Automating impact data collection and developing frameworks to support evaluation of impact-based forecasts

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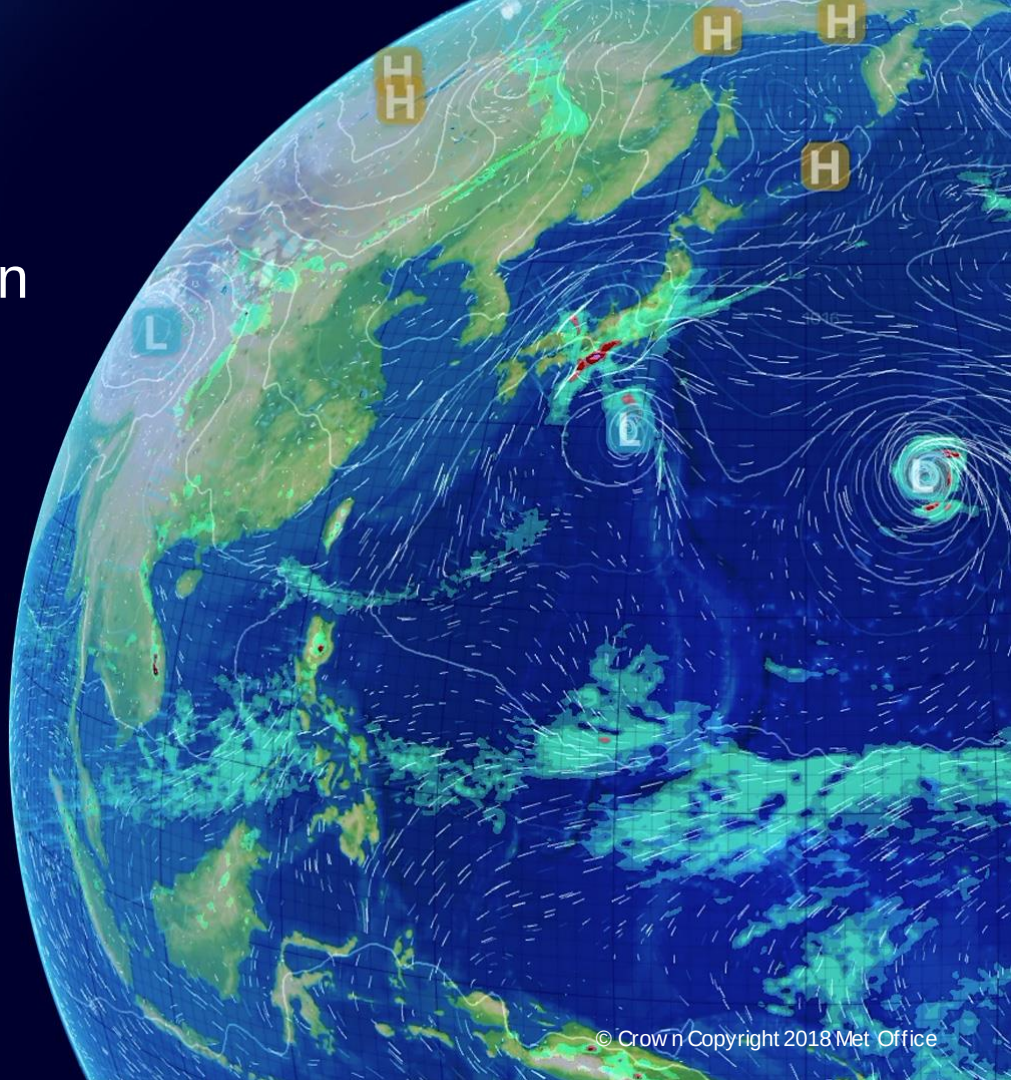

