Port of Beirut Explosion: A Case Study in Applying Comprehensive Quality Assessments to Determine Point of Interest (POI) Reliability in Disaster Areas

Chantelle Rittmaier (Fortier), Kelly Sims, Gautam Thakur, Joseph Bentley, Jamie Wray, Kevin Sparks, David Sheldon, & Sarah Walters
Insight Specific

- Offers global coverage (OCONUS)
- More than 173 Million POIs available
- Over 12,500 data source categories transformed into a standardized schema
All POI (Point of Interest) data sources that PlanetSense collects are open and unauthoritative datasets. As millions of POIs are collected from various data sources, the accuracy of the information is not guaranteed due to the inconsistent nature of user-generated data.
Area of Interest: Beirut, Lebanon
August 4, 2020: Beirut, Lebanon Explosion

- This explosion was caused by 2,750 tons of confiscated ammonium nitrate improperly stored in a warehouse lacking safety standards that resulted in a projected loss of $15 billion (Reuters).

- Different sources were used to fully incorporate the wide variety of VGI data available.

- With a global database of spatially explicit POIs, we can leverage this as a tool for humanitarian crisis events and identify impacted areas using VGI data assessments.
Create a sample to be reviewed: 2,000 POIs

Divide Country evenly for reviewers

Begin Review Period

Assess overall accuracy among country and/or source

Assess and identify level of damage for each POI

Finalize findings in a comprehensive report

Event Occurs: Beirut Explosion

Total Dataset: 111,488 POIs

Utilize existing damage assessment datasets

Identify damage using ARIA raster data

Identify damage using Copernicus building footprints

Infer damage and assign corresponding damage flag in the 'note' field
Insight Workflow

Event Occurs: Beirut Explosion

Utilize existing damage assessment datasets

Total Dataset: 111,488 POIs

Identify damage using ARIA raster data

Identify damage using Copernicus building footprints

Infer damage and assign corresponding damage flag in the ‘note’ field

Begin Review Period

Create a sample to be reviewed: 2,000 POIs

Divide Country evenly for reviewers

Assess overall accuracy among country and/or source

Assess and identify level of damage for each POI

Finalize findings in a comprehensive report

Assess and identify level of damage for each POI

Finalize findings in a comprehensive report

Divide Country evenly for reviewers

Begin Review Period

Create a sample to be reviewed: 2,000 POIs

Utilize existing damage assessment datasets

Total Dataset: 111,488 POIs

Identify damage using ARIA raster data

Identify damage using Copernicus building footprints

Infer damage and assign corresponding damage flag in the ‘note’ field

Finalize findings in a comprehensive report

Assess overall accuracy among country and/or source

Assess and identify level of damage for each POI
**Insight Workflow**

- Create a sample to be reviewed: 2,000 POIs
- Divide Country evenly for reviewers
- Begin Review Period
  - Assess overall accuracy among country and/or source
  - Assess and identify level of damage for each POI

**Event Occurs: Beirut Explosion**

- Total Dataset: 111,488 POIs

**Damage Assessment**

- Utilize existing damage assessment datasets
  - Identify damage using **ARIA raster data**
  - Identify damage using **Copernicus building footprints**

- Infer damage and assign corresponding damage flag in the ‘note’ field

- Finalize findings in a comprehensive report
Structure Destroyed Area Estimate Zone
Prior to Explosion

Intact buildings

Structurally sound port
Structure Destroyed Area Estimate Zone

After Explosion

Destroyed buildings

Explosion crater approx. diameter 130 m
**Insight Workflow**

Create a sample to be reviewed: 2,000 POIs

Divide Country evenly for reviewers

Begin Review Period

Assess overall accuracy among country and/or source

Assess and identify level of damage for each POI

Finalize findings in a comprehensive report

**Damage Assessment**

Event Occurs: Beirut Explosion

Total Dataset: 111,488 POIs

Utilize existing damage assessment datasets

Identify damage using ARIA raster data

Identify damage using Copernicus building footprints

Infer damage and assign corresponding damage flag in the 'note' field
Facebook 2,078 POIs

FourSquare 9,423 POIs

Google 4,485 POIs

Here 8,587 POIs
OSM 3,570 POIs

TomTom 38,008 POIs

VK 3,617 POIs

Wikimapia 5,456 POIs
Area of Interest

- Every reviewed POI was assessed for name, category, and spatial accuracy in addition to being assessed for damage relevant to the explosion.
- Approximately 2,000 POIs were reviewed out of 111,488 total available POIs with a focus on Non-Residential POIs.
- Spatial trends and/or patterns were identified for individual data sources and regional cultural signatures.
**Insight Workflow**

Create a sample to be reviewed: 2,000 POIs

Divide Country evenly for reviewers

Begin Review Period

Assess overall accuracy among country and/or source

Assess and identify level of damage for each POI

Finalize findings in a comprehensive report

**Damage Assessment**

Event Occurs: Beirut Explosion

Total Dataset: 111,488 POIs

Utilize existing damage assessment datasets

Identify damage using ARIA raster data

Identify damage using Copernicus building footprints

Infer damage and assign corresponding damage flag in the ‘note’ field

Finalize findings in a comprehensive report
Reviewed POIs Results

- Every POI reviewed was assigned a confidence value based on the following questions:
  - Was the name correct?
  - Did the category correctly describe the POI?
  - Was the POI on the correct building?

