Big Data for PeaceBuilding

Isha Terdal

G32086729

Introduction to Big Data and Analytics

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Abstract

Data is changing the world as we know it. Information and Communication Technologies (ICTs) have made their way into several aspects of development, whether it is social media analysis for humanitarian aid or SMS crowdsourcing to prevent violence during elections. Data is being produced at an astounding rate through the use of these technologies. If this data is harnessed efficiently, it can enable better decision-making for leading actors in the process and frugal utilization of the resources available for development efforts. The field of conflict resolution and peacebuilding can similarly benefit from the immense amount of data being generated everyday. Big Data for Peace and Security is an interdisciplinary field which requires inputs from both development experts who understand the social, political, and economic facets of conflict environments and technological analysts who can process the available data and interpret the results of their analysis in the relevant context. The first step in this initiative would involve gathering raw, on-the-ground data from viable sources, and storing them for real-time retrieval to observe changes over a period of time. Creating such datasets requires the aggregation of data from myriad sources, cleaning and standardizing the data to remove any identifiable bias that may affect the results, as well as anonymizing the data in order to protect individual privacy. This data accumulated over multiple timeframes can then give the agents involved a realistic idea of the online or ground-level trends that indicate a potential conflict situation. Mass displacements, migration of populations, and hate speech propagation on social media can show an escalating situation anywhere in the world, provoking timely preventive measures that could save the lives of unaware communities in the conflict area. In case of post-conflict scenarios, data could be used by intervening international agencies to determine the best system of governance and humanitarian laws to be established that will help the people of the region get back on their feet. Overall, data can be the game-changer for peacebuilding initiatives and this paper outlines the numerous sources of data that can be used to bring peace in the world.

Introduction

Data is a phenomenon in today's world - it is happening every day, every minute, and every second. 90% of all the data that exists today was created in the last two years alone, which can be approximated to 2.5 quintillion bytes of data per day [1]. These never-ending streams of data must be collected and processed in real-time in order to stay relevant and undertake timely responses, especially in the case of conflict situations. This paper seeks to explore two concepts: 1) the myriad sources from which viable data can be collected and 2) the potential uses of the data from each source in security and peacebuilding operations.

Big Data is generally defined as "data that is too big to be handled by conventional processing approaches". It is generally characterized by the three Vs: Volume of data, the Variety of forms in which data is being produced, and the Velocity at which data is created and collected. An important additional characteristic that must be taken into account is the data Value. Data Value measures the usefulness of data in making decisions[13] which is instrumental in setting the foundation upon which human lives depend.

Creating transparency by making big data openly available for business and functional analysis (quality, lower costs, reduce time to market, etc.)
Supporting experimental analysis in individual locations that can test decisions or approaches, such as specific market programs
Assisting, based on customer information, in defining market segmentation at more narrow levels
Supporting Real-time analysis and decisions based on sophisticated analytics applied to data sets from customers and embedded sensors
Facilitating computer-assisted innovation in products based on embedded product sensors indicating customer responses

Table 1. Value Created from Big Data

The standard definition has been adopted by UN Global Pulse, the arm of United Nations that works on harnessing the power of Big Data and other emerging technologies for sustainable development and humanitarian action [14], and which can be considered the definitive authority undertaking substantial number of projects in the technology for peacebuilding field. Their goal is to not just use data for making decisions in the implementation of developmental projects, but also to measure the impact and efficiency of their undertakings. In a sector where technical expertise is a luxury, the work of the UN Pulse Labs is pioneering efforts to equip decision-makers with toolkits and applications that bridge the gap between development and technological experts.

Such a blending of human and computer analysis is essential to maintain a key aspect of data: context. The background and timeframe in which the data was collected must be articulated so as to give the policymakers and stakeholders a clear picture of the basis and implications of their decisions. Systematic collection and storage of data and its metadata can allow for its proper classification and categorization which makes it easier to analyse, and also conduct a comparative analyses to recognise trends occurred over specified periods of time.

Moreover, people tend to use Information and Communication Technologies in certain ways, inadvertently producing patterns in the data that can then be identified during its analysis. Data processing primarily constitutes finding these patterns in the data. In terms of peacekeeping, the UN Global Pulse highlights the potential use of real-time, long-term data as “digital smoke signals” [7] for identifying the slow onset of crisis situations. The idea of ICTs serving a dual-purpose i.e. improving the quality of life for people by providing digital access while serving as ground-level sensor networks for changing social scenarios, has profound implications in the early detection and prevention of conflict situations.

