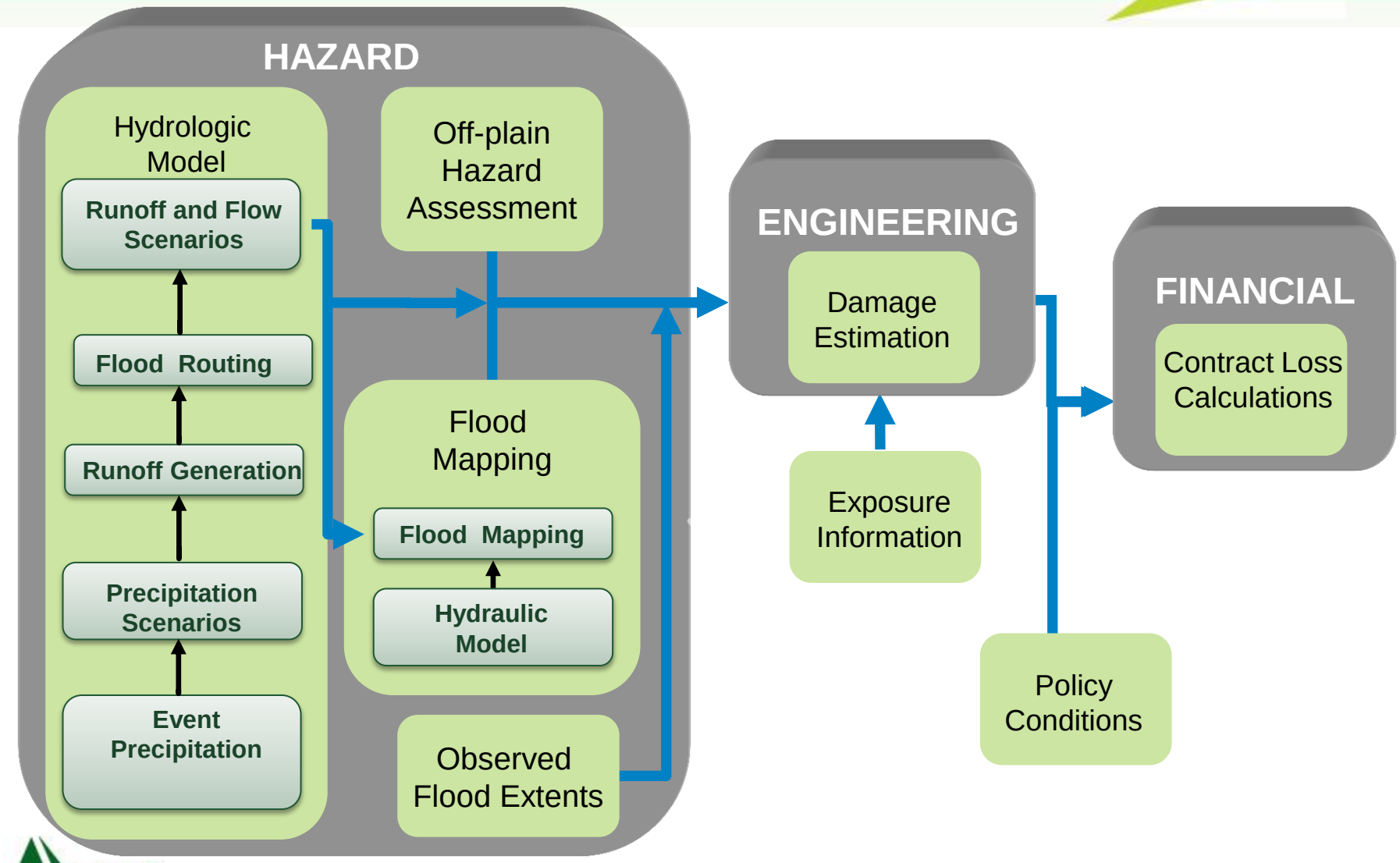
Creation of ALERT Loss Estimates

Model Framework Incorporates Hydrologic and Hydraulic Components to Realistically Simulate Floods



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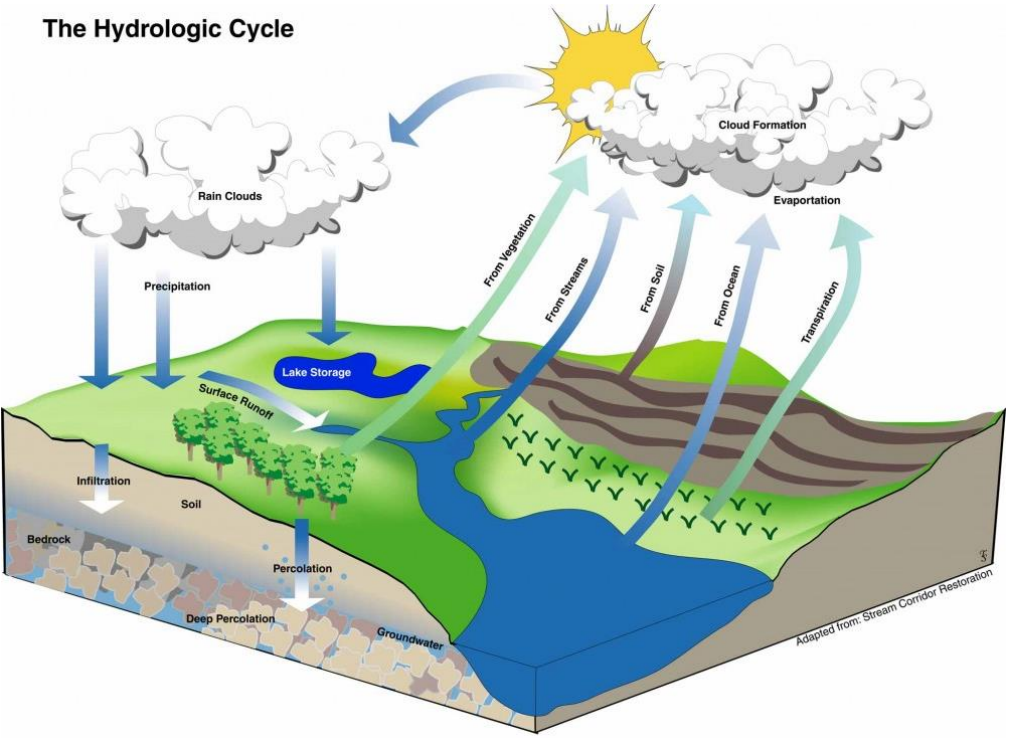
Components of the AIR Flood Model



1. Hydrology

- **<u>Precipitation</u>**
- Precipitation into runoff components
- Storage in soil, snow pack etc…
- Flows in river

2. Hydraulics

- Mechanics of flow
- How water overflows banks
- Mapping of flood zone

Illustration adopted from http://www.metrofieldguide.com/the-hydrologic-cycle/

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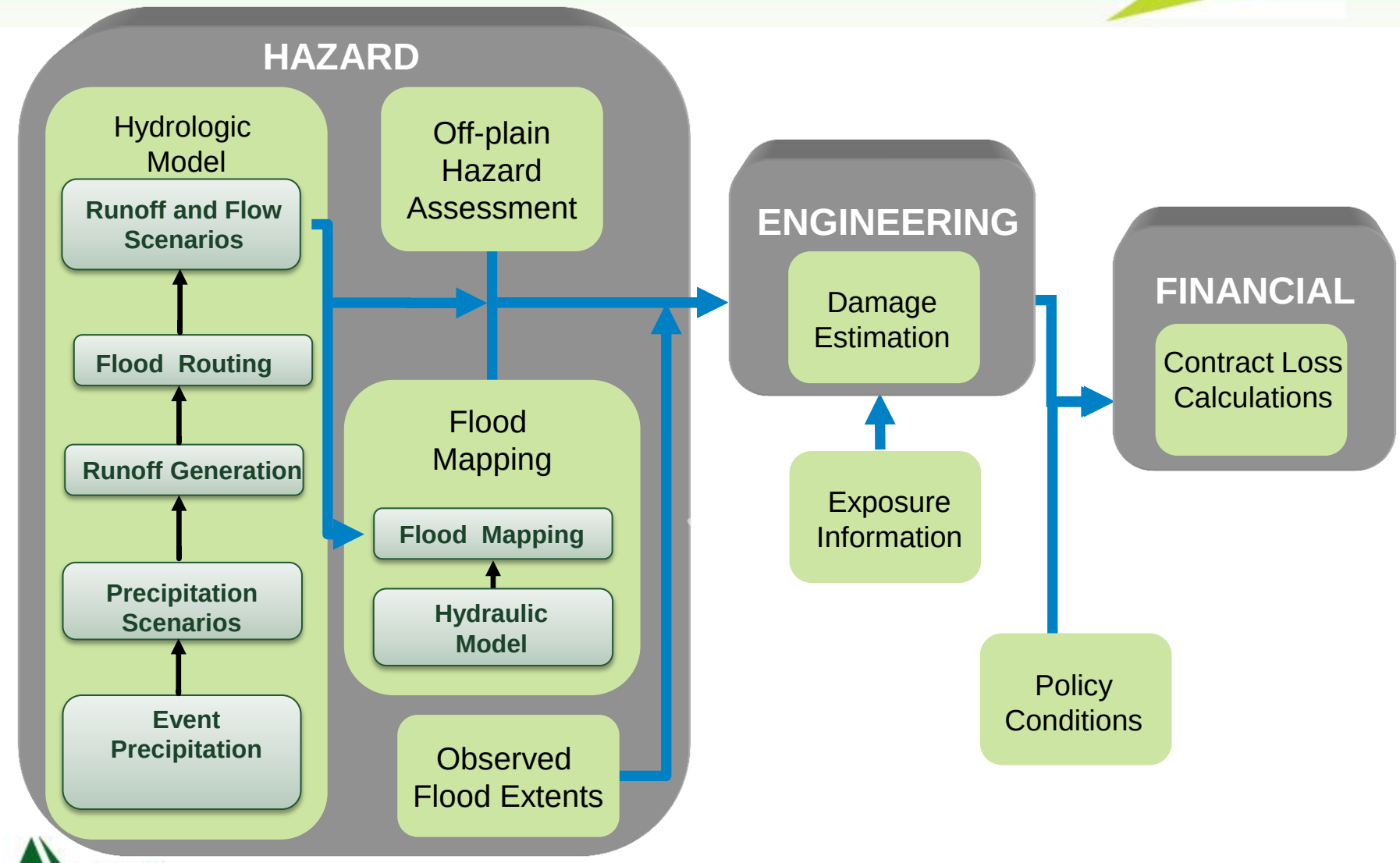