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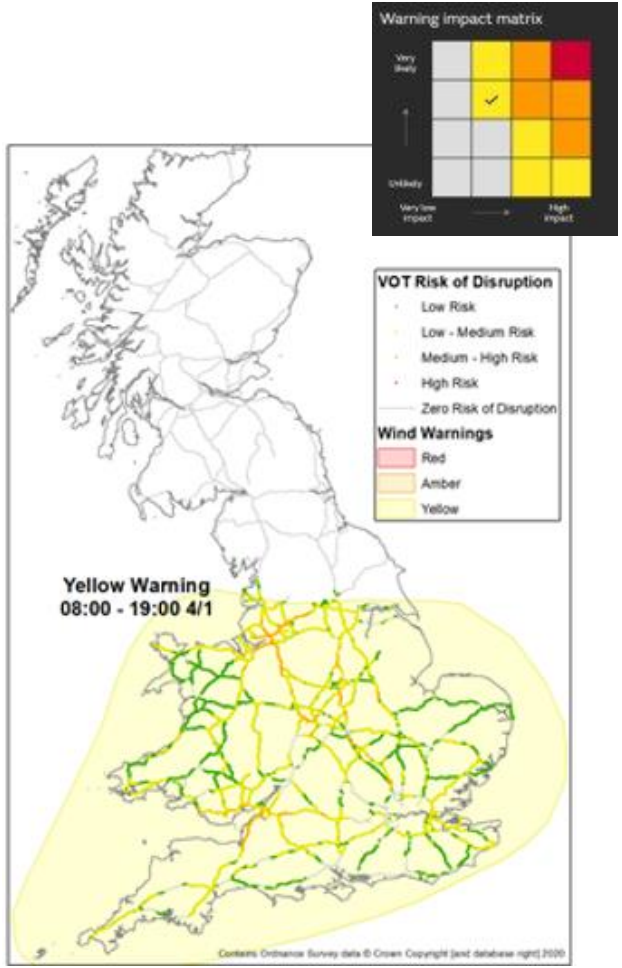
Why is impact data collection important?

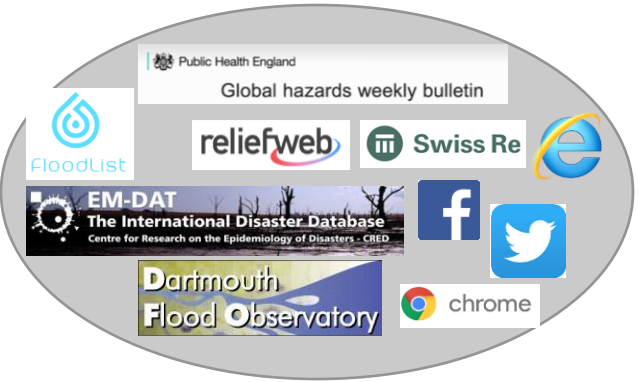
socio-economic impact data are needed to develop, calibrate and verify impact models and impact-based warnings

Key research questions:

1) Which data sources can we use to provide observations of weather-related impacts,
2) What processing is required to automatically collate these impacts to enable consistent and successive verification.

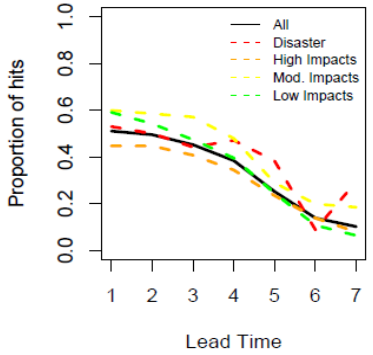


Which data sources can we use to provide observations of weather-related impacts?

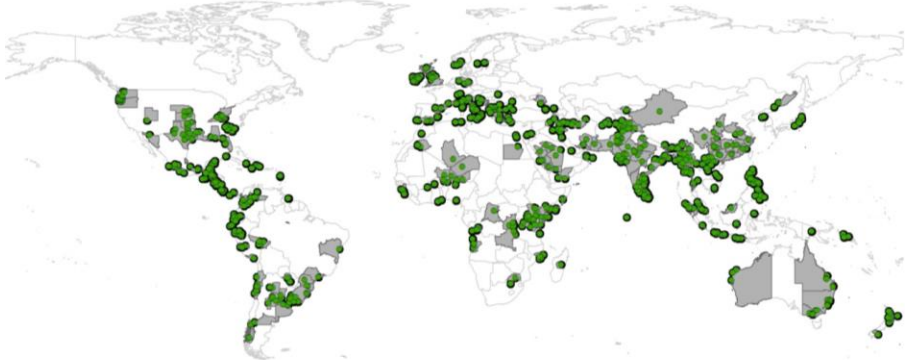


Met Office manually curated Global impact database

Heavy Rainfall Database
Spatial_ID (entry ID)
Event_ID (hazard event ID)
Record Date
Start Date
End Date
Hazard Type ('Heavy rainfall')
Trigger/Cause
Secondary Hazards
Hazard Notes
Country Name
Region/State/Province Name
Region/State/Province Latitude
Region/State/Province Longitude
Settlement Name
Settlement Latitude
Settlement Longitude
Impact Information
Impact Categorisation
References