The following table categorises the technologies available for early warning and response in conflict situations into four distinct generations as follows -

Generation	Location	Objective	Technology
1st Generation Since 1990's	Headquarters	Conflict detection	• Expensive, proprietary technology
2nd Generation Since 2000	Headquarters with stronger links to networks in the field	Conflict detection with limited response (mainly recommend-ations)	• GIS and satellites • Internet (email & websites)
3rd Generation Since 2003	Conflict areas with local networks included in the system	Conflict detection with stronger links to response mechanisms; monitors often serve as "first responders"	• Proprietary software with structured reporting & coding protocols • Mobile phones • GIS and open-source satellite imaging
4th Generation Since 2008	Conflict areas with less central-ized organizational frameworks	Decentralized two-way informa-tion service for collection and dissemination	• Free and/or open source technologies, especially mobile phones

Table 2. Four Generations of Early Warning and Response

Once the relevant data has been collected and pre-processed, machine learning techniques can be used to derive meaningful information from the myriad types of data inputs. The advantage of using machine learning models for analysis is its ability to integrate diverse factors such as commodity prices, cell phone records, and geospatial data records to produce an all-round view of the current scenario, as well as predict several possible outcomes of peacebuilding solutions implemented.

Data Collection

Nowadays, data is readily available simply through people's regular use of technologies such as cell phones, web searches, and social media posts among other forms. Known as "data exhaust" [8], this data is being generated at an exponential rate and is the best source of real-time and freely available data there is. This explosion of data presents a unique opportunity for policymakers and other peacebuilding stakeholders to tap into pulse of the community or region they are working with.

There are two ways in which data can be collected - actively and passively. Active data collection entails direct and intentional user participation. The analyst can easily classify the data being collected into distinct categories for analytical model training. For example, data collected via surveys can be labeled and classified since the parameters being evaluated are known. Conversely, passively-collected data is obtained from the "data exhaust" mentioned above, where the end users are not consciously aware of their contribution. This type of data can come in various forms and thus needs to be cleaned and processed in order to be of use. Publicly available social media posts in the form of videos, text, and images form a major part of passively collected data.

Big Data in Peacebuilding

Big data plays a promising role in conflict situations. The myriad forms of data discussed in this paper can help define the continuously changing data, highlight patterns that indicate drivers of conflict, and identify prime indicators that can provide relevant information in a timely manner. All the data sources described in the paper can be classified into five major categories -

1) Data Exhaust

The data generated from the use of digital services such as email, online transactions, web searches and others constitute the data exhaust. This data provides a first-hand view of user behaviour and ideologies, forming a networked sensor through which data can be collected.

2) Online Information and Media

Web content browsed, the news article you clicked on, radio, television subscriptions, and social media likes are all building blocks of a user profile that provide insight into their thought processes and beliefs.

3) Physical Sensors

Security cameras, biometric identifiers, and GPS tracking are some of the physical sensors that prove to be rich sources of information.

4) Crowdsourcing

Data that has been gathered from the actors involved in the initiative is known as crowdsourcing. There are several advantages and disadvantages to collecting data from such an open source which are highlighted in the relevant section below.

5) Open online datasets

Datasets that have been built over a long period of time with contribution from various members in the community who have an interest in the benefits of such datasets. For example, Hatebase.org [15] provides an extensive list of terms used in hate speech.