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AIR Obtained Data from Multiple Sources to Model the 2013 Event

- Precipitation
  - Radar
  - NOAA's Climate Prediction Center's gridded daily precipitation
- Stream flow data
- Flood footprints
  - DLR (German Aerospace Center)
  - Landsat
  - MODIS

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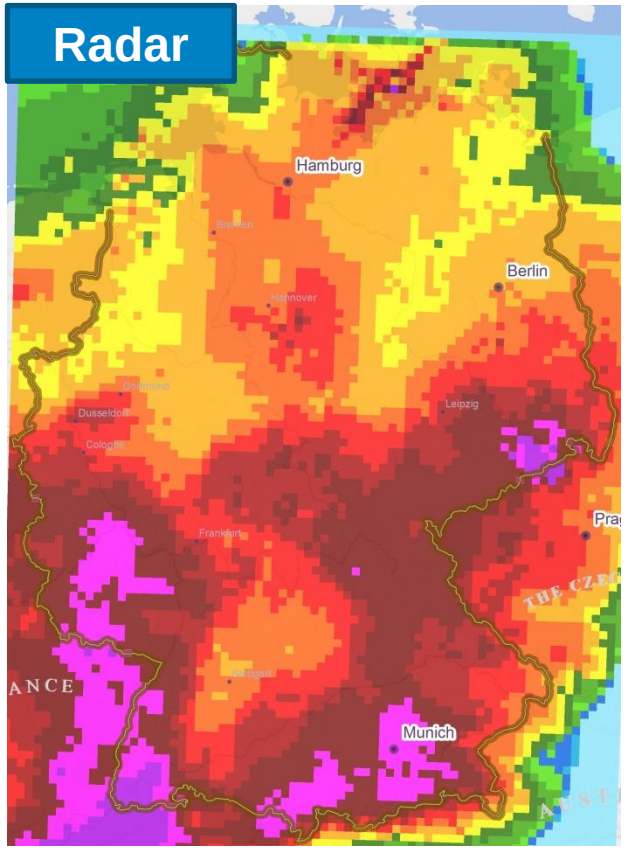
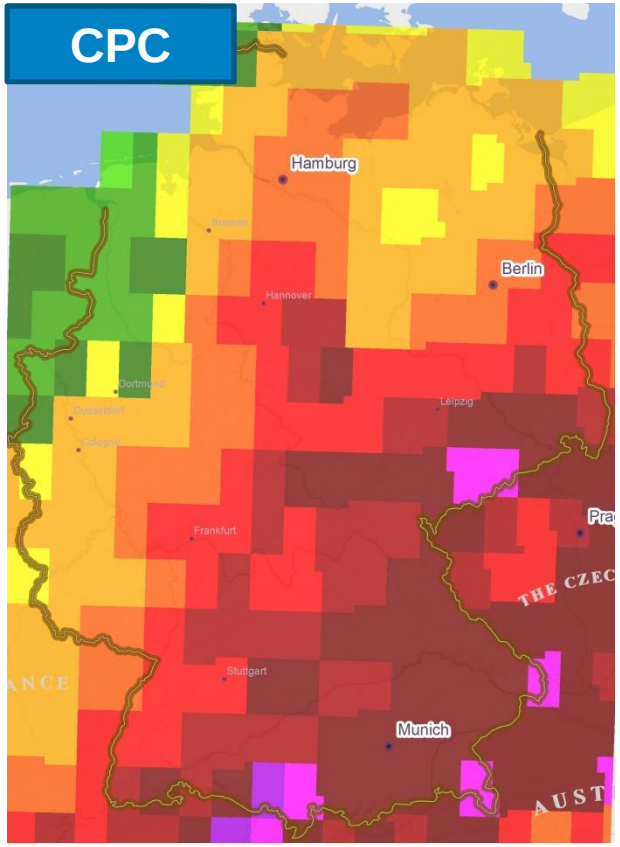
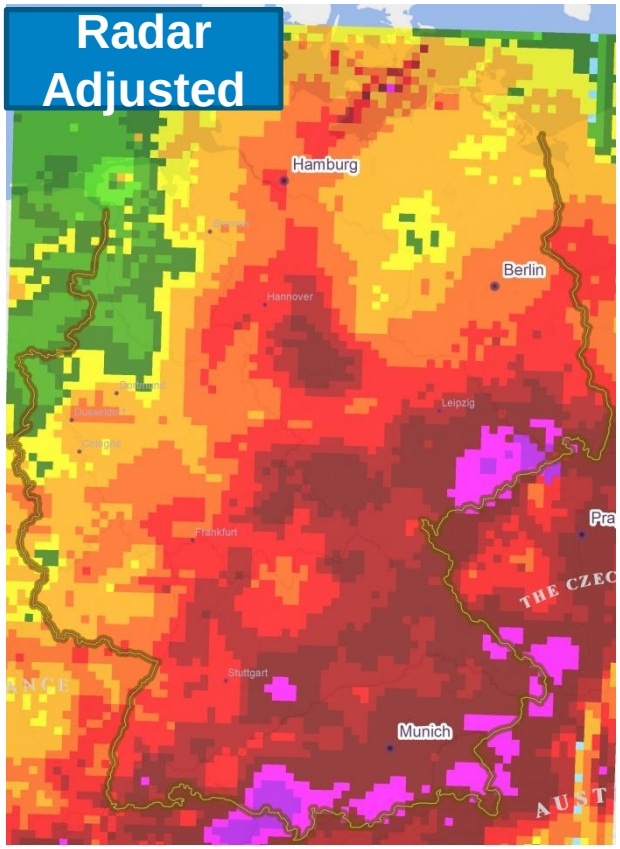
Radar Precipitation Generally Overestimates the Amount of Precipitation

Accumulated Precipitation for the period 21 May – 10 Jun







Precipitation in mm

6.3 - 13	38 - 51	102 - 127	203 - 254
13 - 25	51 - 76	127 - 152	254 - 381
25 - 38	76 - 102	152 - 203	381 -508

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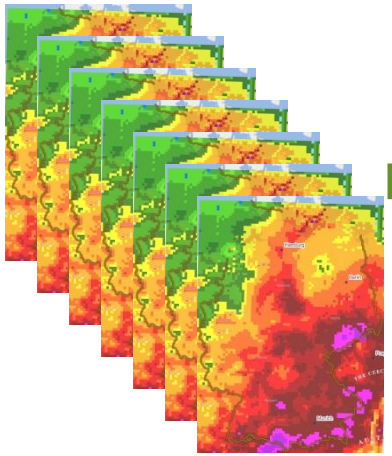
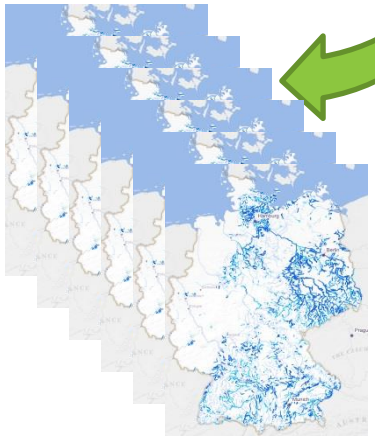
Perturbations Based on the Spatial Correlation of Differences Between Radar and CPC



