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GEOSPATIAL WORLD FORUM
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Geo-social media and AI for Early Warning

A data source for multifaceted spatiotemporal information

Shaily Gandhi, Sebastian Schmidt, David Hanny, Merve Keskin, Bernd Resch

Geospatial World Forum 13-16 May 2024, Rotterdam

Z_GIS

DEPARTMENT OF GEOINFORMATICS - Z_GIS

Geo-social media

- Social media
- Digital platfoms to create, share and exchange user-generated content

- Geo-social media
- Adds (user) location

Source: https://cdn.pixabay.com/photo/2021/10/23/08/25/social-media-6734382_1280.png

Geo-social media

- Text
- Location
- Imagery
- Metadata

AIFER

Artificial Intelligence for Emergency Response

- Bilateral project (Austria & Germany)

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Z_GIS

ÖSTERREICHISCHES ROTES KREUZ SALZBURG

DIE JOHANNITER
Aus Liebe zum Leben

IFES

spatial services
WHERE GEOINFORMATION MEETS TECHNOLOGY

DLR

Bayerisches Rotes Kreuz

Technisches Hilfswerk

UNIKASSEL VERSITÄT

disy

Project Film: https://www.youtube.com/watch?v=fu4mAVe3bVg

TEMA

TRUSTED
EXTREMELY PRECISE
MAPPING AND PREDICTION
FOR EMERGENCY
MANAGEMENT

- European Horizon project

Main scenario: Ahrtal flood

Source: BRK

Remote sensing

Source: DLR

Remote sensing

- Can provide vital information
- However: multiple drawbacks
  - Timely data collection
  - Weather conditions
  - Spatial structures (e.g. urban)
  - High costs

Social media

Evidenz #solidAHRität @Evidenz2 · 31. Juli 2021

Die Brücke hat einen neuen Standort. Ich schätze das Gewicht mal auf 10 bis 15t. 1km weit weg getragen worden. Unfassbare Dimensionen der Gewalt. Die Ahr hat an der Mündung ein völlig neues Bett gefräst. #Sinzig #Flutkatastrophe **#Ahrtal**

1 4 46

Landesregierung Rheinland-Pfalz @rlpNews · 28. Juli 2021

Ministerpräsidentin Malu #Dreyer informiert sich in #Mayschoß über Zerstörungen der Hochwasserkatastrophe. „Wir lassen die Menschen im **#Ahrtal** nicht im Stich. Wiederaufbau ist langfristige Aufgabe, bei der Land und Bund helfen."

2 15 69

A. Murmann @ajmurmann · 15. Juli 2021

Hat jemand Informationen zum Stand in Liers im **#Ahrtal**? Ich versuche da schon ewig meine Familie zu erreichen oder zumindest etwas über den Zustand des Ortes zu erfahren. Alle (grauenhaften) Informationen sind über umliegende Orte #Ahr #Hochwasser

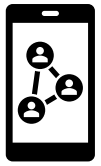
6 20 26

Amelie @amelieseastar · 17. Juli 2021

Danke für die lieben Worte ihr alle und für die netten Entgegenkommen von euch. Ich bin mittlerweile bei einer Freundin untergekommen, mir geht es also soweit ganz gut und ich bin versorgt. Trotzdem geht es den meisten **Ahrtal** Anwohnern nicht so glücklich. 1/2

1 4 39

Workflow



Data extraction via Twitter API

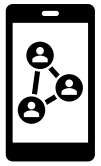
Pre-processing & relevance classification

Semantic analysis & sentiment analysis

Spatial hot spot analysis

Information fusion

Workflow



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Relevance classification

- Time

- Space

- Semantics

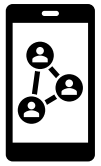
- Imagery

Multidimensional classification

Relevance classification

Source: Jose Maria Miranda Orte (ATOS)

