8. Big data for crisis anticipation and crisis management

8.1 Focus of the use case

The Oxford dictionary defines crisis in two ways:

> *"A time of intense difficulty or danger" or*
>
> *"A time when a difficult or important decision must be made".*

Crisis, therefore, is an integral part of policymaking. At the same time, a crisis is a unique situation in the policy chain. On the one hand, there are measures that can be taken before events in order to prevent financial, social and environmental damages that the event can cause. On the other hand, some crises cannot be prevented, and their damage cannot be minimized. In these cases, the policy makers need to make fast decisions that will help to support the efforts at the scene of the crisis. In this case study, we will look at how data can assist both anticipating crises and manage it. Both are complex and require multiple data sources in order to get a comprehensive analysis and best results.

There are many types of crises. Lerbinger defines eight types of crisis.[52] From these eight, this use case will look at the following crises:

- Natural crisis: A crisis that is usually not caused by humans but by nature. These are usually environmental phenomena and not always easy to predict. They are also known as disasters.
- Confrontation crisis: Discontented individuals and/or groups fight businesses, government, and various interest groups to win acceptance of their demands and expectations.
- The crisis of malevolence: Opponents or individuals use criminal, violent means or other extreme tactics for the purpose of expressing hostility or anger toward, or seeking gain from, a company, country, or economic system, perhaps with the aim of destabilising or destroying it.
- Technological crisis: When manmade technologies suffer from a bug or fault. This can happen as an accident, faulty treatment or malfunction. A technological crisis can also have serious environmental implications.

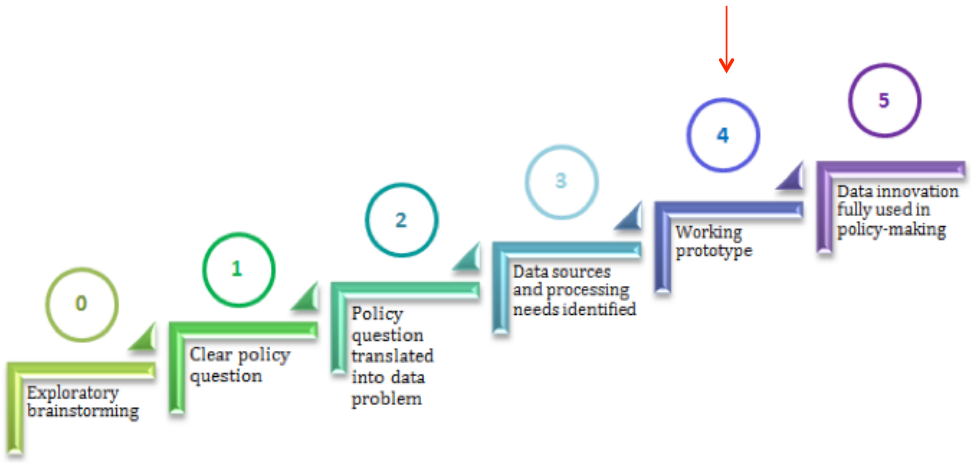
This use case will not examine crises within organisations (misdeeds, rumours and workplace violence). These types of crisis have different characteristics and have a different method of crisis management.

It is important to note that some natural or technological crises can be predictable or anticipated, due to the fact that there are patterns that can warn us when a crisis will start. People, however, are less predictable and are harder to anticipate.

This use case refers to big data applications that are already used in policymaking, although this mostly concerns natural crisis and crisis management rather than crisis anticipation. Overall, the readiness of this use case can be assessed as level 4 (next page).

[52] Lerbinger, O. (1997). The crisis manager: Facing risk and responsibility. Mahwah, NJ: Erlbaum

Figure 15 Use case readiness level



8.2 The rationale

In the past, data on crises was limited to a few data sources, usually mapping and real-time sensors. Technological advancements and the internet have brought new data sources that allow policymakers to understand the state of play before, during and after the event. This allows policymakers to use data for creating tools for two main goals - predictive, anticipatory crisis management and crisis intervention and in itinere/ex-post management.