Precipitation scenarios

1 …. 200

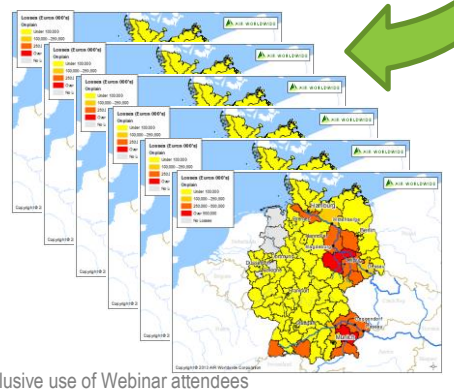
Runoff and Flow model



Runoff and flow scenarios

1 …. 200

Loss model



Loss scenarios

1 …. 200

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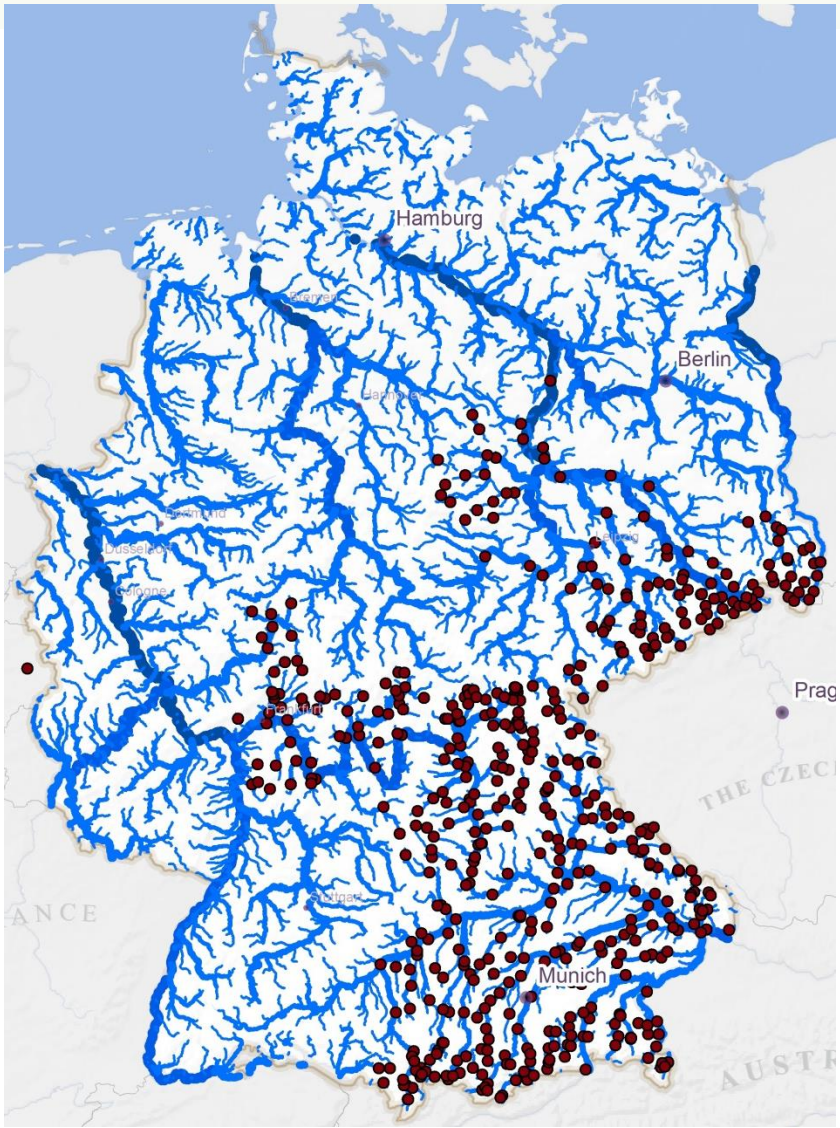
Data from 525 Gauge Stations Were Used to Validate the Modelled Flows



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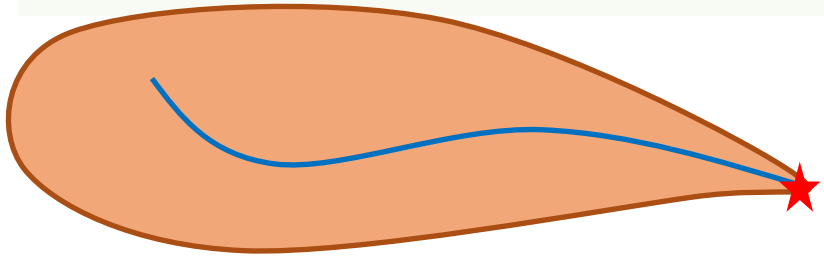
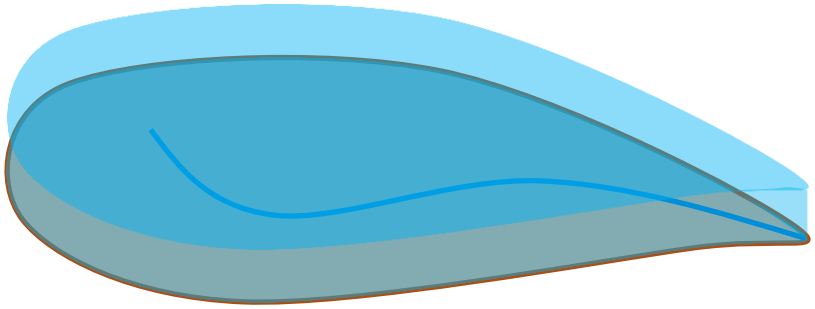
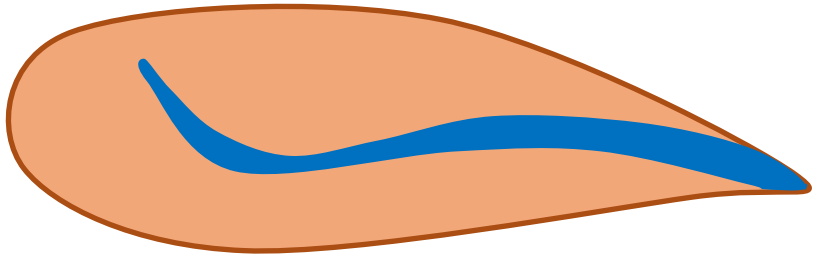
Runoff and Stream Flow Are Both Important when Providing a Comprehensive Estimate of Losses



Watershed



Runoff



Stream Flow

- A watershed is defined as the area that appears, on the basis of topography, to contribute all the water that passes through a given cross-section of a river
- Runoff is the precipitation that cannot infiltrate into the soil
- Runoff is represented at the catchment level
- Runoff is correlated with precipitation pattern

- Runoff is the main driver of off-floodplain losses
- Stream flow is the main driver of on-floodplain losses

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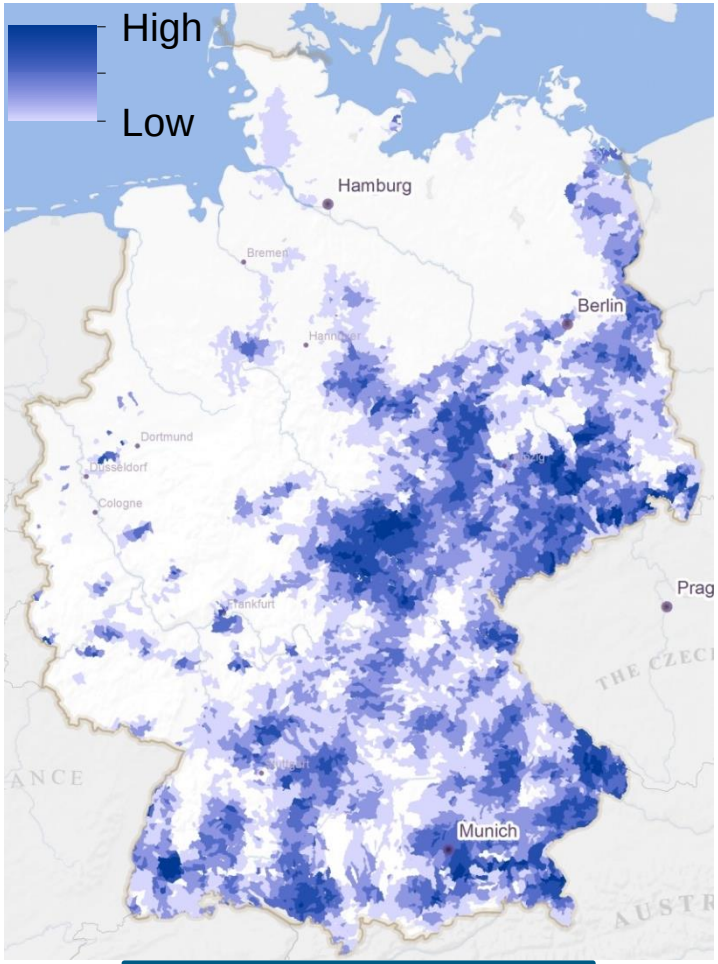
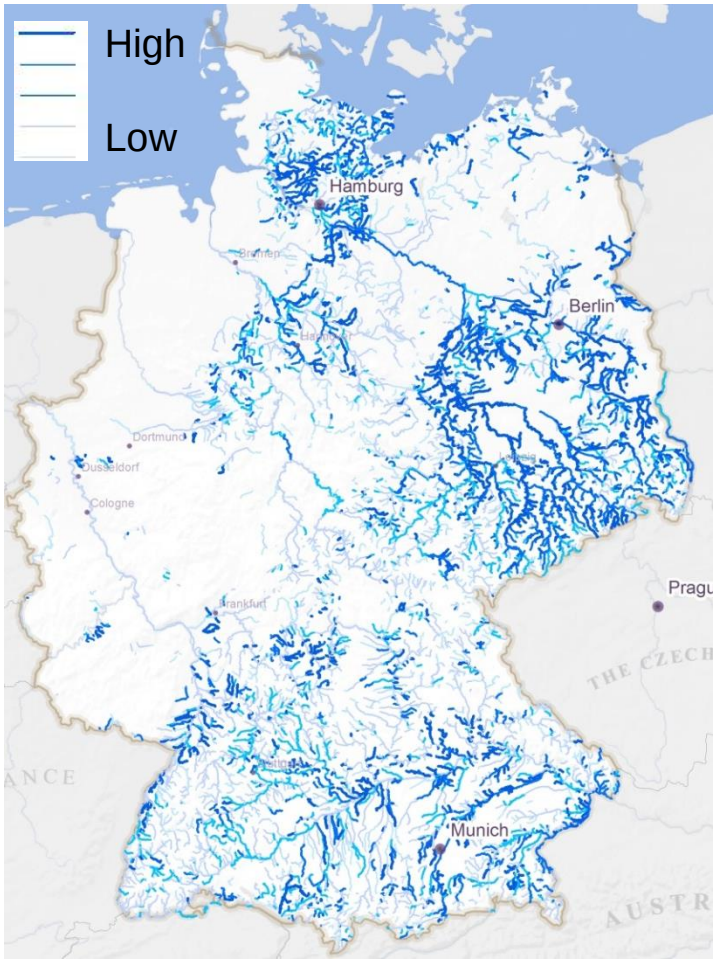
Relative Runoff and Relative Flow Illustrates the Extent of Flooding Throughout Southern Germany