Workflow



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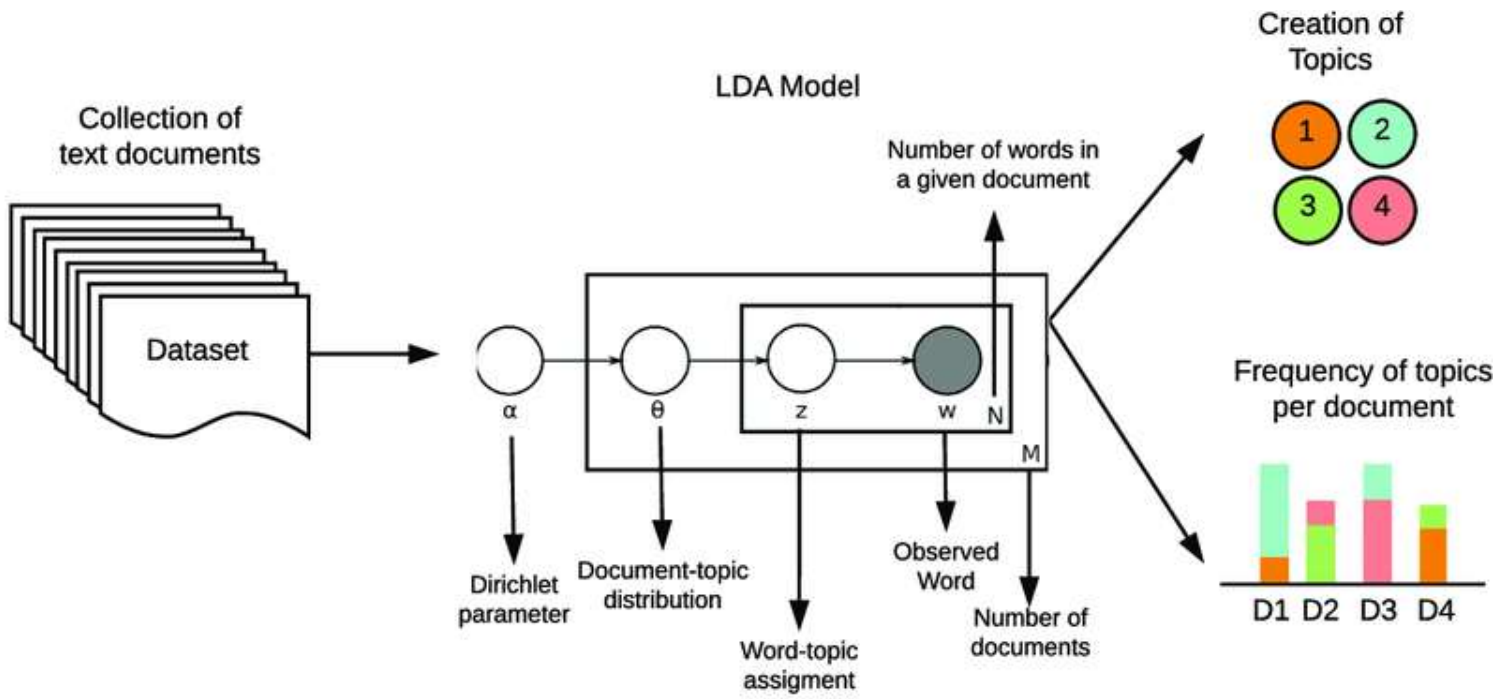
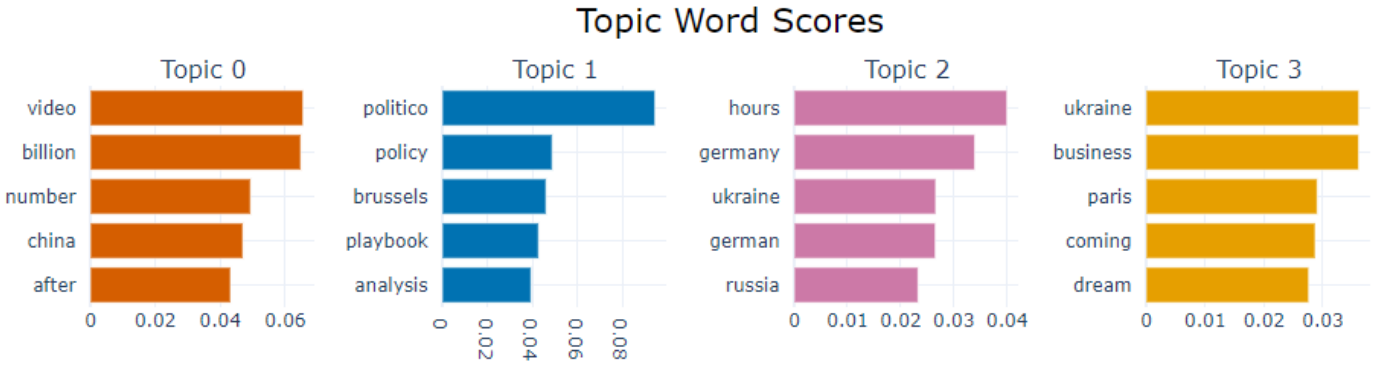
Semantic analysis

- Established methods
  - Keyword-based filtering
  - Latent Dirichlet Allocation
  - BERTopic



Source: Buenaño-Fernández et al. (2020)



Semantic analysis

- JSTTS model
- Joint Spatio-Temporal-Topic-Sentiment Model
- Growing self-organising map (GSOM)
- Higher topic coherence and diversity than BERTopic