For predictive crisis management, in measuring and evaluating data on a regular basis, researchers can find anomalies in the data and create algorithms that can sometimes predict crises, for example, volcano eruptions.[53] By using these methods, early detection can help save lives and minimise social and financial damage. Gathering huge amounts of real-time data during a crisis can be analysed and in return find new patterns that will allow us to anticipate future crises.

When a crisis cannot be prevented or minimised, it is important for policymakers to get a clear picture of the current situation at the location of the crisis. Social media and cell phone data have been used in the last decade, adding to sensors, geospatial data, and reports from the ground.

Real-time gathering and analysis of data can assist policymakers throughout the whole of the policy cycle and allow flexibility. Monitoring allows for identifying the policy problem, then to tailor the solution to it, and modify if needed. Since the crisis is a state of emergency and needs clear fast decisions, real-time data allows policy makers to become agile and to react promptly. The cross-referencing of data and creating a database accordingly allows policymakers not only to evaluate the policy work but also to help in future anticipation of crises. Lastly, data can help in the evaluation of reconstruction efforts.

8.3 The policy context

The main organisation that is responsible for crisis assistance outside of the EU is the European External Action Service, which is connected to EU's Common Foreign and Security policy. The service was initiated as part of the Lisbon treaty, and it aspires to increase responsiveness to crises and emergencies outside of the EU that require ad-

[53] Voight, Barry. "A method for prediction of volcanic eruptions." *Nature* 332.6160 (1988): 125-130.

hoc decision-making. The EU does not work alone in the international sphere, and coordination is needed with the UN and other INGOs that are operating in the field.

The EU has a joint project with the UN, the Global Disaster Alert and Coordination Systems (GDACS)[54], which gathers data to improve alerts and help in coordination during a crisis. It is mainly used to help fill the information gap in the first phase after a major disaster. It is used by policymakers to assess the event and manage the disaster. The EU also operates the ERCC, - the European Response Coordination Centre that coordinates response to crisis situations in the EU and outside of it.[55]

In addition, the EC established Copernicus, a central database that aims to gather every piece of information on earth in order to monitor it. The system has six thematic areas - land, marine, atmosphere, climate change, emergency management and security. In the theme of emergency management, Copernicus helps by providing maps based on satellite imagery. They may also be combined with other data sources (e.g. digital feature sets in a geographic information system) to support geospatial analysis and decision-making processes of emergency managers. This mapping can support all stages of the crisis: preparedness, prevention, disaster risk reduction, emergency response and recovery.

One of the systems that is based on Copernicus data is the European Flood Awareness System (EFAS). EFAS idea was born at 2002, after the Elbe and Danube river floods. It can assist in forecast and prevention of floods by gathering and forecasting data on floods across Europe and can give information up to ten days in advance.[56] Besides Copernicus, it uses hydrological data collection such as present and historical water data and meteorological data.

8.4 The data process: from data collection to analysis and visualisation

Data sources

Crisis data is gathered from many sources at different times. In both anticipating and monitoring a crisis, data can be images, text, video or sensor data. Image data for crisis is usually satellite images of the crisis area. In addition, there are maps which are created based on the data and updated in a timely way (such as model output data, priority areas, and baseline data). Textual data is common when a crisis is already happening. Social media, and specifically Twitter, can be used to understand the situation live from users reporting. Videos and news data are common as well as part of the media reporting from the ground. Sensor data is used in technological or natural crises and allows anticipating or monitoring values in real time.

The data collection process

Imagery data is collected via satellite, usually on timed slots. They can be, if needed, be taken ad-hoc. It is part of the coordination efforts and can also be used as a layer to enrich other map data and to create a better picture of the event.

Satellite imaging data continues to be a relevant data source for anticipating and monitoring natural disasters. It is used for informing policy makers and supporting operational crisis management. One example is using satellite data for drought monitoring. A partnership that includes the United Nations ESCAP (Economic and Social Commission for Asia and the Pacific) and several national and ministries and agencies operates The Regional Drought Mechanism[57]. This mechanism integrates

[54] http://portal.gdacs.org/data
[55] http://ec.europa.eu/echo/what/civil-protection/emergency-response-coordination-centre-ercc_en
[56] https://www.efas.eu/
[57] "UN initiative strengthens drought monitoring and early warning in Asia-Pacific", 1 July 2014, UN ESCAP press release.

organizational support and technical tools for access to satellite data, developing Geographic Information Systems, using data analytics and exploring policy implications. For example, indications of increased drought are used to provide recommendations for using different or fewer crops, extend water buffers and improve irrigation, and thereby reduce risks such as extreme drought, floods, landslides and food scarcity. Satellite data about crop land use is linked to meteorological data. This allows for more precision when anticipating risks that are triggered by heavy rain and cyclones.