Relative Runoff



Relative Flow

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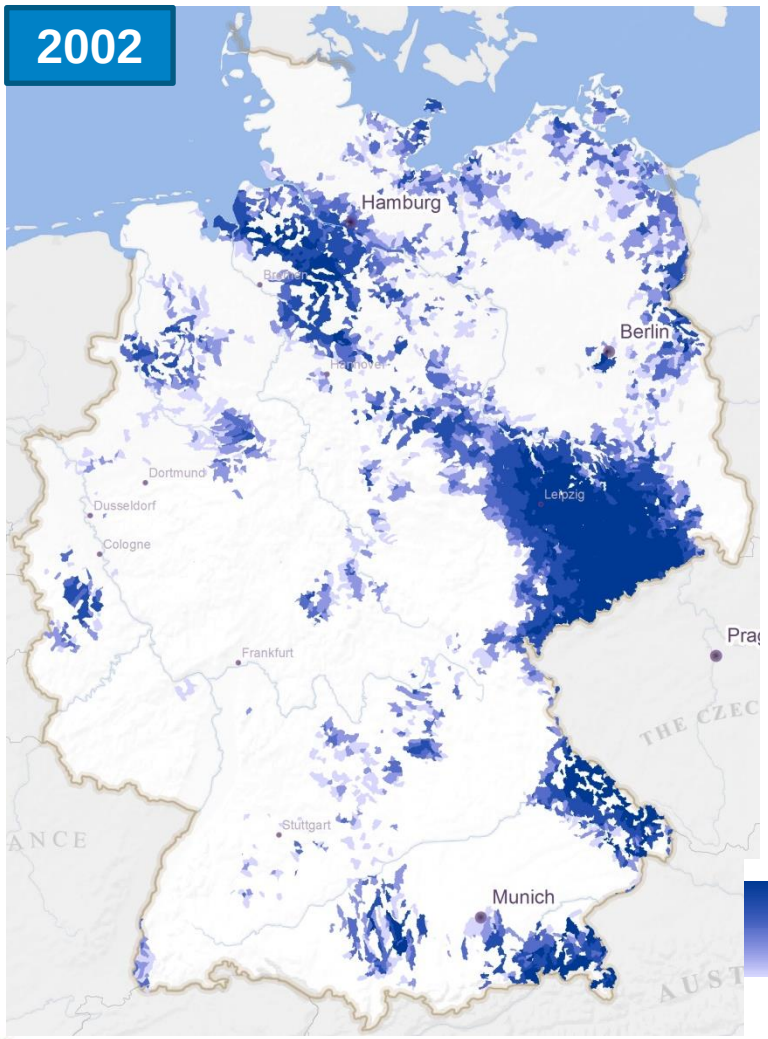
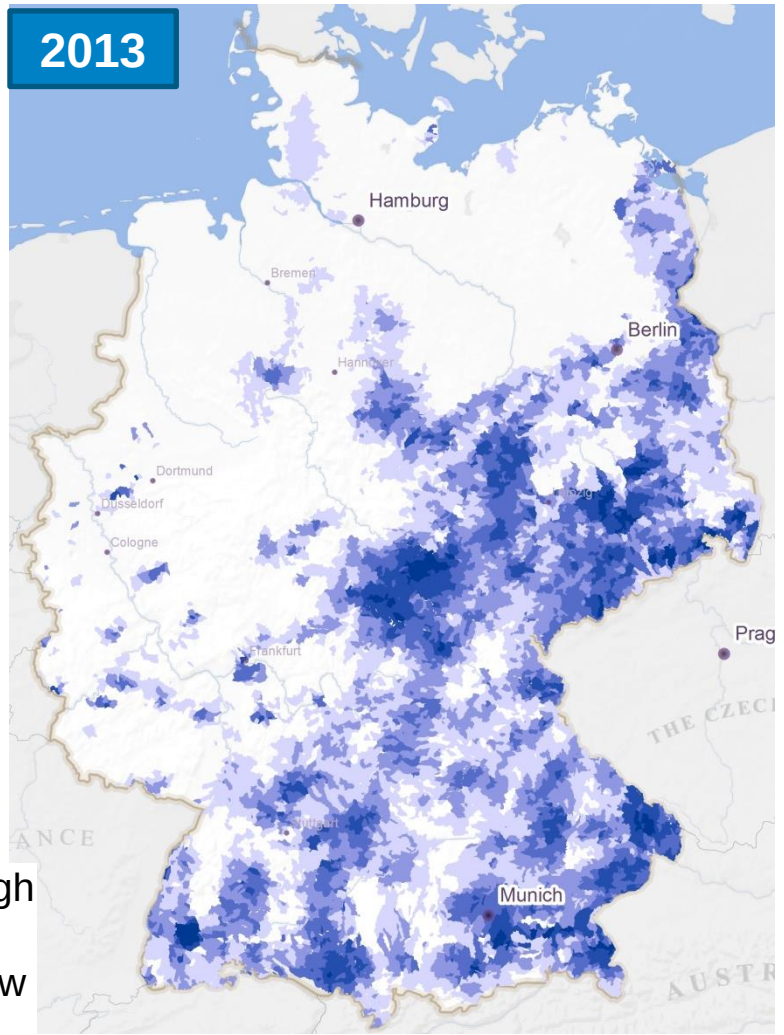
Comparison of 2013 Floods with 2002 Floods Highlights the Differences in the Affected Regions





High

Low

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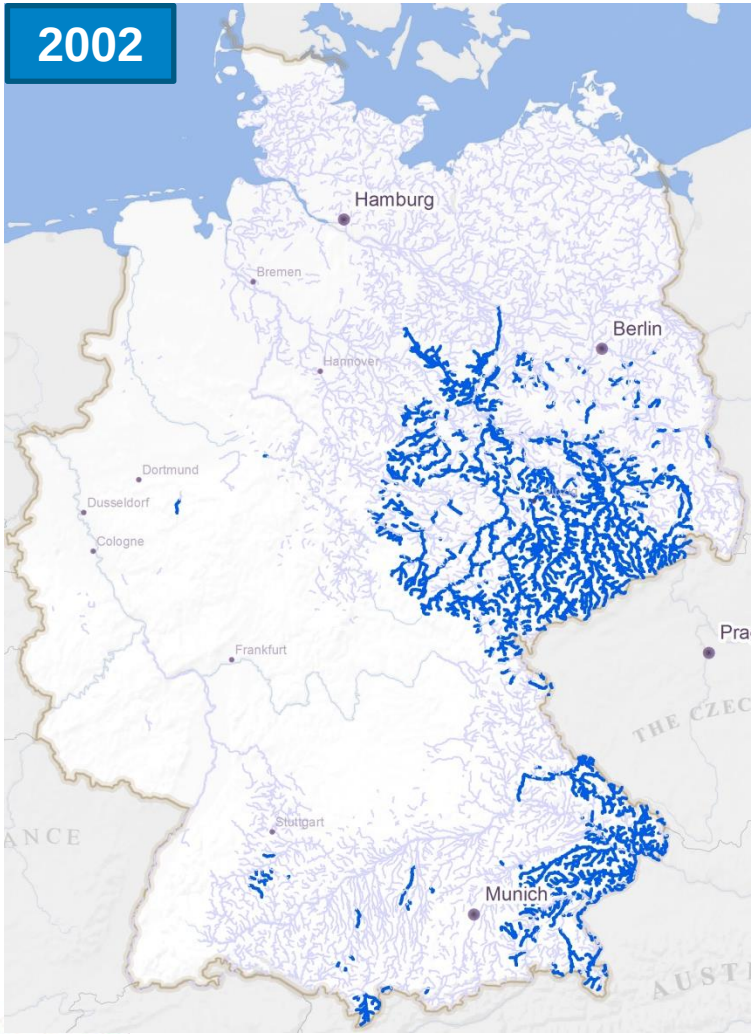
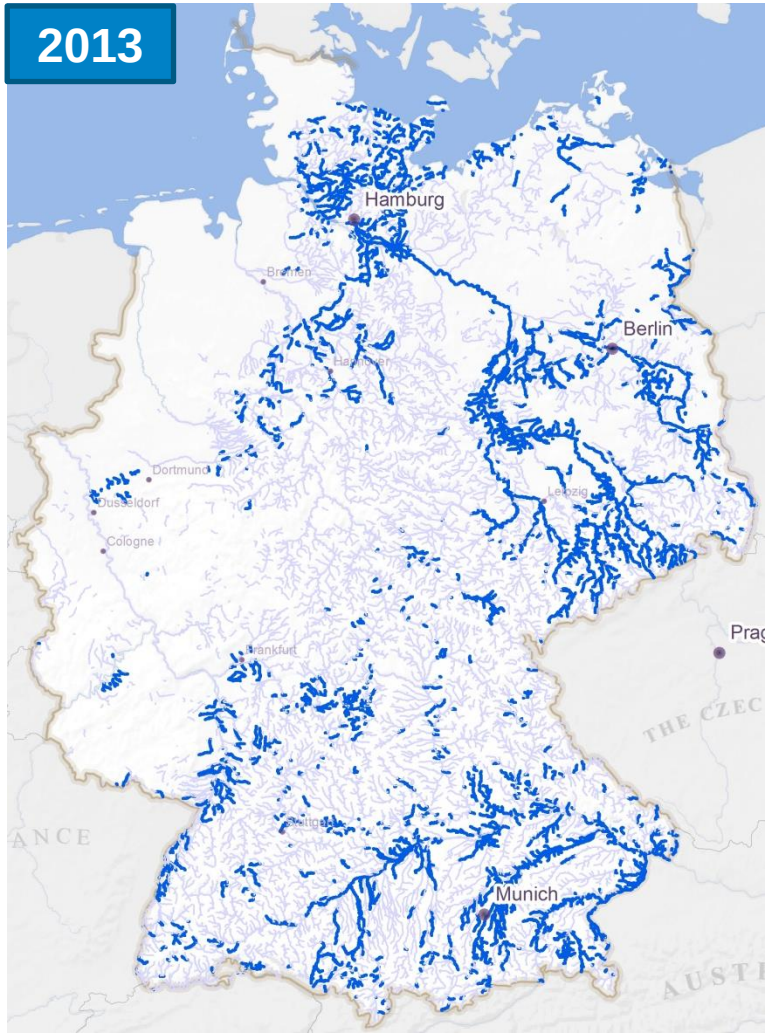
2002 Floods Were More Localised Whereas 2013 Floods Affected Virtually All of Germany