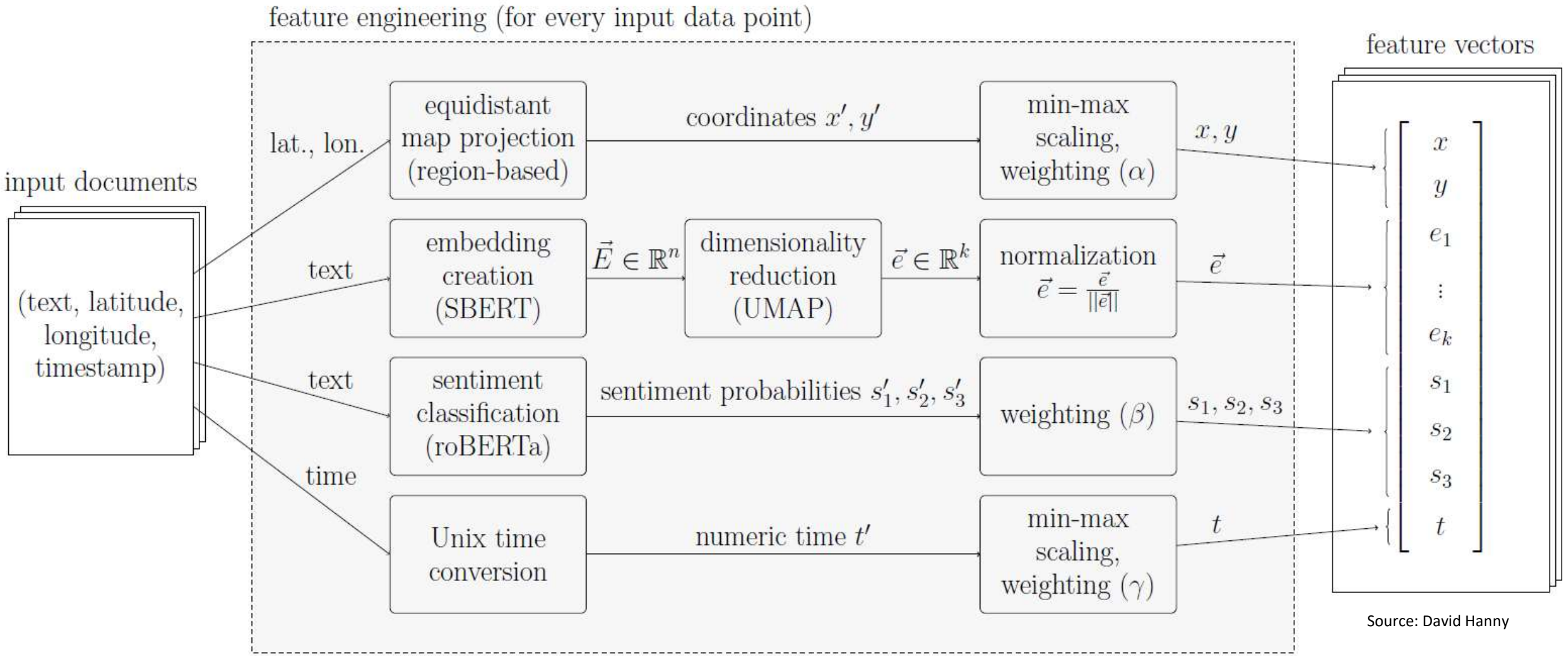
Time

Space

Semantics

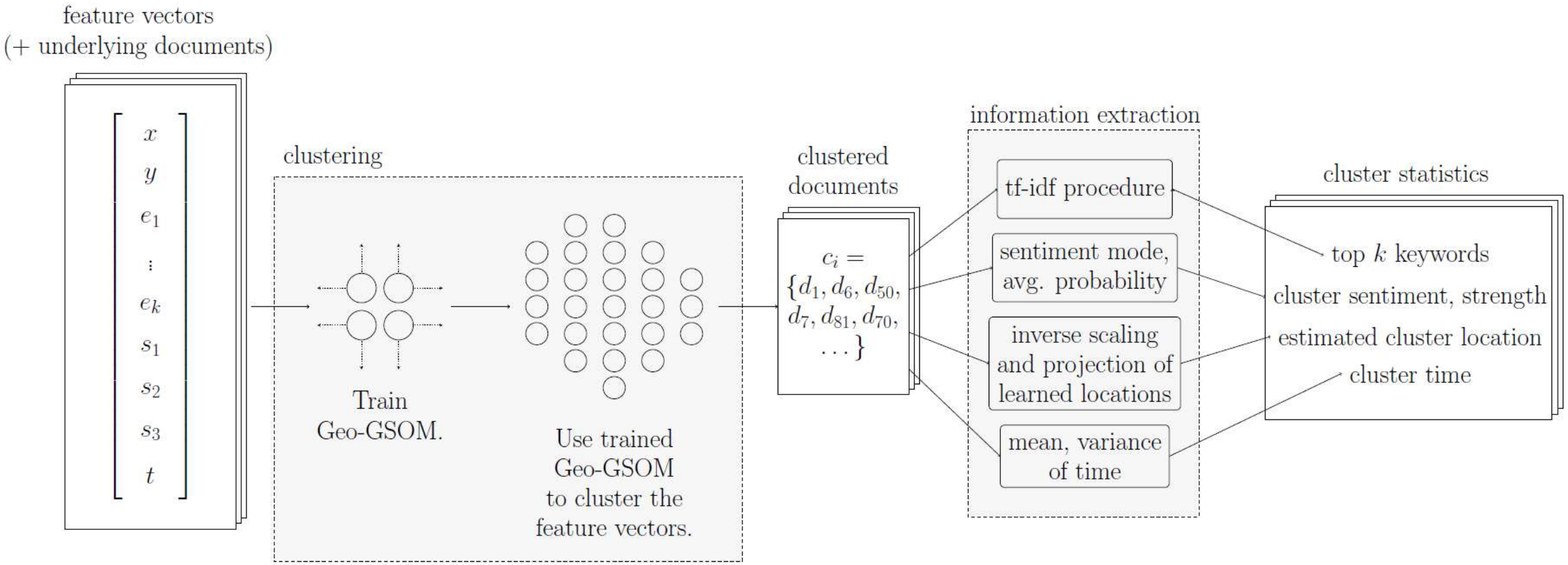
Sentiments

Semantic analysis



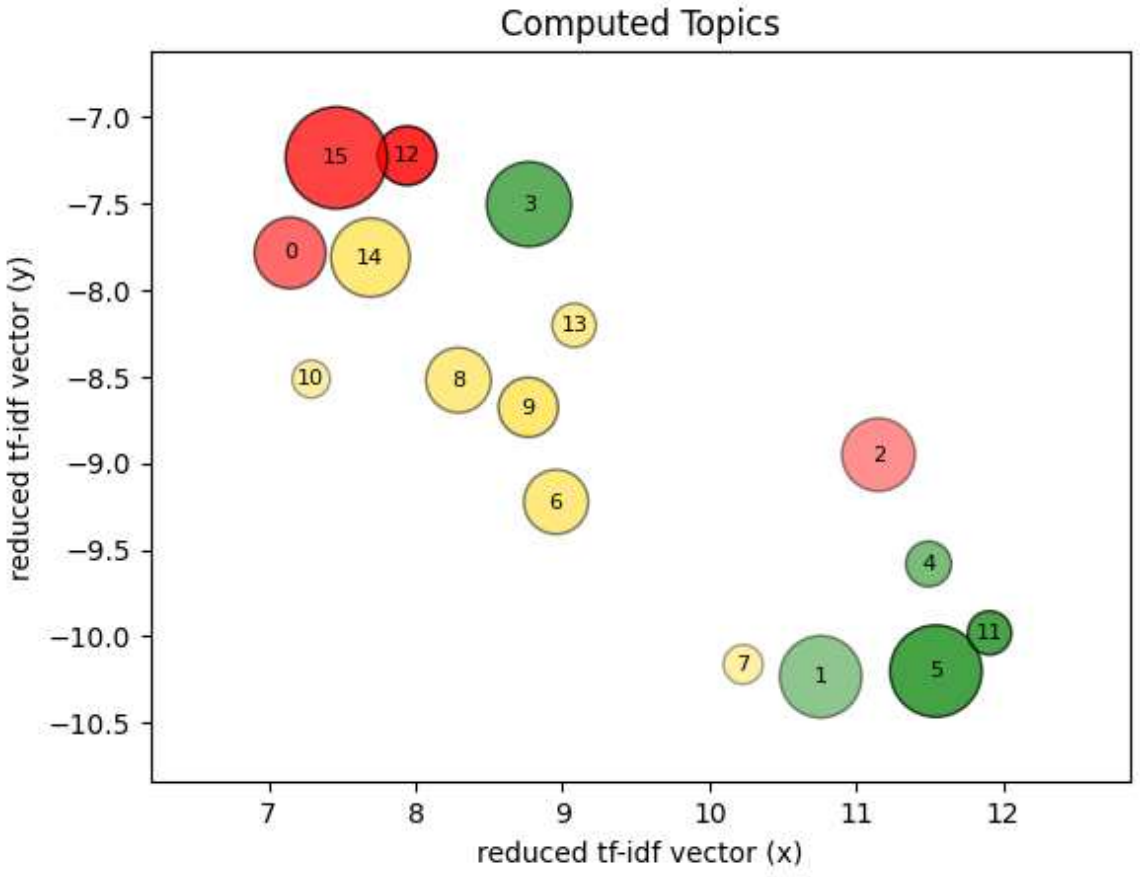
Source: David Hanny

