Integrating Social Media into a Pan-European Flood Awareness System: A Multilingual Approach

Valerio Lorini
ISCRAM19

European Commission, Joint Research Centre (JRC), Ispra, Italy

Universitat Pompeu Fabra, Barcelona, Spain
valerio.lorini@ec.europa.eu

V.Lorini valerio.lorini@ec.europa.eu, C.Castillo chato@acm.org
F.Dottori francesco.dottori@ec.europa.eu
Milan Kalas milan.kalas@kajoservices.com
D.Nappo domenico.nappo@gmail.com
P.Salamon peter.salamon@ec.europa.eu
https://ec-jrc.github.io/lisflood/
Open Source Hydrological model
This presentation

Context

SMFR

Deployment

Copernicus

JRC

EFAS GLOFAS

Collector

Aggregator

Annotator

Geotagger

case study
future dev

Integrating Social Media into a Pan-European Flood Awareness System

valerio.Lorini@ec.europa.eu
Context
Weather driven disasters are on the rise...
225 Billion USD
Total losses for natural disaster

45% hydro events
Paris climate agreement: 185 countries have committed to limit the increase of average temperature to 1.5°C

<table>
<thead>
<tr>
<th>Temperature (°C)</th>
<th>Number of Deaths</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.5</td>
<td>5,700</td>
</tr>
<tr>
<td>2</td>
<td>&gt;10,000</td>
</tr>
<tr>
<td>3</td>
<td>&gt;12,000</td>
</tr>
<tr>
<td></td>
<td>&gt;20,000</td>
</tr>
</tbody>
</table>

Dottori et al, Nature Climate Change, 2019
Copernicus Emergency Management Services

- Complementary to national efforts
- Providing European wide information to the EU’s Emergency Response and Coordination Centre (ERCC)
- Knowledge exchange on emergency management for disaster risk at European level
- Focus on Europe but available globally
Copernicus Emergency Management Services

Early Warning & Monitoring Systems
European Forest Fire & Global Wildfire Information Systems (EFFIS & GWIS)
Near real-time & historical information on forest fires & forest fire regimes

European & Global Drought Observatory
Drought monitoring and forecasting

European & Global Flood Awareness Systems (EFAS & GloFAS)
Flood monitoring and forecasting

On-demand Mapping
Rapid Mapping
24/7 on-demand and fast provision of geospatial information

Risk & Recovery Mapping
On-demand GI supporting prevention, preparedness, disaster risk reduction, reconstruction, recovery
EFAS – European Flood Awareness System

Provide complementary, added value flood early warning & monitoring products to improve the preparedness and emergency response of relevant stakeholders

different forecasting & monitoring products (probabilistic, multi-ensemble, medium-range flood forecasts, flash flood indicators, radar nowcasting, etc.)

impact forecasting (possible consequences of predicted events, e.g. flood extent, population affected)
GloFAS – Global Flood Awareness System

Provide complementary, added value flood early warning & monitoring products to improve the preparedness and emergency response of relevant stakeholders.

Different forecasting & monitoring products (probabilistic, multi-ensemble, medium-range flood forecasts, flash flood indicators, radar nowcasting, etc.)

Impact forecasting (possible consequences of predicted events, e.g., flood extent, population affected)
Isn’t it perfect???

What can go wrong???

Preparedness  ➔  Response  ➔  Recovery

valerio.Lorini@ec.europa.eu

Integrating Social Media into a Pan-European Flood Awareness System
The Seine river is rising. 2pm in Paris, Pont Neuf. More flooding coming!

Let's check social media

Encouraging results

Let's use SM

Iterative keywords refinement

On a side note...among us...by the way... If only ALL the tweets were like these...

Integrating Social Media into a Pan-European Flood Awareness System

valerio.Lorini@ec.europa.eu
Preparedness ➔ Response ➔ Recovery

Connecting flood early warning systems with social media information

Provide forecast verification

Improve situation awareness

valerio.Lorini@ec.europa.eu

Integrating Social Media into a Pan-European Flood Awareness System
Social and mainstream media monitoring can provide early information and data on hazardous events at large scale.

Social media analysis (passive, general-purpose user contributions)

crowdsourcing (active, targeted contributions requested by emergency responders)

There were not yet approaches able to provide seamless and reliable integration of this information with existing forecasting, monitoring and mapping tools.

It is difficult to process data in a time frame appropriate for emergency management.