Rivers that Exceeded 100 Year Flow in 2002 and 2013





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AIR Compares Satellite Flood Footprints Over Time to Determine the Maximum Extent of Flooding

- Flooded areas were extracted from images
  - Spectral classification algorithms used to remove non-flooded areas
- Compared extent data temporally to determine which dataset captured maximum extent of floods for each day along rivers
- Lakes and other non-riverine water bodies were removed

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Floods Affected Areas Along Vast Stretches of the Elbe and Danube Rivers

- This map shows areas where AIR obtained high resolution data
- For all other areas, AIR used a combination of MODIS and Landsat data
- AIR obtained flood data for all three countries

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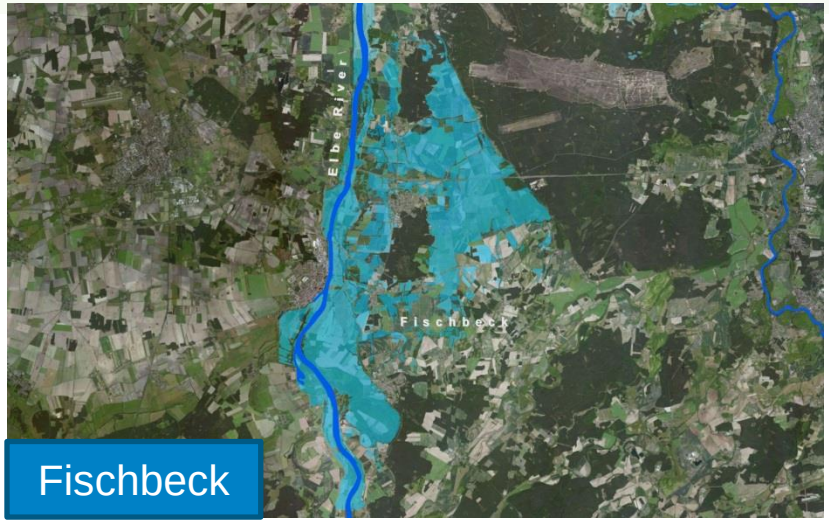
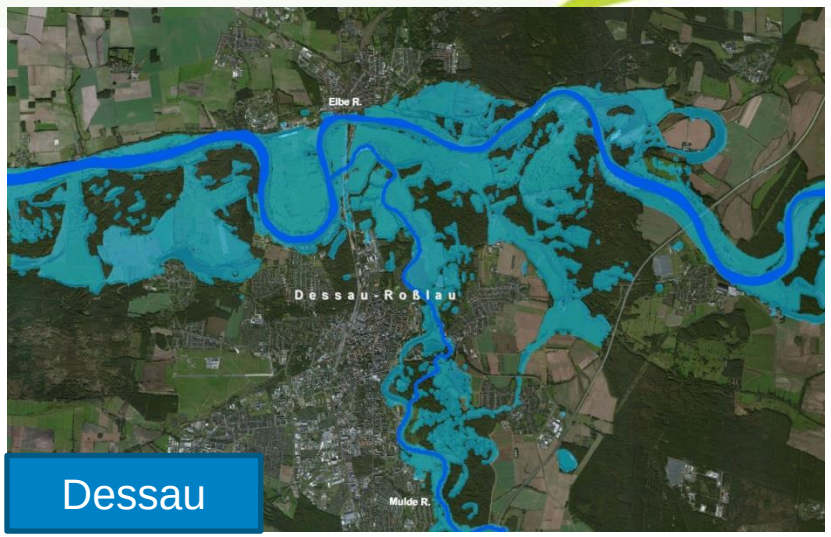
AIR Used High Resolution Satellite Data to Develop Flood Footprints



Fischbeck



Dessau

Magdeburg

Dresden

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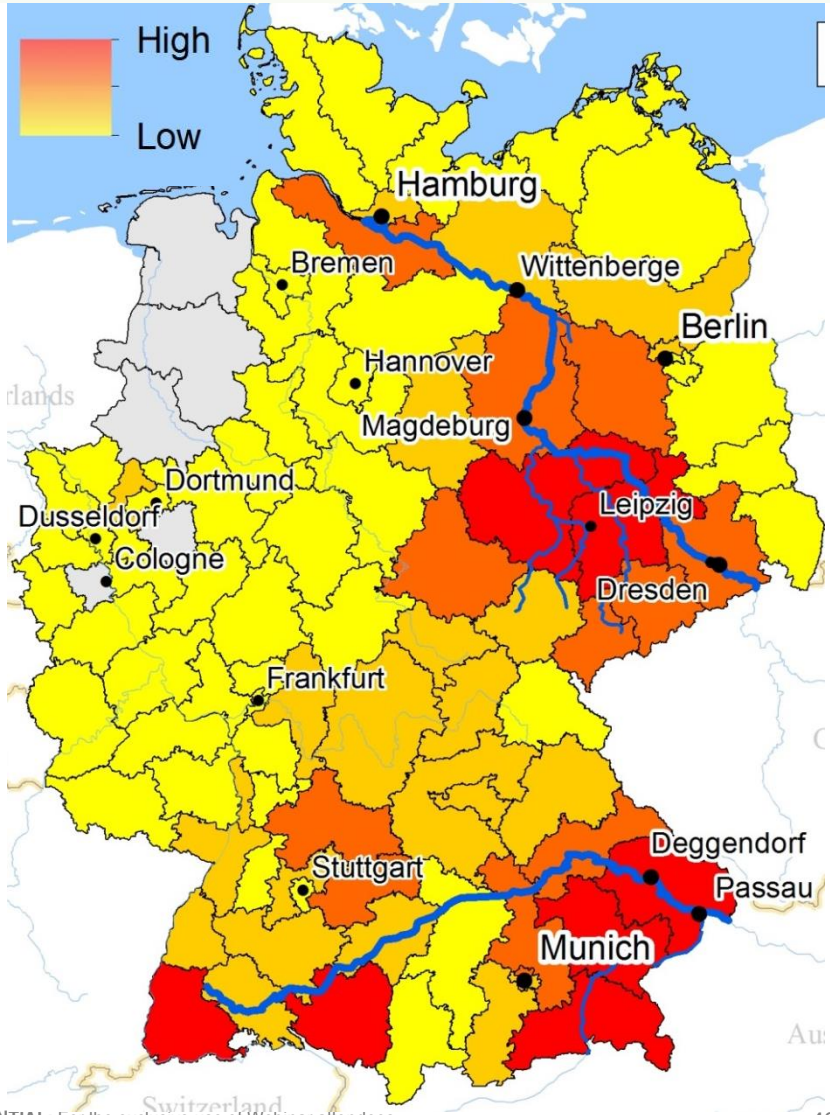
Five Scenarios Were Selected Based on Spatial Pattern of Loss

- Based on expert judgment and knowledge base, we retained only realistic loss scenarios

- From these scenarios, 10, 25, 50, 75 and 90 percentile loss scenarios were selected



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It Is Important to Note What AIR's Loss Estimates Include and What Is Excluded

- **AIR's loss estimates reflect:**
  - AIR's assumed take-up rates in Germany, about which there is uncertainty
  - Insured physical damage to property (residential, commercial, industrial, auto), both structures and their contents, from both on- and off-floodplain flooding
  - Additional living expenses (ALE) for residential claims and business interruption (BI) for commercial claims
- **Loss estimates *do not* reflect**:
  - Losses to uninsured properties
  - Losses to infrastructure
  - Losses from extra-contractual obligations
  - Losses from hazardous waste cleanup, vandalism, or civil commotion, whether directly or indirectly caused by the event
  - Demand surge
  - Contingent BI
  - Other non-modelled losses

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AIR Estimates an Expected Loss of €5.1 Billion

Scenarios	On-Plain Loss	Off-Plain Loss	Off / On	Total Loss
1	1,851	2,189	1.18	4,041
2	2,207	2,413	1.09	4,620
3	2,580	2,523	0.98	5,103
4	2,505	2,925	1.17	5,431
5	2,545	3,239	1.27	5,784