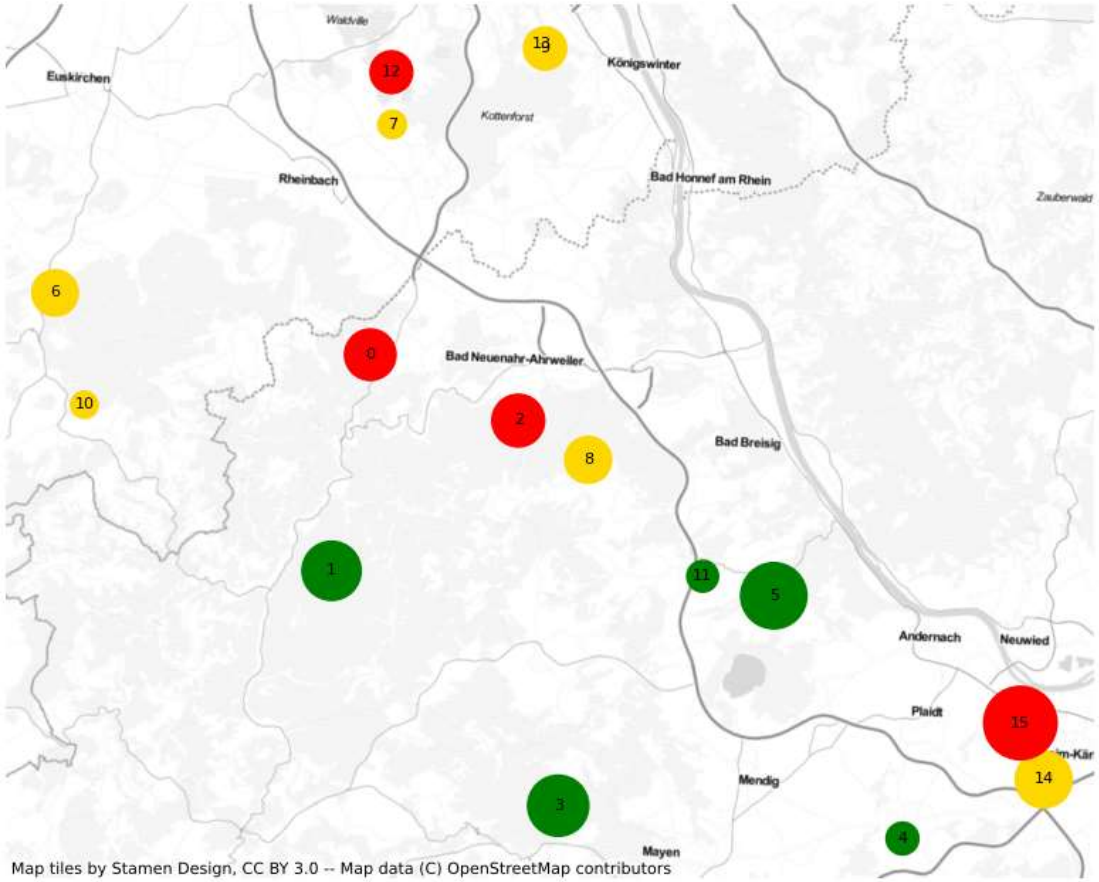
Semantic analysis



Source: David Hanny

Semantic analysis





Source: David Hanny

Sentiment analysis

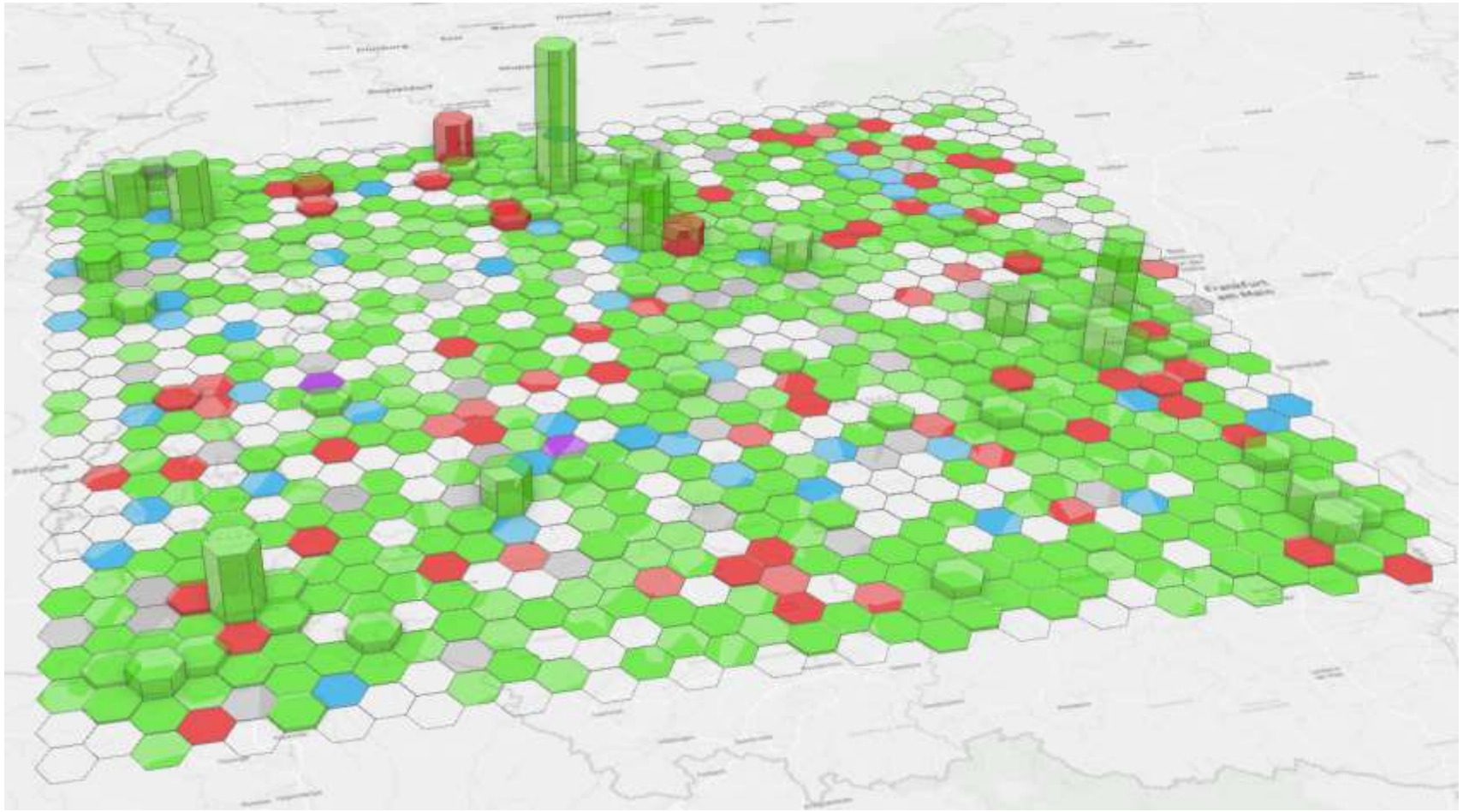
Polarity

- Positive
- Neutral
- Negative

Emotions

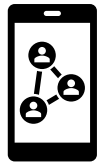
Dominant Emotion

- Anger
- Fear
- Sadness
- Happiness
- Conflict (2 or more dominant emotions)
- No emotions