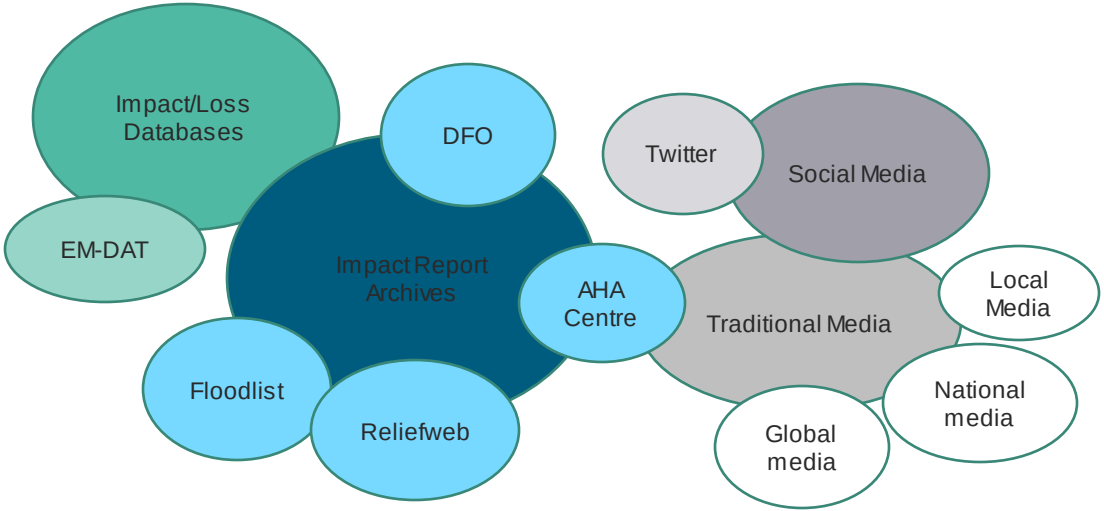
Location of heavy rainfall impacts (February – December 2015)



261 heavy rainfall events were recorded, resulting in 853 impact entries

- Labour-intensive
- Significant amount of detail in the impact information
- Good accuracy in temporal and spatial location of each record
- Increased likelihood of events not being captured due to the resource required for manual curation

Which data sources can we use to provide observations of weather-related impacts?



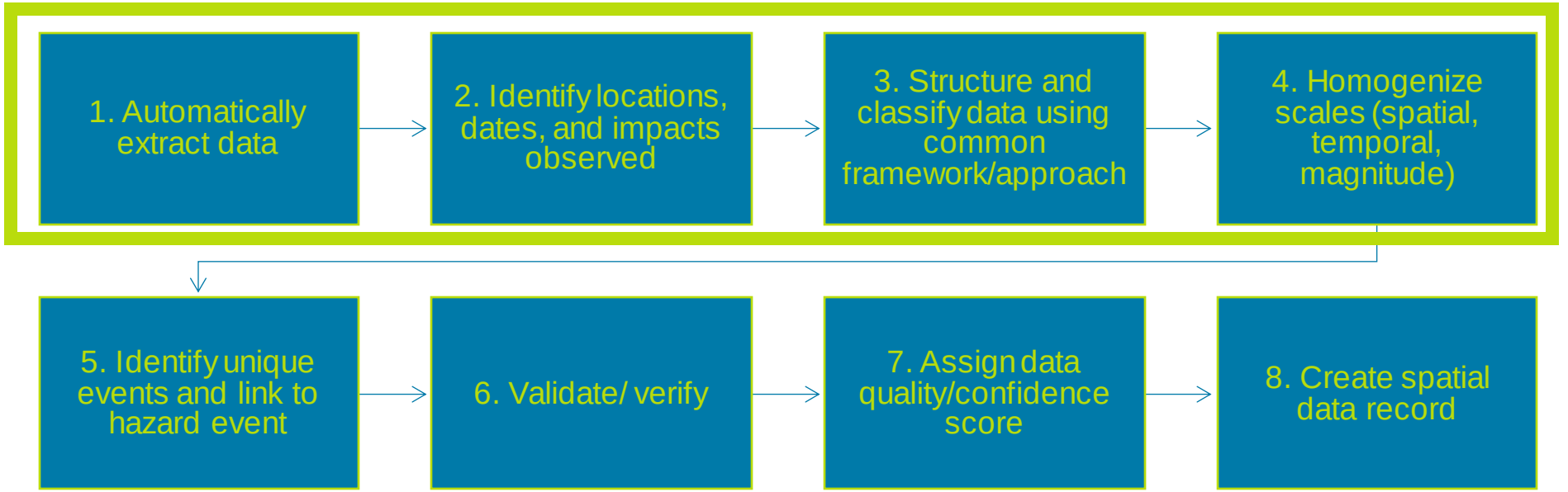
- Biases associated with each data source have been examined, together with their accessibility and usability

Can we compile impact data into a single source of "truth"?