Confidence Distribution by Source

- VKontakte
- Facebook
- OSM
- Google
- Wikimapia
- FourSquare
- Here
- TomTom

Legend:
- Low
- Medium_Low
- Medium_High
- High
Review Process: ABC Mall Achrafieh  

Source: TomTom
**Insight Workflow**

- Create a sample to be reviewed: 2,000 POIs
- Divide Country evenly for reviewers
- Begin Review Period
- Assess overall accuracy among country and/or source
- Assess and identify level of damage for each POI
- Finalize findings in a comprehensive report

**Damage Assessment**

- Event Occurs: Beirut Explosion
- Total Dataset: 111,488 POIs
- Utilize existing damage assessment datasets
- Identify damage using ARIA raster data
- Identify damage using Copernicus building footprints
- Infer damage and assign corresponding damage flag in the 'note' field
- Assess and identify level of damage for each POI
- Finalize findings in a comprehensive report

**Event Occurs:** Beirut Explosion

**Total Dataset:** 111,488 POIs

Create a sample to be reviewed: 2,000 POIs
Users and reporters were rapidly publishing data on locations or businesses affected throughout the city.

Google reviews or news stories would commonly describe the level of damage or show this through linked images.

Most of this information was available the same day as the explosion.

Ghazi Aboufayad
Local Guide • 149 reviews

(Translated by Google) Severely damaged.

(Original)
Gravement endommagé.
Serious damage to Saint George Greek Orthodox Cathedral in Beirut

Aug 05, 2020 | 11:17 in FrontPage, Parishionate of Antioch

Collective Action

SVPV are gathering food donations for families affected by the Beirut port explosion...Luxury

HELP HOSTEL BEIRUT AND NEIGHBORS

€3,287 out of €15,000 goal

Sarah Buchenau is organizing this fundraiser.

DEAR ALL WHO REMEMBER HOSTEL BEIRUT...
The explosion was only 1km away from the hostel and blasted all of its window doors and a lot of its furniture as well as the rest of the neighborhood area. It donate and help us rebuild the broken pieces so we can set up ways to support the neighborhood with shelter for people who have lost their homes in the explosion and set up a food kitchen for those in need.

THANK YOU!

Oak Ridge National Laboratory

Tuesday, August 4, 2020, around 6:02 p.m. local time, we saw and heard a very loud explosion so far from our residence. A big black smoke rose to the sky, the whole building was shaken, the windows blown out, the doors ripped open, the false ceiling on the floor.

A scene of desolation and massive destruction everywhere in our 11-story residence. Also, the community and St. Gregory's College were heavily damaged. Thank God we only had two minor injuries.

More than 100 people were killed and 4000 injured. The hospital, Hôtel Dieu de France run by the University of Saint Joseph did not stop treating the wounded in the corridors, the doctors were stitching up stitches. The buildings of the university and the hospital were badly damaged.
PlanetSense Insight
2,000 POIs Reviewed
PlanetSense Insight
2,000 POIs Reviewed
156 POIs Confirmed for Damage
Insight Workflow

Create a sample to be reviewed: 2,000 POIs

Divide Country evenly for reviewers

Begin Review Period

Assess overall accuracy among country and/or source

Assess and identify level of damage for each POI

Damage Assessment

Event Occurs: Beirut Explosion

Total Dataset: 111,488 POIs

Utilize existing damage assessment datasets

Identify damage using ARIA raster data

Identify damage using Copernicus building footprints

Infer damage and assign corresponding damage flag in the ‘note’ field

Finalize findings in a comprehensive report
Open-Source Damage Assessments

- **ARIA (Advanced Rapid Imaging and Analysis)**
  - Incorporated raster data in assessments
  - [https://aria-share.jpl.nasa.gov/20200804-Beirut_Blast/](https://aria-share.jpl.nasa.gov/20200804-Beirut_Blast/)
  - Release Date: August 4, 2020

- **Copernicus: Emergency Management Service**
  - Incorporated building footprints in assessments
  - [https://emergency.copernicus.eu/mapping/list-of-components/EMSR452](https://emergency.copernicus.eu/mapping/list-of-components/EMSR452)
  - Release Date: August 6, 2020 and August 12, 2020
External Data Assessments
2,728 POIs inferred through ARIA
External Data Assessments
2,728 POIs inferred through ARIA
1,547 POIs inferred through Copernicus
Total Inferred Damaged POIs: 4,275 POIs
Future Work & Applications

• Paper is currently being written that analyzes 100,000 POIs that have been reviewed over the last year
  – Cultural and spatial patterns for eight different sources across a variety of countries

• Upcoming AAG Presentation:
  – Joseph Bentley on April 9, 2021 at 8:45 am PST
  – A Spatio-Semantic Approach for Quality Control of Global Point of Interest Data
Questions?

- Contact: Chantelle Rittmaier (Fortier), rittmaiercm@ornl.gov
- For more information, please visit https://planetsense.ornl.gov/

PlanetSense

- Demonstrating PlanetSense: gathering geo-spatial intelligence from crowd-sourced and social-media data (Thakur, G. S. et al., 2016)
- PlanetSense: a real-time streaming and spatio-temporal analytics platform for gathering geo-spatial intelligence from open source data (Thakur, G. S. et al., 2015)
- SONET: a semantic ontological network graph for managing points of interest data heterogeneity (Palumbo, R. et al., 2019)

Copyright: This manuscript has been authored by UT-Battelle, LLC under Contract No. DE-AC05-00OR22725 with the U.S. Department of Energy. The United States Government retains and the publisher, by accepting the article for publication, acknowledges that the United States Government retains a non-exclusive, paid-up, irrevocable, world-wide license to publish or reproduce the published form of this manuscript, or allow others to do so, for United States Government purposes. The Department of Energy will provide public access to these results of federally sponsored research in accordance with the DOE Public Access Plan (http://energy.gov/downloads/doe-public-access-plan).

Acknowledgement: This material is based upon the work supported by the U.S. Department of Energy under contract no. DE-AC05-00OR22725.