Source: Christina Zorenböhmer

Workflow



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Information fusion

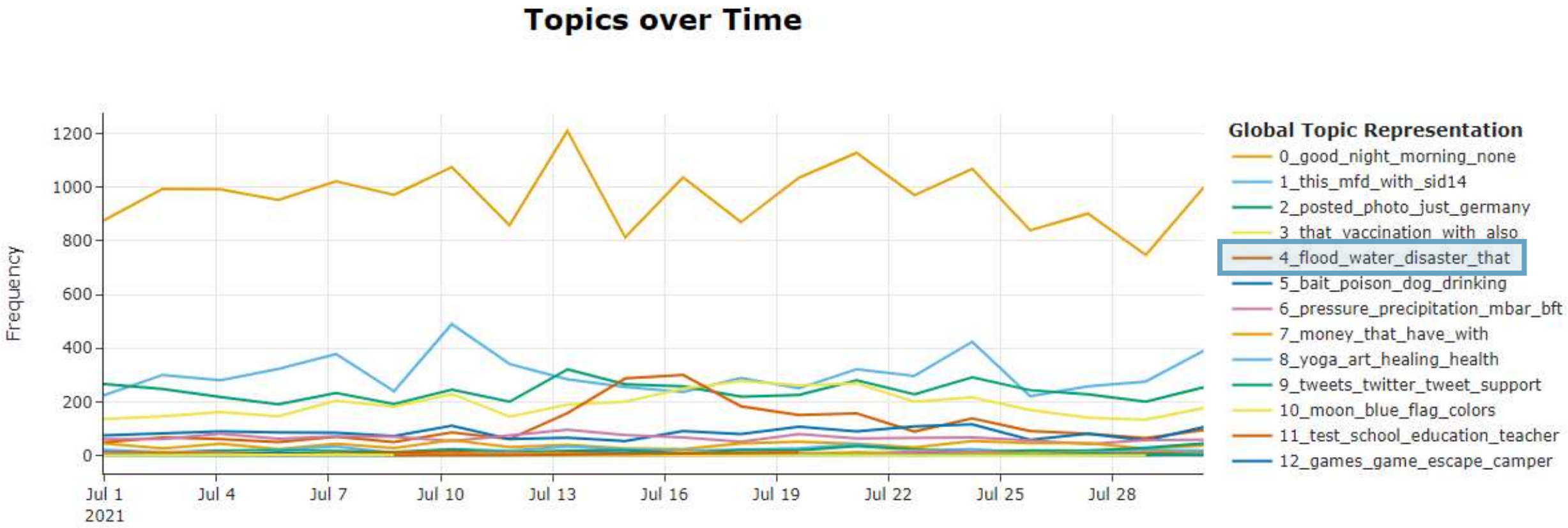
Spatio-temporal analysis

- Getis-Ord Gi*

$$G_i^* = \frac{\sum_{j=1}^{n} w_{ij} x_j - \bar{x} \sum_{j=1}^{n} w_{ij}}{S \sqrt{\frac{n \sum_{j=1}^{n} w_{ij}^2 - \left(\sum_{j=1}^{n} w_{ij} \right)^2}{n-1}}}$$

- Ratio of relevant to all Tweets in respective unit
- Emerging hot spot analysis

Spatio-temporal analysis



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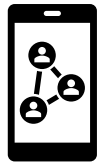

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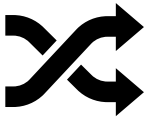
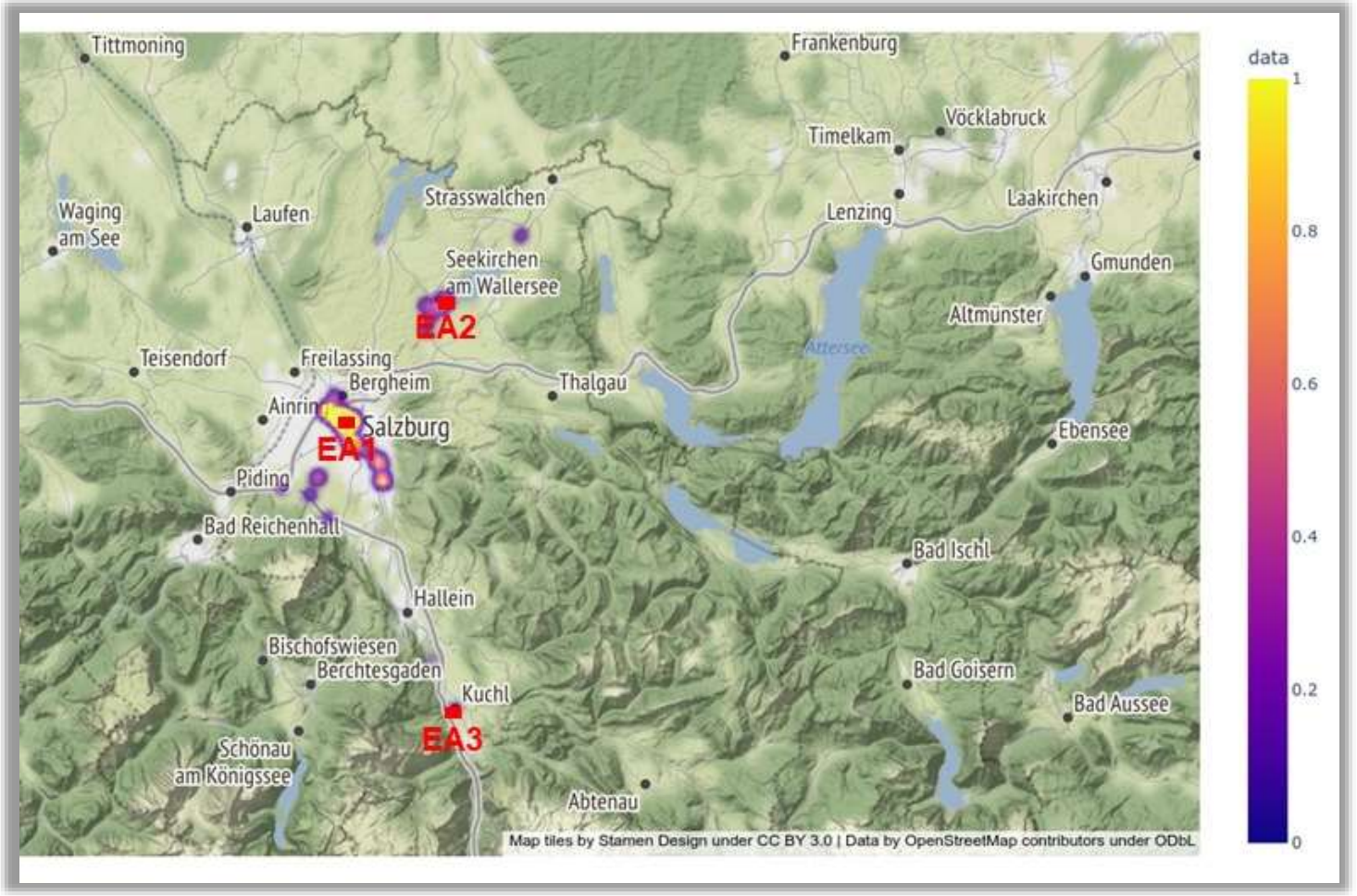