In Millions of Euros

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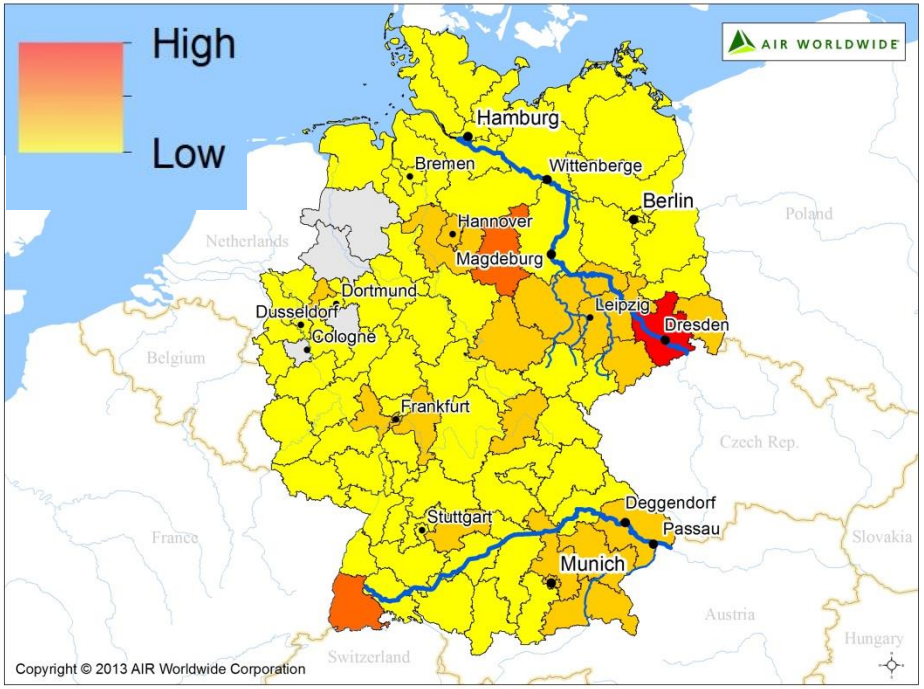
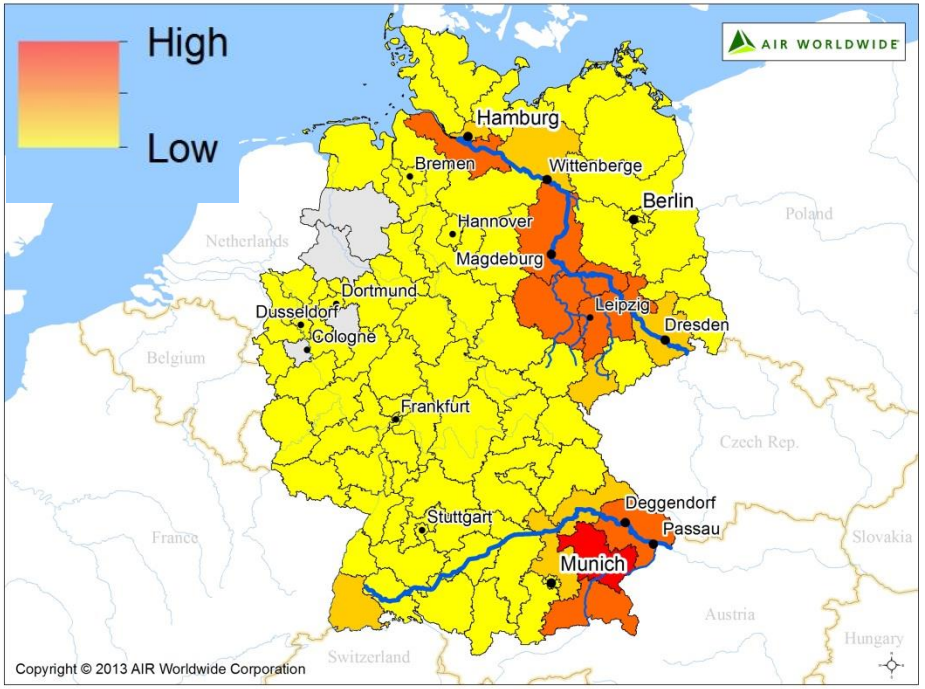
Scenario 1 – 10th Percentile



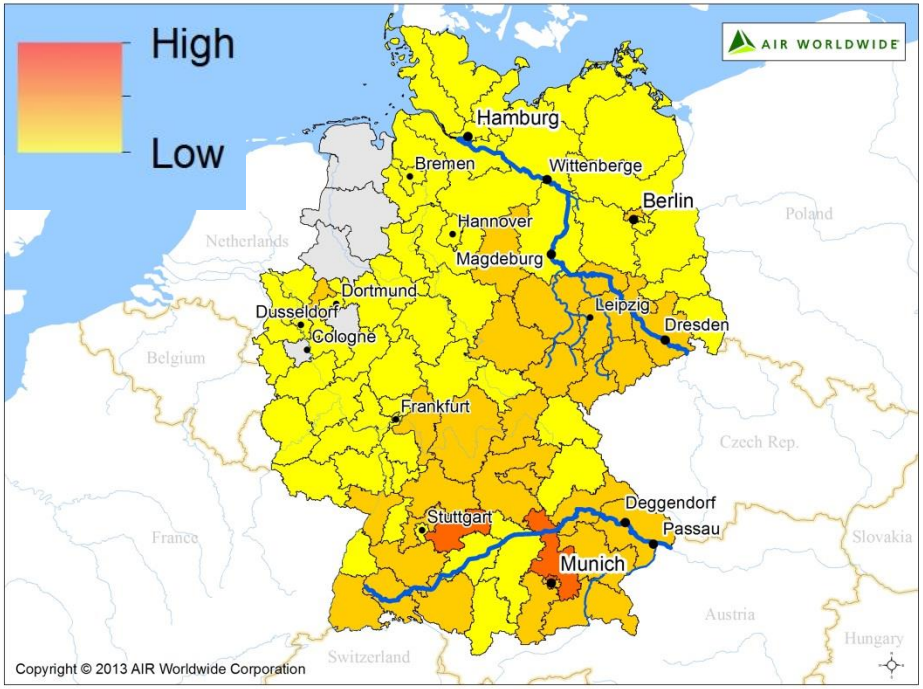
Off–Plain losses



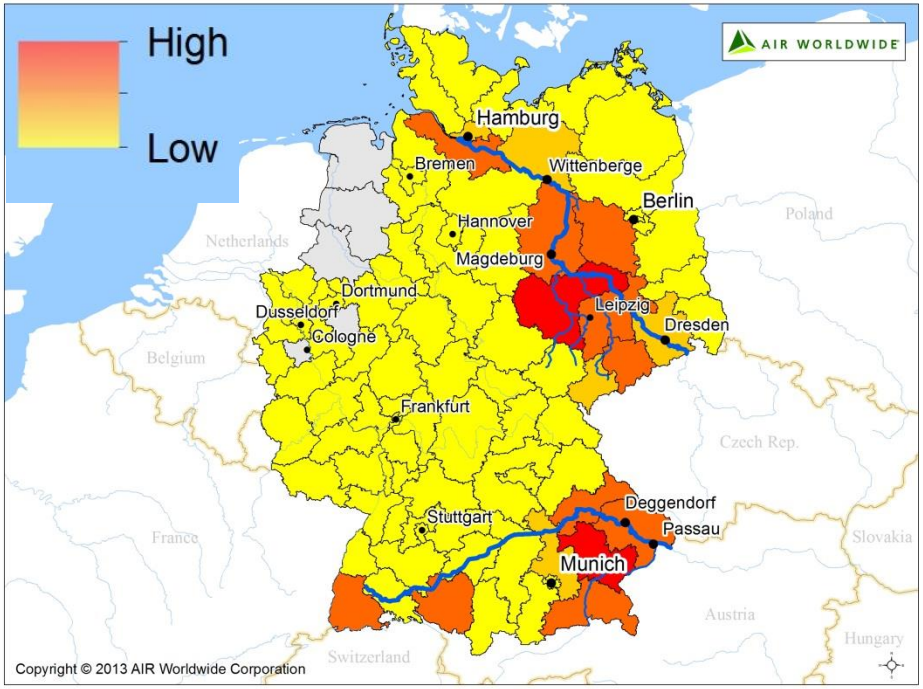
On–Plain losses

Scenario	On-Plain Loss	Off-Plain Loss	Off / On	Total Loss
1	1,851	2,189	1.18	4,041