	EM-DAT	DesInventar	DFO	GLIDE	Reliefweb	FloodList	AHA Centre	Traditional Media	Social Media
Spatial Scale	Coarse	Medium	Medium	Medium	Medium	Medium	Fine	Fine	Variable
Magnitude	High	Variable	High	High	High	Moderate	Moderate	Moderate	Variable
Accuracy	Verified	Good	Good	Verified	Good	Good	Verified	Good	TBD
Use Type	Publicly available	Publicly available	Publicly available	Accessible	Publicly available	Accessible	Accessible	Accessible	Accessible
Access	Dow nloadable	Dow nloadable	Dow nloadable	View report	API	View web page	View web page	View web page	API
Usability	Formatted	Formatted	Formatted	Formatted	Unformatted	unformatted	Semi-formatted	Unformatted	Unformatted
Threshold Bias	Yes	No	Yes	?	?	No	No	No	No
Geographic bias	?	Yes	No	No	No	No	Yes	No	No
Hazard Bias	No	No	Yes	No	No	Yes	No	No	?
Accounting Bias	No	Yes	Yes	Yes	No	No	No	No	?
Temporal Bias	?	?	?	?	No	No	No	?	?

What processing is required to automatically collate impacts?

Impact data collection roadmap tested using 7 data sources



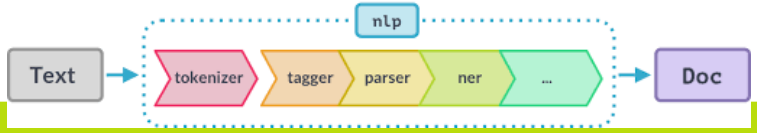
Extracting critical information from unstructured data

Key challenges associated with step 2:

(1) Wide variety of date formats used. Dates represent different things.
(2) Location naming conventions vary (as does spelling).
(3) Linking numbers with impacts in a consistent way is challenging

"Due to heavy rains since 16 March 2018 at 17:00hrs on the mountain, landslides hit the riverbed around Sentani causing flash floods with logs and sedimentary rocks that were channeled to the downstream. Nine villages in Sentani sub-district, Jayapura regency were affected. According to Sutopo Purwo Nugroho, the spoke person from the National Agency for Disaster Countermeasure or Badan Nasional Penganggulangan Bencana (BNPB), during eight hours of rains, the rainfall reached its extreme condition up to 235.1 mm/hour.There is an indication that landslide occurred in Cyclop Mountain which is the upstream area. Cyclop mountain is one of the conservation mountains in Papua. According to the information provided by BNPB and Meteorology, Climatology and Geophysical Agency that was compiled and circulated via e-mail by UNOCHA; as well as information from PMI, on Sunday, 17 March 2019, the flash flood affected nine sub districts in Jayapura regency, and four sub-districts in Jayapura city. Furthermore, according to the report: • Around 11,725 households are affected where among those 77 people died, 43 people missing, 74people injured, and 4,226 people displaced, who are scattered around various sites and evacuated to 6 different evacuation points. • Approximately 350 houses were damaged; while the water also inundated six areas, including 1,450houses in Gajah Mada, 1,000 in Jayapura, Kemiri dan Sentani, 200 district offices, and 200 in Doyo.• Water resource at Cyclop Mountain contaminated by mud and logs from the landslide. The number of casualties is estimated to increase as the evacuation process is still continuing and not all the affected areas have been reached by the joint Search and Rescue (SAR) team, as they are covered by trees, rocks, muds and other flash floods materials. ([IFRC, 20 Mar 2019](https://reliefweb.int/node/3042983))According to media reports as of 2 April at 8.00 UTC, 112 people are dead and at least 90 are still reported missing after flooding and landslides in Sentani District (Jayapura Regency, Papua Province) in mid-March. The National Disaster Management Agency reports more than 11 000 people displaced in 28 sites, 375 buildings severely damaged and four bridges collapsed. ([ECHO, 2 Apr 2019](https://reliefweb.int/node/3064108))"