Information fusion

Information fusion

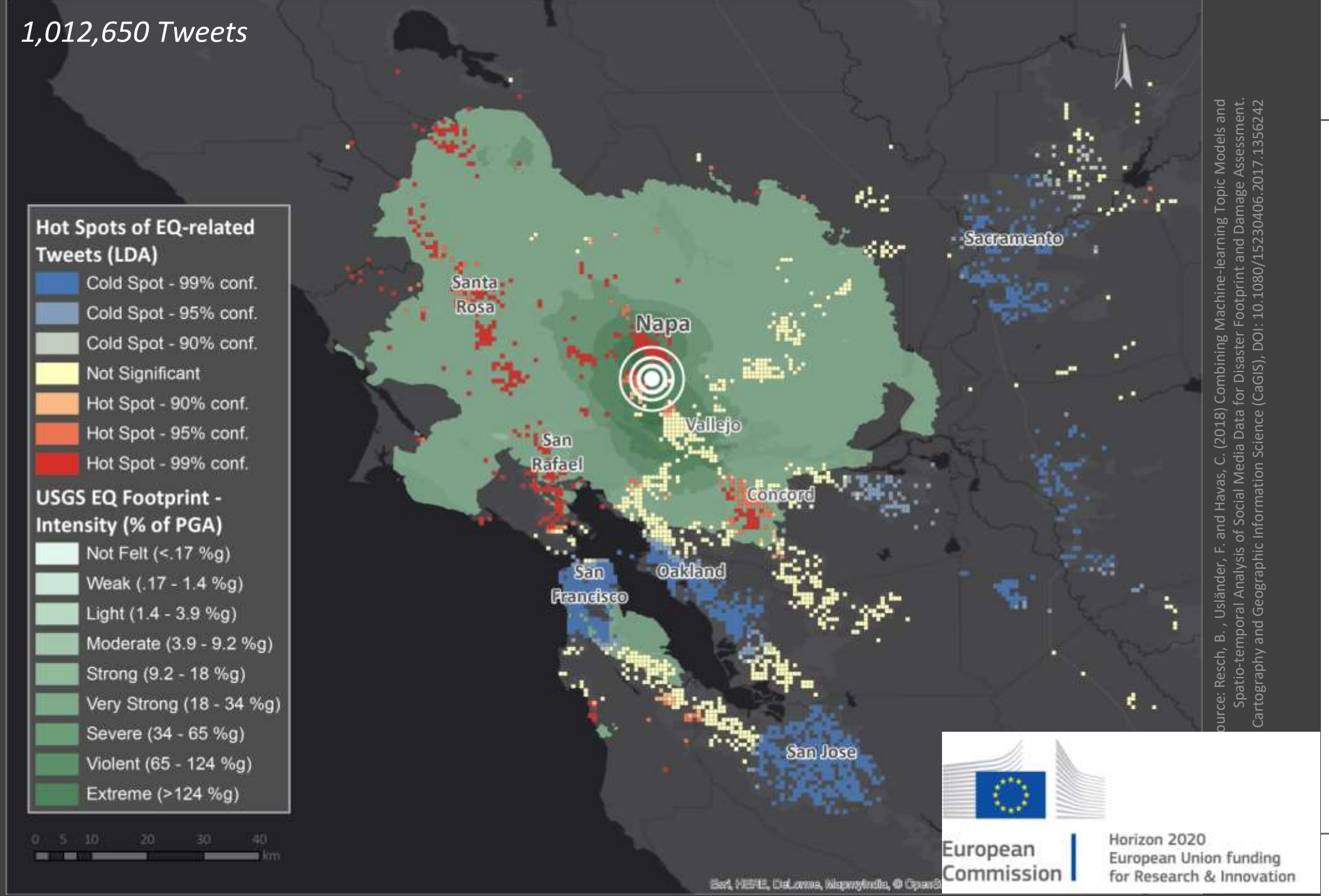
- Combination with remote sensing imagery
- Identification of particularly affected regions
- Aerial survey planning
- Basis for deployment of emergency forces
- Other use cases:
  - Climate data
  - Mobile phone data
  - Epidemiological data
  - …