Scenario 3 – Median Losses



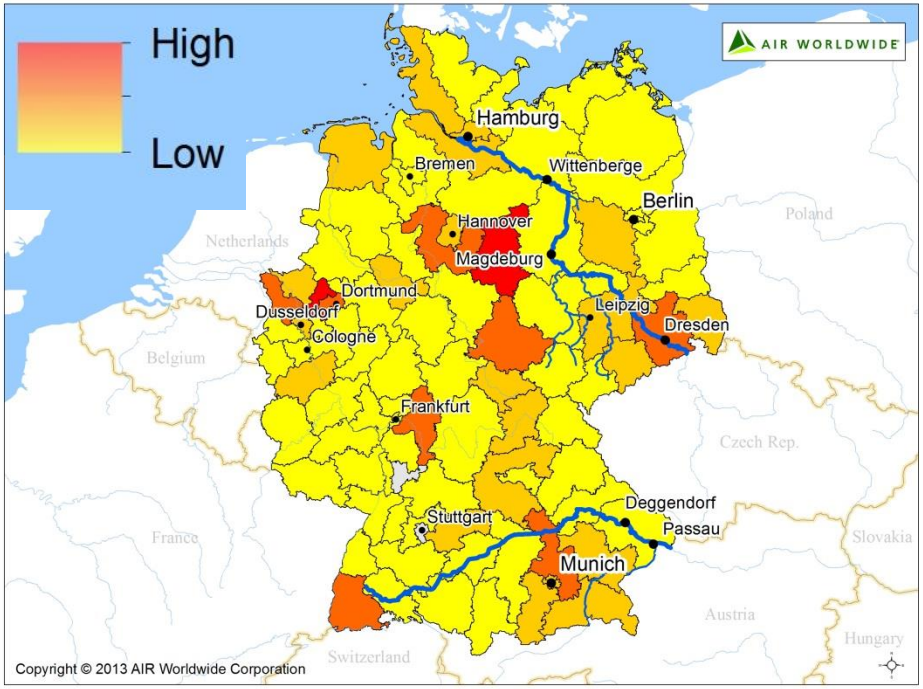
Off–Plain losses



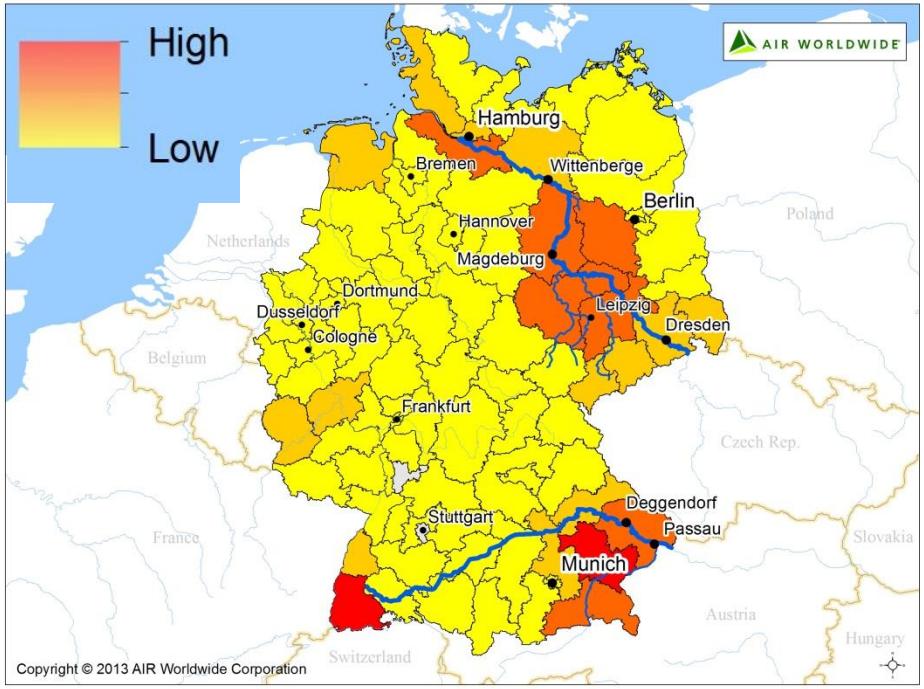
On–Plain losses

Scenario	On-Plain Loss	Off-Plain Loss	Off / On	Total Loss
3	2,580	2,523	0.98	5,103

Scenario 5 – 90th Percentile



Off–Plain losses



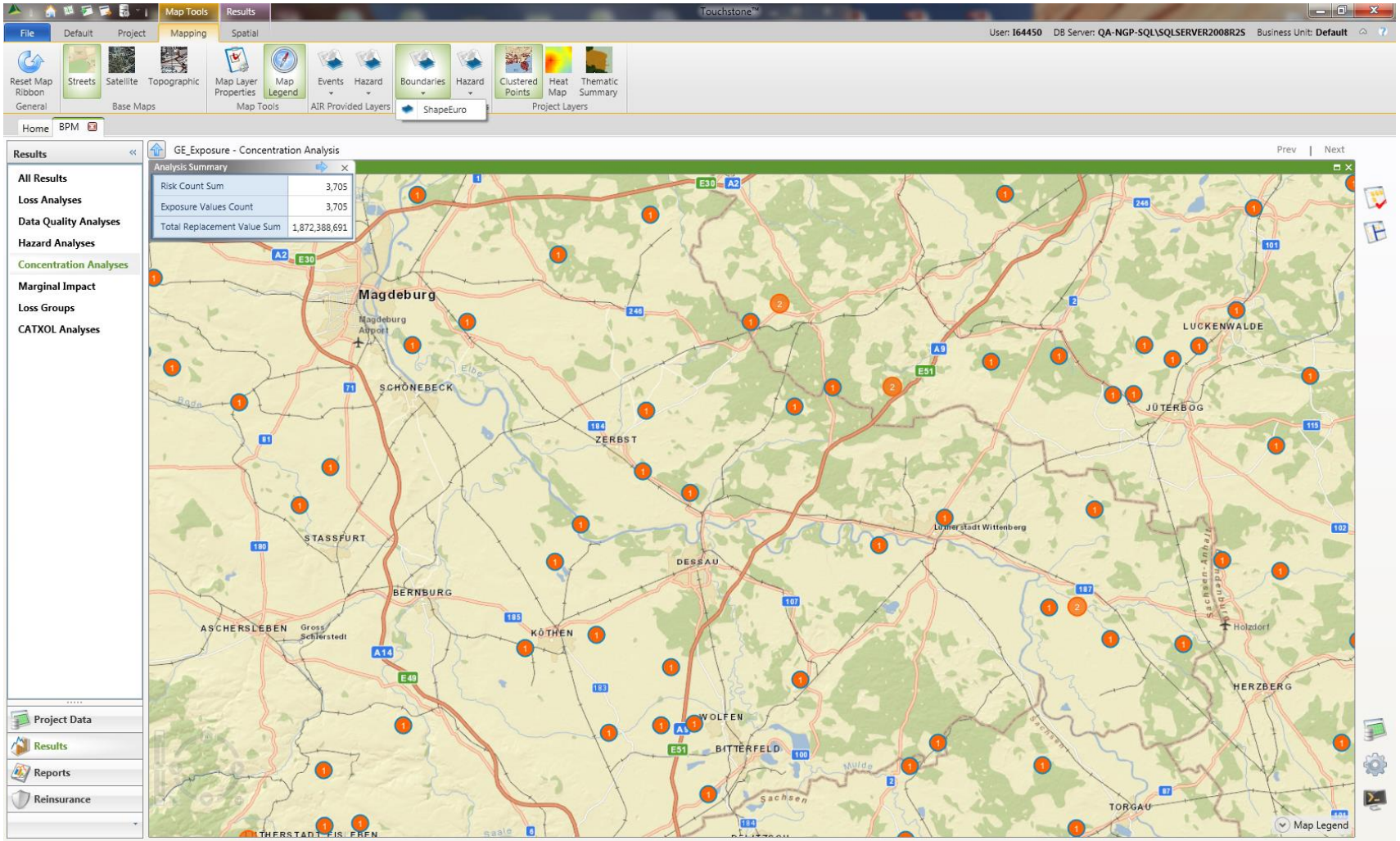
On–Plain losses

Scenario	On-Plain Loss	Off-Plain Loss	Off / On	Total Loss
5	2,545	3,239	1.27	5,784

Flood Extent Maps in Touchstone

AIR

Touchstone Enables You to Evaluate Your Exposed Limits within the Flood Extent



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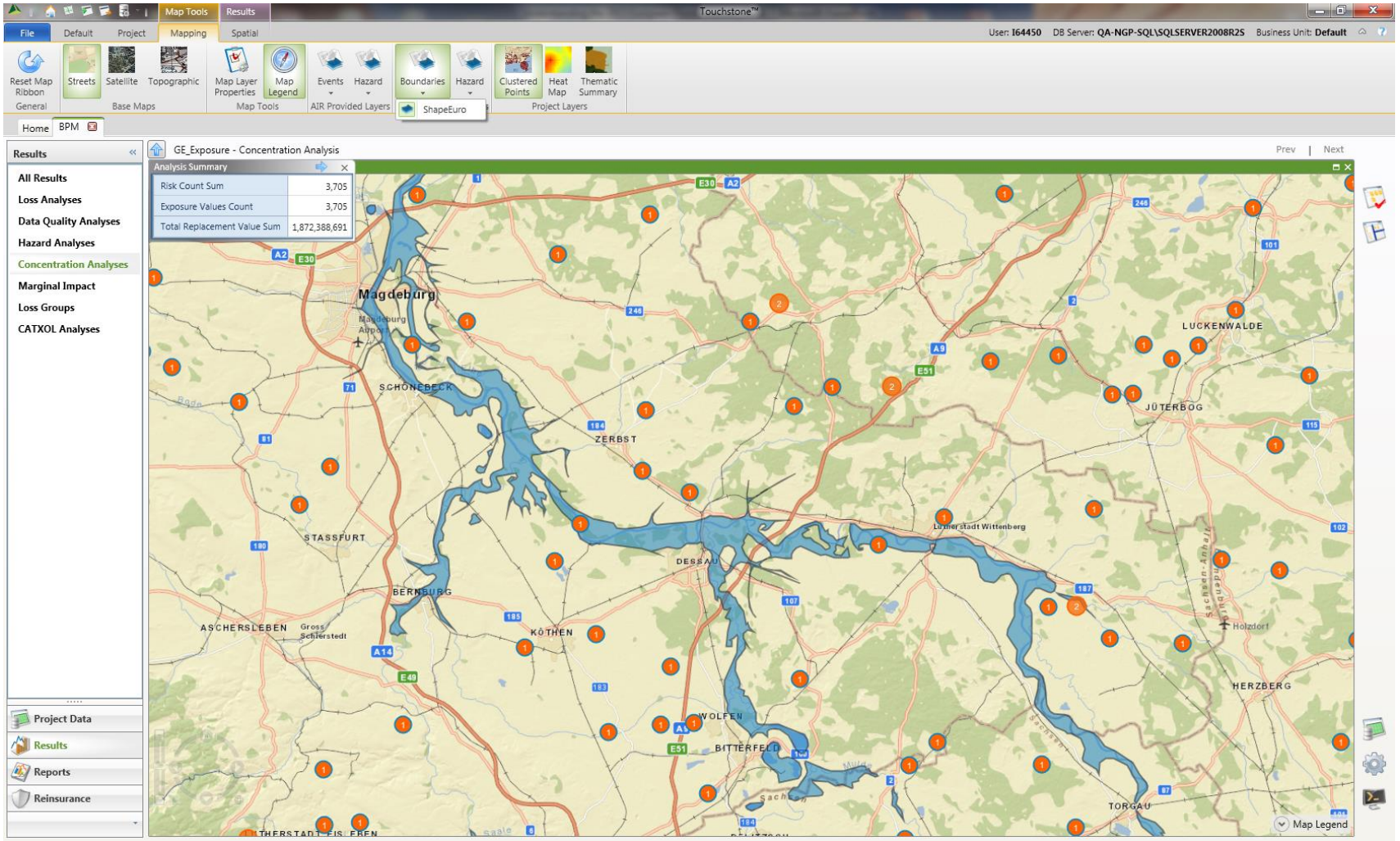
Add a Layer to Simulate the Areas that Have Been Inundated by the 2013 Flood