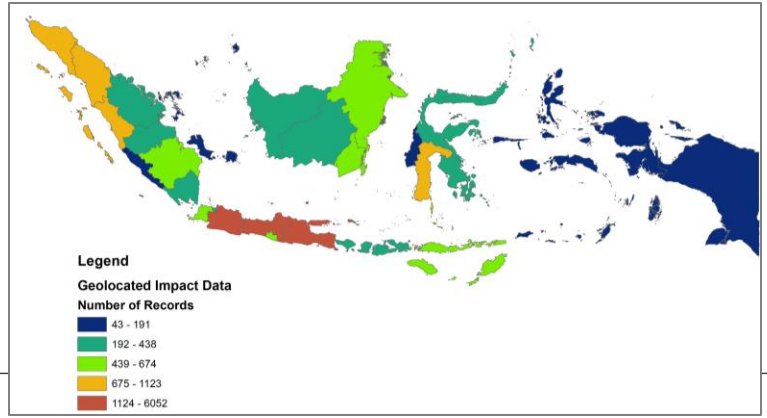
spaCy



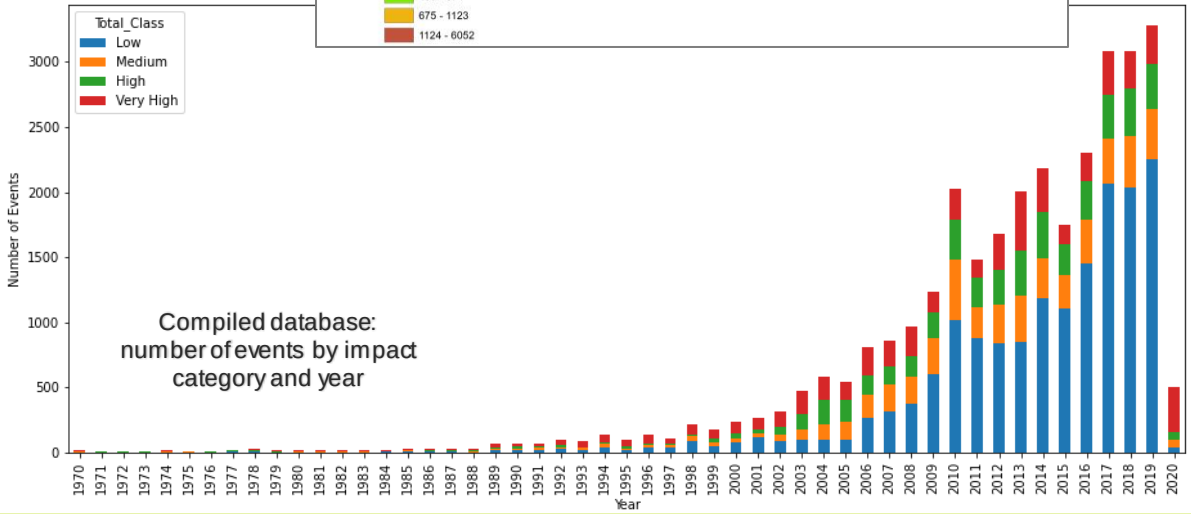
Structuring and classifying impact data

How best to classify impact magnitude?

- Compiled and verified database for each database (1 per data source) by parsing out the impacts from the unstructured & structured data
- Calculated impact magnitude for each event at the country scale. The total and maximum impact scores were classified as low, medium, high, very high based on historical event information.