Source: Marc Wieland, German Aerospace Centre

Napa Valley Earthquake

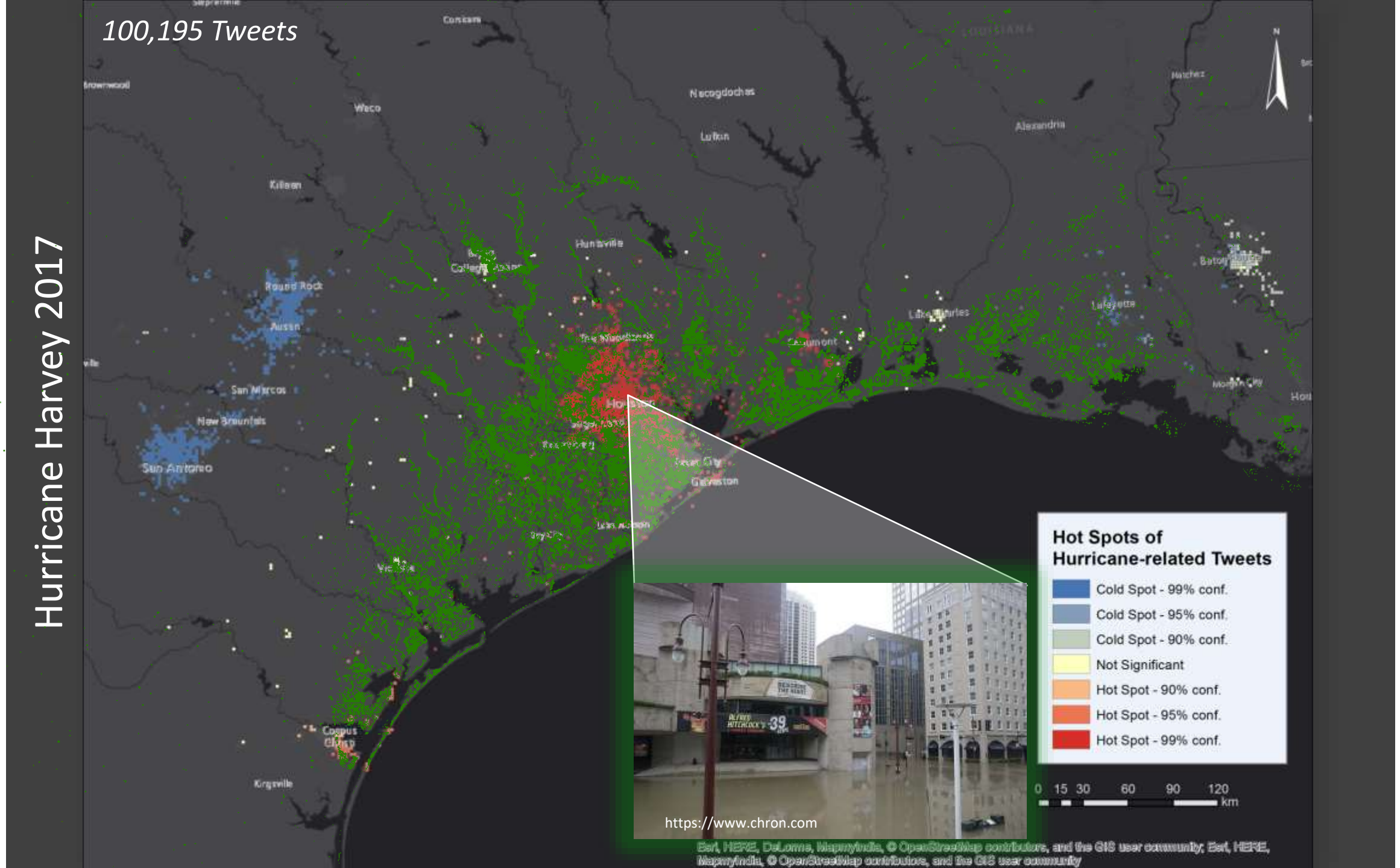
1,012,650 Tweets



Source: Resch, B. , Usländer, F. and Havas, C. (2018) Combining Machine-learning Topic Models and Spatio-temporal Analysis of Social Media Data for Disaster Footprint and Damage Assessment. Cartography and Geographic Information Science (CaGIS), DOI: 10.1080/15230406.2017.1356242

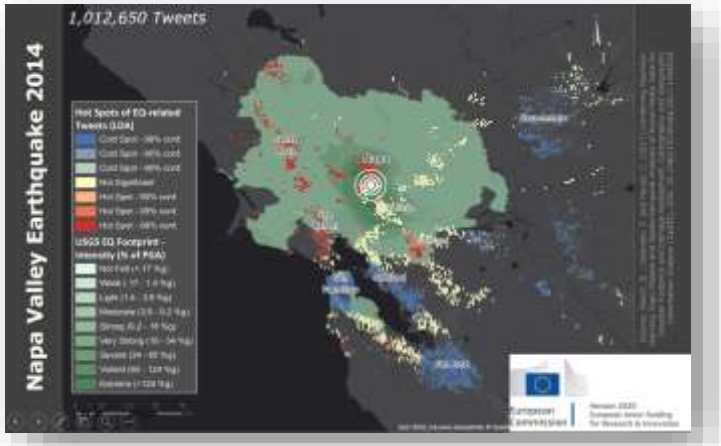
European Commission | Horizon 2020 European Union funding for Research & Innovation

Hurricane Harvey 2017



AI in Disaster Management

- Analysis of **heterogeneous big data**
- **Automation** of the analysis of EO and Web data
- Quantification of the **spatial extent and affected areas**



Conclusion

- Social media can provide vital spatio-temporal information during disaster situation
- Fusion with other data sources is promising
- Many potential use cases for social media data

Natural hazards

Epidemiology

Politics

Geo-social Media Analytics ::: In Action

- **Worldwide** availability, Modelling the **spatial spread** of crisis situations
- **Continuous** data stream, **real-time** situation reports
- **Intuitive** information visualisation
- **Transferability** between use cases and geographic regions
- **Simple integration** of information into DM processes
  - Generation of decision support information for staff **together with users**

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Thank you for your attention!

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Z_GIS

Image sources

- Ahrtal flood (https://media1.faz.net/ppmedia/aktuell/gesellschaft/539412956/1.7780895/default-retina/15-juli-2021-eine-luftaufnahme.jpg)
- Buenaño-Fernández et al. (2020): Text Mining of Open-Ended Questions in Self-Assessment of University Teachers: An LDA Topic Modeling Approach, in: IEEE Access PP(99):1-1, DOI: 10.1109/ACCESS.2020.2974983
- Hurricane Katrina (https://upload.wikimedia.org/wikipedia/en/4/49/KatrinaNewOrleansFlooded-edit1.jpg)
- COVID-19 (https://media-cldnry.s-nbcnews.com/image/upload/rockcms/2022-09/220914-covid-vaccination-germany-al-1118-f9b617.jpg)
- Demonstration (https://www.humanosphere.org/wp-content/uploads/2017/03/32559700202_bab8814c4b_o.jpg)