It is difficult to provide multilingual coverage coherent with CEMS domains.
SMFR

Collector

Annotator

Geotagger

Aggregator

valerio.Lorini@ec.europa.eu
Main technical challenges

- **Twitter's API restrictions**: limit data collection
- **Lack of explicit geographical coordinates**: requires geo-coding
- **Multiple languages**: multiplies data annotation requirements
- **Language ambiguity**: requires automatic classification
SMFR architecture

Integrating Social Media into a Pan-European Flood Awareness System

valerio.Lorini@ec.europa.eu
System infrastructure

Architecture based on a “facade” REST SERVER and microservices which expose start/stop operations.

Asynchronous persistence to Cassandra leveraging on Kafka queues.

Development phases and deployment are based on containers. We use an internal Docker SWARM of 4 nodes.
Integrating Social Media into a Pan-European Flood Awareness System
NUTS-lev.2 EU = ADM-lev.2 GADM

valerio.Lorini@ec.europa.eu

Integrating Social Media into a Pan-European Flood Awareness System

Keywords:

Locations:
bbox_AlIskandariyah=[30.3369,29.5981,31.3311,30.1435]
bbox_AlJawf=[29.2072,34.9073,29.2087,34.9101]
bbox_Bursa=[40.5112,28.516,40.5669,28.5549]
bbox_Bukhara=[59.6875,10.5188,59.7448,10.5485]
bbox_Lazio=[41.2034,11.6287,42.2972,13.7103]
bbox_Liepaja=Aprins=56.0702,20.9712,56.9715,21.3264]
bbox_Mugla=[36.6496,27.2034,37.1740,20.0543]
bbox_Primorsko-goranska zupanija=[45.0393,14.1762,45.6697,15.2437]
bbox_Sicilia=[36.6437,12.4239,38.3015,15.6525]
Text classification: first attempts

Diverse training sets
Crowdsourced annotations
Multiple annotators/tweet
Typically 80%-85% accurate
Other methods (e.g., SVM)

Example Decision Tree

valerio.Lorini@ec.europa.eu Integrating Social Media into a Pan-European Flood Awareness System
CNN for text classification

S x D embedding
Initialized w/ word2vec

Convolutions
Width C

Max-Pooling
Size m x d

flood

warning

due

to

heavy

rain

\[ S = 50 \]
\[ D = 300 \]
\[ C = 5 \]
\[ m \times d = 5 \times 128 \]

• Maximum sequence length in words
• Word embeddings dimensionality
• Width of convolutions
• Size of max-pooling

valerio.Lorini@ec.europa.eu

Integrating Social Media into a Pan-European Flood Awareness System
CNN for text classification

- **Training time**: 30'
- **Training samples**: 1K
- **Accuracy**: 85%

### Embedding
- **flood**
- **warning**
- **due**
- **to**
- **heavy**
- **rain**

### Convolution

### Max pooling

### Hidden (2) dense in/out

- **YES**
- **NO**

#### Examples:
- "photos of students helping families clean up their flooded..."
  - **99% YES**
- "was having a rough day till i saw tops pics flooding my social media"
  - **39% YES**
- "reeds beach restoration aims to improve water flow, reduce flooding"
  - **2% YES**

Integrating Social Media into a Pan-European Flood Awareness System

valerio.Lorini@ec.europa.eu
MUSE – Facebook – language agnostic

valerio.Lorini@ec.europa.eu

Integrating Social Media into a Pan-European Flood Awareness System
We try to use mordecai for geolocating the most comprehensive text.

In second instance we take "place" and "coordinates" objects from the tweet.

If the geolocator cannot find lat, lon, we do not assign the tweets to the collection.

Text: Ministrul Apelor și Pădurilor în zonele cu risc la inundații din județul Sibiu.

SpaCy POS

ElasticSearch + Geonames

NER

{‘country_conf’: 0.837,
 ‘country_predicted’: ‘ROU’,
 ‘geo’: {...
 ‘lat’: ‘45.8’,
 ‘lon’: ‘24.15’,
 ‘place_name’: ‘Sibiu’} ...
Aggregating tweets per collection

Integrating Social Media into a Pan-European Flood Awareness System

valerio.Lorini@ec.europa.eu
This Talk

Deployment

- case study
- future dev

valerio.Lorini@ec.europa.eu
• EFAS forecasted a potential flood in the Calabria NUTS-2 area on the 4th of October with a predicted peak time of the event for the following day.