Several related initiatives by UN ESCAP and partners concern so-called Regional Multi-hazard Estimated Risk Maps.[58] Here, data about drought, climate and weather is mapped and linked to data about faults (that create risks for earthquakes), population density and vital infrastructures. Combining these datasets not only allows for calculating the likelihood of hazards but also for predicting their magnitude and provide early warnings. This information is used to prepare for effective crisis management by means of installing coordination/governance structures and training disaster response teams.

Media outlets report during disasters via traditional news channels such as radio or television. The collection of the data can be done manually by recording the source. Today, media offer online versions to their broadcast audiences. These can be scraped and analysed with text mining to offer new angles on current events.

In addition, text can be collected from social media. During a disaster, Twitter operates as a broadcaster, which means helping people in the affected area to understand and assess the situation they are in and help in the coordination of efforts.[59] Twitter may also help to analyse the event after the first stage of assistance, to allow better practices in the future. Facebook also started to react to crises by adding the feature "Safety Check". The social network allows people in the disaster area to report that they are safe to other users, giving it more viability than other posts.[60]

In addition to social media, there are also crowdsourced platforms. Ushahidi, an open source community, provides an array of tools that use citizens reports, through mail or mobile phones, to report on current events. The platform was created to monitor violence during elections in Kenya, and is known to be very affective in monitoring events or acts of violins in confrontational or malevolence crisis. Ushahidi also offers the product Crisis.net, a database that collects data from crises around the world and allows policymakers to analyse it for ad hoc or future policy implementation. From riots to epidemics or protests, Crisis.net allows policymakers to monitor many types of crisis in real-time streams.

In addition, open data can also assist in supporting and predicting a crisis. The set of Humanitarian Data Exchange projects allow multiple stakeholders to share their data on a special portal, which allows other users to analyse it.[61] Currently, the main use cases are related to natural disasters such as the Ebola apedimic and El Niño, but other types of data that are related, such as immigration data, which can be relevant for confrontational crises, can be added as well.

Lastly, there is sensor data. This data is collected on a continuous basis and allows anticipation or signalling of events that are about to happen, for example when weather data can help predict hurricanes and other deadly storms. In addition, sensor data can be collected from users, such as mobile phone SIM data (that are linked to Call Detail Records) which can be used to assess how many people were involved in

[58] N. Vinod Chandra Menon (2014), "Working Paper on the Road Map for the Asia Pacific Centre for Disaster Information Management (APDIM) in the Context of of the Multi-Hazard Risk, Vulnerability and Exposure Profile."
[59] https://media.twitter.com/best-practice/using-twitter-in-a-crisis
[60] http://www.technologyreview.com/view/419368/how-twitter-helps-in-a-disaster/
[61] https://data.hdx.rwlabs.org/

the event. Other types of sensors, such as temperature sensors, can be installed in specific areas and help to detect fire. In California, these types of sensors have been installed in forests and help to detect fire in forests earlier.[62]