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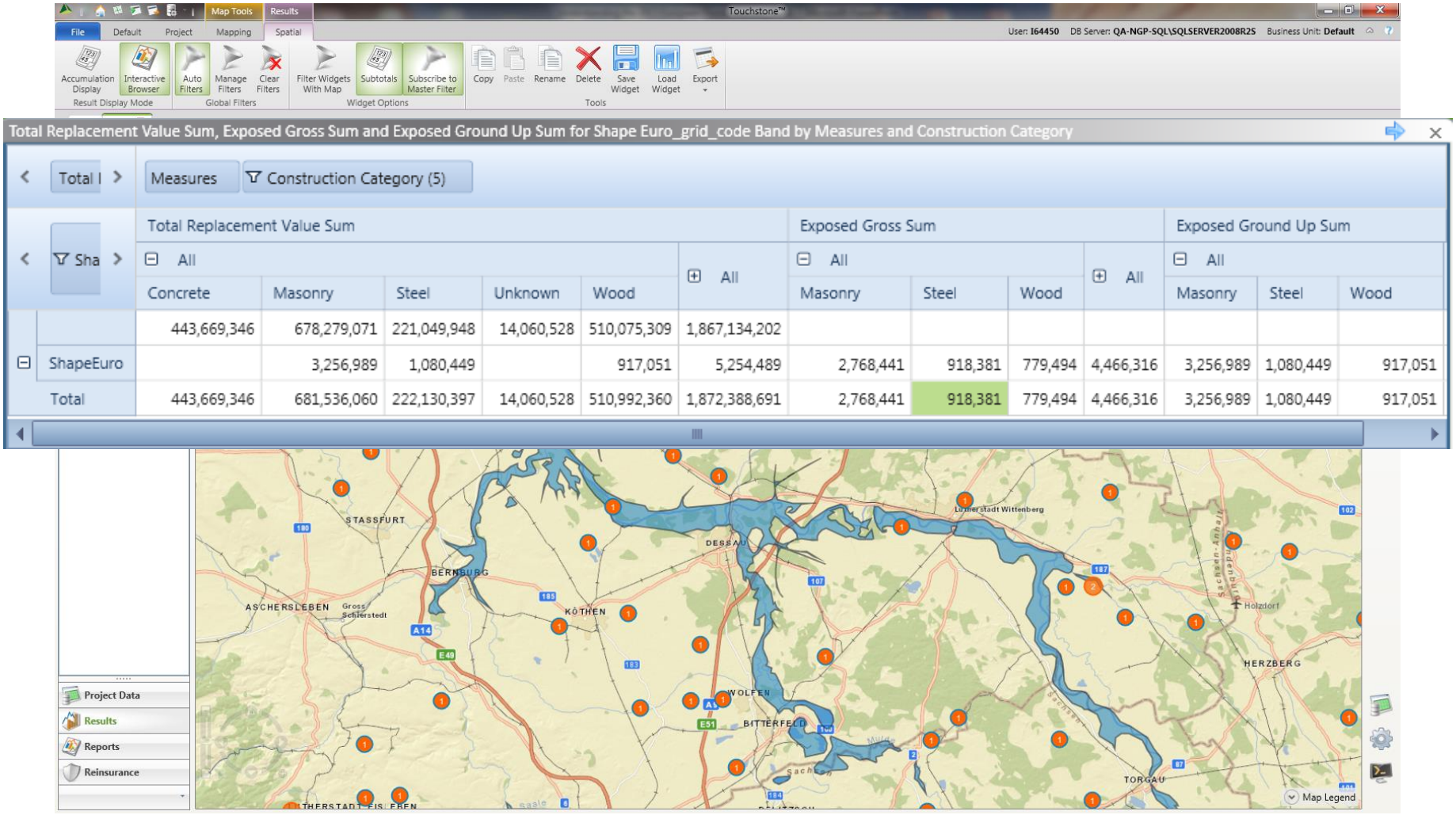
Evaluate Gross Exposed Limits within Flood Footprint to Assess Potential Risk



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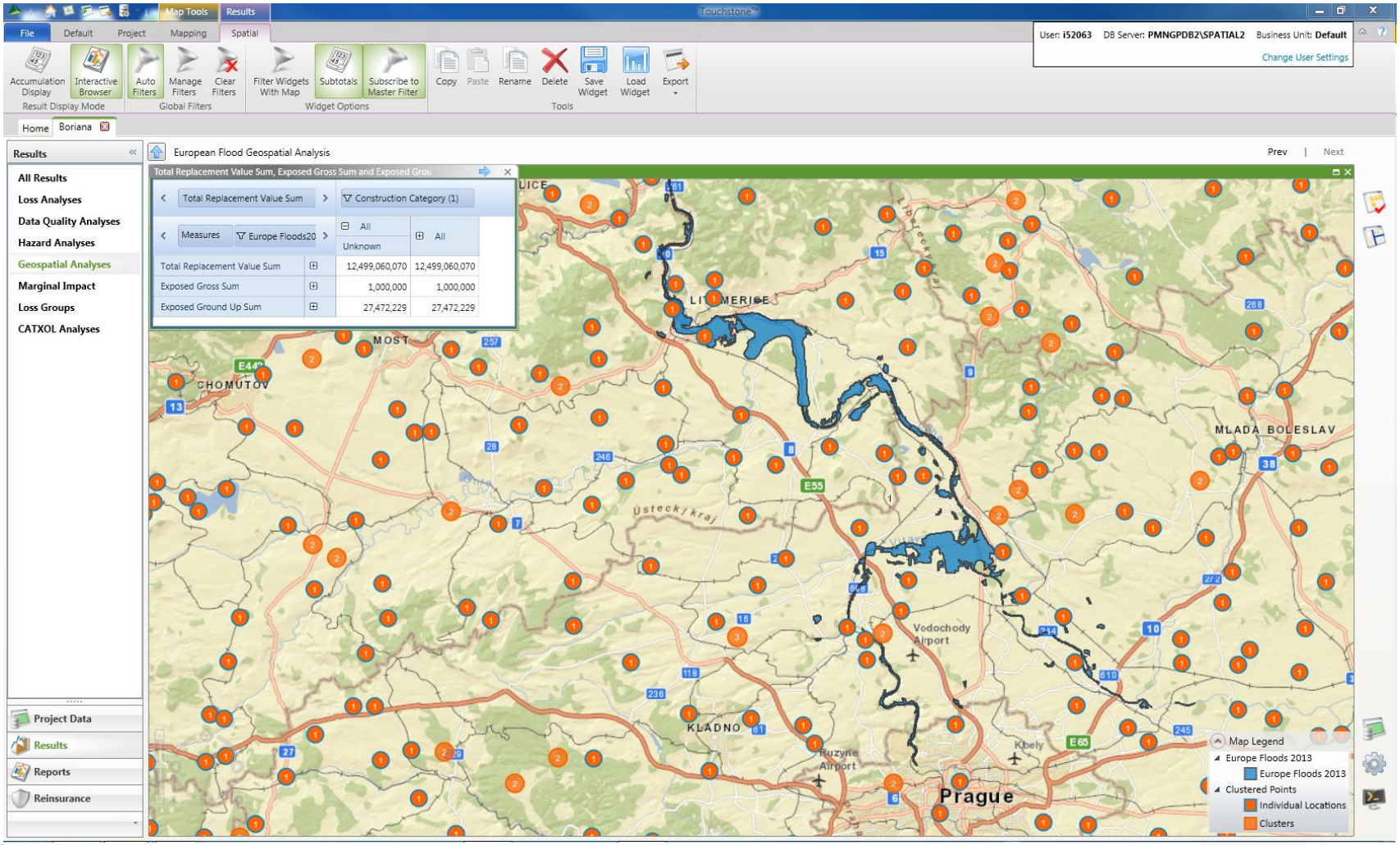
Touchstone Can Also Help Manage Accumulations of At-Risk Exposure in Non-Modelled Countries



Summary

- A disruption in the jet stream caused a series of wet storms to linger over Central Europe, causing heavy rains that led to intense flooding
- AIR scientists conducted a damage survey to collect data on the severity and extent of the floods to inform the model
- AIR created a set of ALERT scenarios that estimated the range of losses to be between €4.0 and €5.8 billion
- Clients can perform geospatial analyses in Touchstone using flood extent shape files (available as part of the ALERT posting) for Germany, Austria and the Czech Republic

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