Several families were forced to evacuate their homes and people were rescued after they climbed onto the rooftops of houses to escape the flooding. Italian news agency ANSA, stated that the Ponte delle Grazie bridge on provincial highway 19 in the area collapsed during the storms (Redazione ANSA 2018). Vigili del Fuoco, Italy’s National Firefighters Corps, reported major flooding in Ciro Marina, Petilia de Policastro, Strongoli, Cotronei and Isola di Capo Rizzuto.

Integrating Social Media into a Pan-European Flood Awareness System

valerio.Lorini@ec.europa.eu
Case Study: Calabria Floods in October 2018

SMFR triggered a collection with a duration of 2 days that was later extended for an additional day due to persistence of the signal from EFAS forecasts.

We analyzed the collection once it was stopped, at midnight on the 7th of October, after collecting 14,347 tweets.

(cold-start) using only labeled data in German, English, Spanish, and French

(warm-start) adding 300 manually labeled tweets in Italian from the collected dataset.

valerio.Lorini@ec.europa.eu

Integrating Social Media into a Pan-European Flood Awareness System
Case Study: Calabria Floods in October 2018

$P \geq 0.8$. 

integrating social media into a pan-european flood awareness system

valerio.Lorini@ec.europa.eu
<table>
<thead>
<tr>
<th>Conf</th>
<th>Mult</th>
<th>Cent</th>
<th>Text (10 words)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>87</td>
<td>89</td>
<td>Second flood in Calabria in 40 days. Devastation and 2 casualties ... (Seconda inondazione in Calabria in soli 40 giorni. Devastazione e 2 vittime ...)</td>
</tr>
<tr>
<td>1.0</td>
<td>11</td>
<td>93</td>
<td>Bad weather in Calabria, the kennel is flooded ... (Maltempo in Calabria, il canile è 'sommerso dall'acqua ...)</td>
</tr>
<tr>
<td>1.0</td>
<td>7</td>
<td>97</td>
<td>Bad weather: Red alert in Calabria today and in Puglia tomorrow ... (Maltempo: oggi allerta rossa in Calabria e domani in Puglia ...)</td>
</tr>
<tr>
<td>1.0</td>
<td>5</td>
<td>97</td>
<td>Meteo, panic in Calabria: streams flooding roads. Rescuers using rubber boats ... (Meteo, caos in Calabria: torrenti esondati e strade allagate. Soccorsi in gommone ...)</td>
</tr>
<tr>
<td>1.0</td>
<td>5</td>
<td>87</td>
<td>Bad weather in Calabria, missing mother and her two sons found dead ... (Maltempo Calabria, trovati morti mamma e due bimbi dispersi ...)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Conf</th>
<th>Mult</th>
<th>Cent</th>
<th>Text (10 words)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>194</td>
<td>76</td>
<td>I follow with concern the evolution of events in #Calabria ... (Seguo con apprensione l'evolversi degli eventi in #Calabria ...)</td>
</tr>
<tr>
<td>1.0</td>
<td>14</td>
<td>88</td>
<td>Water bomb in Calabria, among the upset in the population ... (Bomba d'acqua in Calabria, tra la popolazione sconvolta ...)</td>
</tr>
<tr>
<td>1.0</td>
<td>14</td>
<td>46</td>
<td># breakingnews Bad weather Calabria: a woman and one of her son found dead. ... (#ultimora Maltempo Calabria: morta una donna e suo figlio, disperso il fratello ...)</td>
</tr>
<tr>
<td>1.0</td>
<td>23</td>
<td>98</td>
<td>Bad weather in Calabria, mom and son found dead, missing 2yrs old brother ... (Maltempo Calabria, morti mamma e figlio: sic erca il fratellino di 2 anni ...)</td>
</tr>
<tr>
<td>1.0</td>
<td>8</td>
<td>94</td>
<td>Bad weather, nightmarish night in Calabria, Civil Protection: “High risk” ... (Maltempo, notte da incubo in Calabria, Protezione civile: “rischio vittime” ...)</td>
</tr>
</tbody>
</table>
Exploitation SMFR outcomes

Potential
SMFR-MULTI
(all or parts of it)
could be
adapted for
other natural
disaster / health
indicators /

NOW
SMFR-EFAS
SMFR-GloFAS
31/93 languages
in MUSE/LASER

Next
SELF-SMFR
SMFR-URBAN

FIRST AID
CASE

future
dev

Deployment

Photo by rawpixel.com from Pexels

Integrating Social Media into a Pan-European Flood Awareness System

valerio.Lorini@ec.europa.eu
Integrating Social Media into a Pan-European Flood Awareness System

Any question?

valerio.lorini@ec.europa.eu
lorinivalerio@gmail.com
@valeriolorini