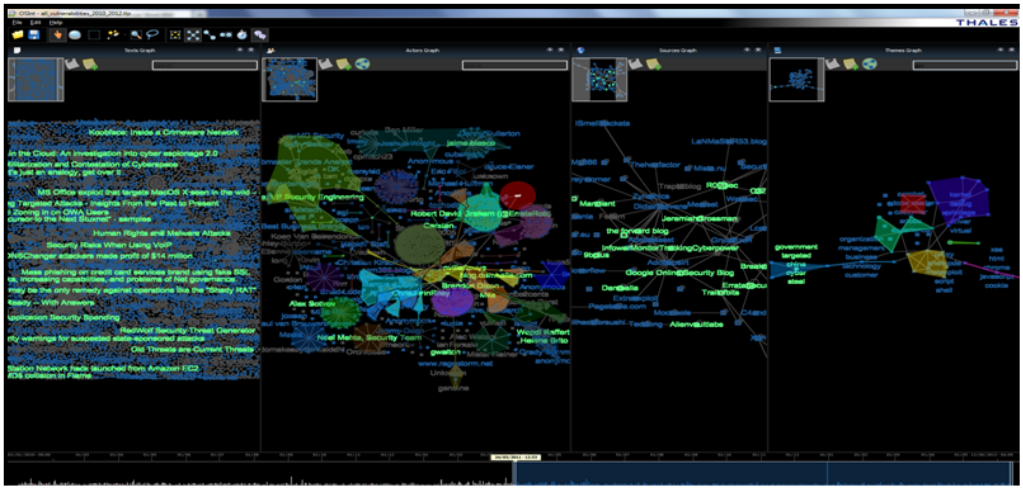
More in general, early warning systems are among the priorities of the international disaster risk reduction community. PreventionWeb provides an overview of partnerships and systems in place for anticipating, monitoring and addressing natural disasters. PreventionWeb is created and co-funded by the UN's UNISDR (Office for Disaster Risk Reduction) with additional support from the UPS Foundation and the European Commission (Directorate-General for Humanitarian Aid and Civil Protection).

Data analytics and visualisation

Since crisis data comes from various resources, it is important to cross-reference and aggregate them to get as much of a complete assessment of the situation as possible. The GDACS uses different maps to show different variables about a current view. Maps can be baseline maps, situation specific maps, damage assessments and web maps.

In addition to physical maps, there are also maps of the virtual world which are important when it comes to a cyber crisis. Thelas allows anticipating cyber crises by using social networks' maps of threats in the web.[63]

Figure 16 Network mapping of Thales



In addition to network analysis, text mining has been used in the past to find common elements which can help predict a future crisis and help us deal with it better. The United Nations Global Pulse Initiative uses big data practices in crisis prediction and management. They have used sentiment analysis, a method in which sentiment is extracted out of the text in order to be analysed and track immunization awareness. This helps practitioners to deduct vulnerable places in which diseases can break out.[64]

Censoring phones can also be a big part of crisis management and anticipation. Analyzing movement of people before and during a fire can help assist during flood

[62] http://www.feweb.vu.nl/gis/publications/docs/Review%20of%20emerging%20technologies%20for%20crisis%20management.pdf
[63] https://www.thalesgroup.com/en/worldwide/big-data/thales-early-warning
[64] http://www.unglobalpulse.org/sites/default/files/UNGP_ProjectSeries_Immunisation_Awareness_2015.pdf

rescue missions. Phones calls are used more than texting during states of emergency, and censoring them can help identify where the most critical areas are.[65]

8.5 Reflections on challenges and next steps

Crisis data can help policymakers save lives, rebuild infrastructure and improve the environment. There are many sources of data that already exist today that can assist policymakers in creating ad-hoc policies for crisis data. Tools from civil society and government are already in place to assist in the coordination during the event. Data is then available for analysis to help improvements of processes.

Different types of crisis needs different data sources, and there is no one size fits all type of solution. Social media sentiment analysis can help predict riots or show people in distress during an event, but it cannot predict a storm. In addition, it is also important to consider issues of privacy. In the case of Facebook for example, it is unknown if the data can be available for policymakers without risking users privacy. Moreover, Facebook's crisis related services are new, and it is hard for the company to determine when and where to operate it.

Sensory data is important for the anticipation of crises and big data analytics allows for identification of patterns for examination. The use of sensory data is different during an event, in which it is used for helping agencies on the ground.

Sharing data between agencies, citizens and media allows for quicker and more reliable assessments, since multiple resources allow 'reality checks' and validation of data. It also allows for innovation and new thinking in the field of crisis management which contributes to pollinations of ideas between different stakeholders and better cooperation.

Further reading

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[65] http://www.unglobalpulse.org/sites/default/files/UNGP_ProjectSeries_Tabasco_Flooding_2014_0.pdf