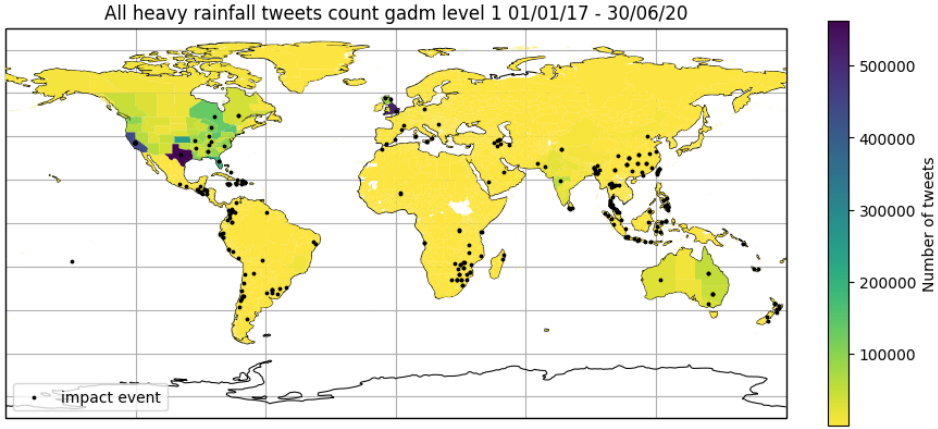
- **Human Loss**: Deaths + Missing + Injuries
- **Population Impact**: Maximum (Families affected or persons affected or persons displaced)
- **Infrastructure Impact**: Damages education + damages medical + damages public + damages infrastructure
- **Economic Impact**: Damage house + agriculture loss

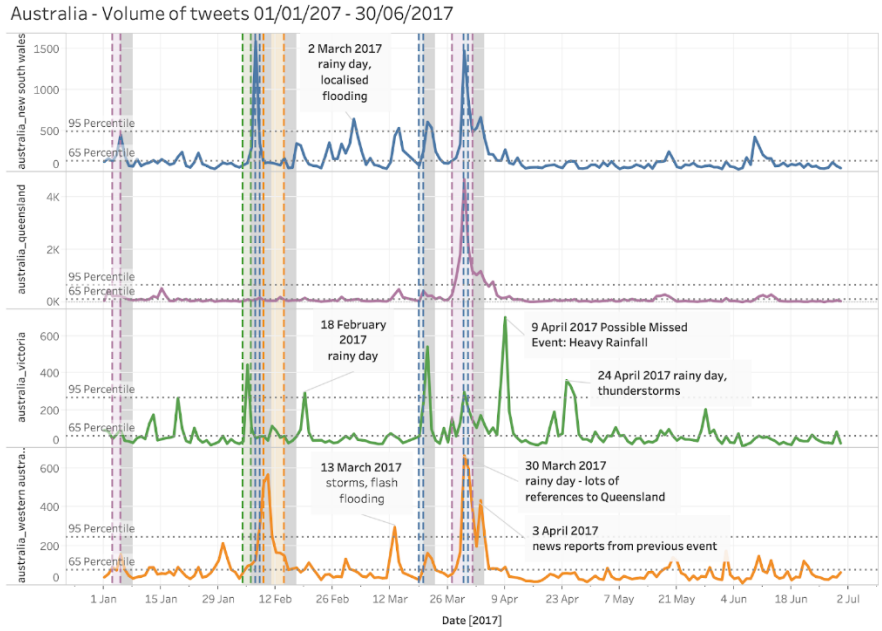


What about social media: What processing is required to automatically collate impacts?

Event detection using social sensing

- Filtering tweet data to remove retweets, quotes, bots and other non-relevant data
- Location inference of the tweets
- Matching to GADM level 1 locations for comparison with the manually curated dataset





- Volume of tweets compared to known high-impact weather events and Met Office manually curated impact database

Spruce et al. 2021. NHESS – In review

Summary & On-going Research

- It is possible to automatically extract impact observations from a range of information sources, however more agnostic methods will likely be needed.
- The use of multiple sources does add detail above singular sources but also introduces complexity to the methodological framework
- Challenges that are actively being addressed in future work:
  - Improvements to date and impact extraction
  - Duplicates and update processing

  Better NLP extraction
  - Improved understanding of the lag associated with sources
  - Identifying processes to link impact information to hazards

  Better event creation
  - Testing of impact classification strategies
  - Data visualisation

  Better IbF & IbW evaluation techniques

Met Office

More information:

Robbins J.C. & Titley H.A. (2018) Evaluating high-impact precipitation forecasts from the Met Office Global Hazard Map (GHM) using a global impact database. Meteorological Applications, 25, 4, 548-560 (https://rmets.onlinelibrary.wiley.com/doi/10.1002/met.1720)

Spruce, M.D., Arthur R., Robbins, J.C. & Williams, H.T.P (2021) Social sensing of high impact rainfall events worldwide: A benchmark comparison against manually curated impact observations. Nat Hazards Earth Syst. Sci – *In Review* (https://nhess.copernicus.org/preprints/nhess-2020-413/)

Thank you for your attention!

Questions?