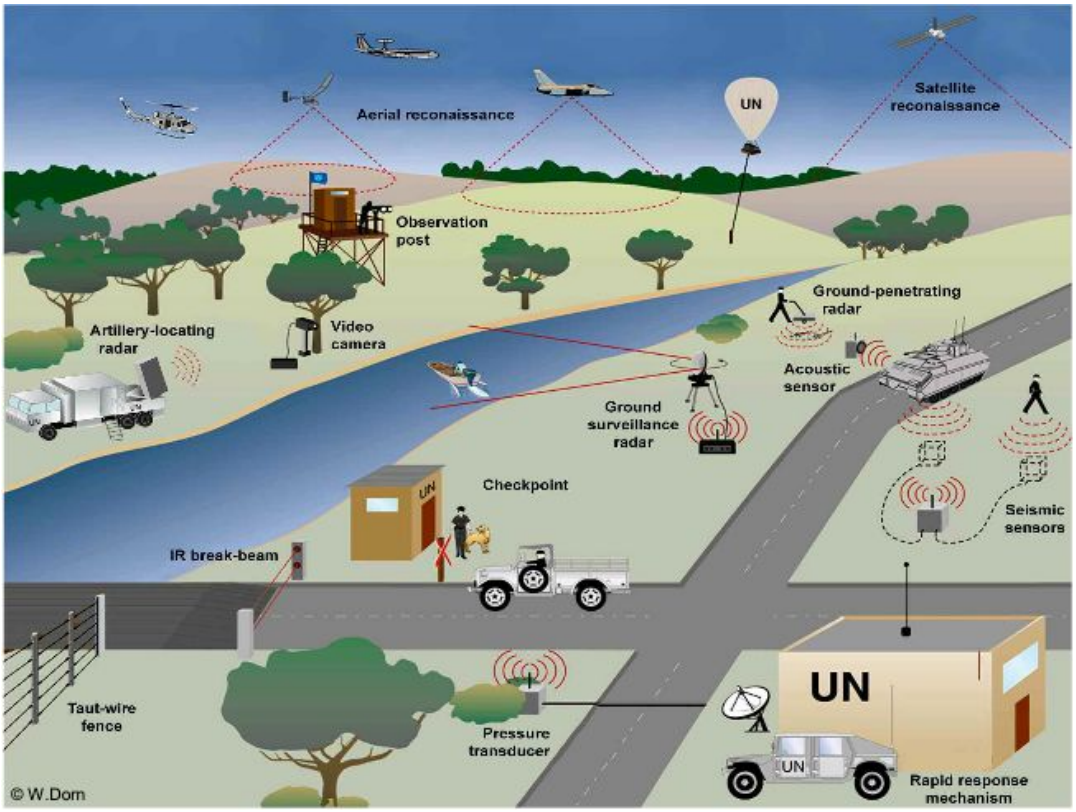

Figure 1. Monitoring technology in peacekeeping operations

Data Sources

1. Call Detail Records (CDR)

It is estimated that approximately 5 billion people around the world own mobile devices, and over half of these devices are smartphones [2]. Developing economies in particular are increasingly adopting cell phones, increasing the last mile reach of data collected from cell phones. Mobile phone penetration has reached 69% in Africa and 89% in Asia and Pacific, with higher growth in Africa than in any other region [3]. This makes call data a crucial source of information for various reasons.

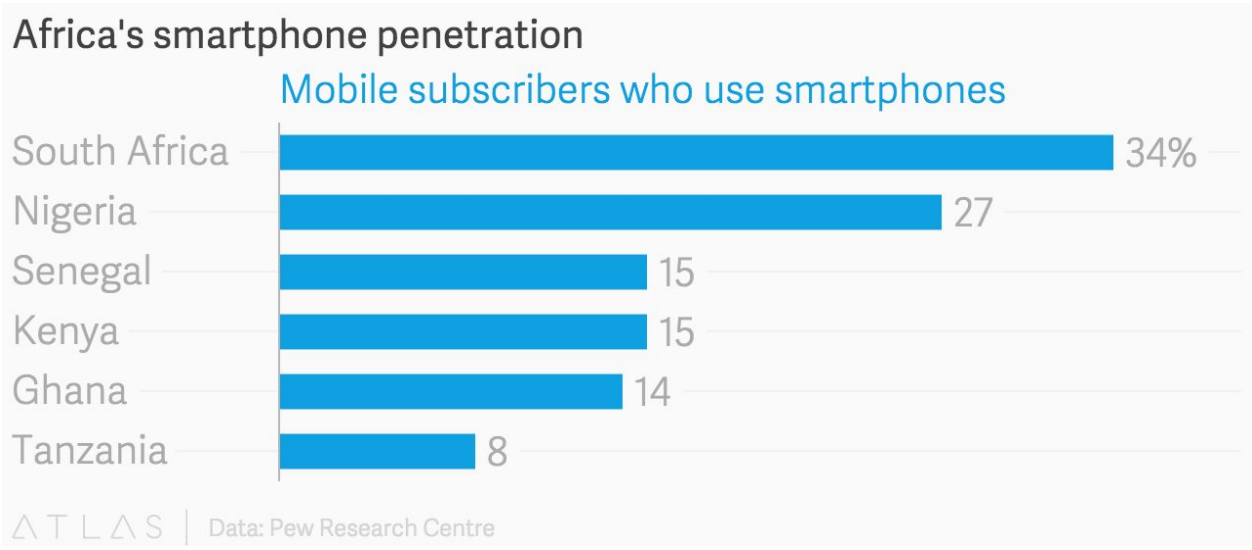

Figure 2. Pew Research Center, 2013

Call Detail Records (CDRs) collected by cellular service providers for billing purposes contains information about each time a user makes or receives a voice-call or a Short Messaging Service (SMS). In case of smart phones, internet-data access records are also stored in the database. The most important piece of information that this data can provide is location references for each cell phone to the nearest cell tower.

Location information can be crucial in detecting migration trends, or in the aftermath of a disaster, when real-time location information can enable connectivity between affected communities and aid workers. Migration is known to be a primary driver of conflict, and Call Data Records are the best way to track mass displacements. Since the number of towers are greater in number in urban areas than in rural ones, it is easier to determine locations with greater accuracy in urban areas. Global Positioning Systems (GPS) enabled smartphones are even more straightforward to track and place on a map.

The caveat is that voice-call and SMS information require active participation[4] from the users in order for data to be generated i.e. they have to be making or receiving calls and text messages in order for data to be generated. Internet-data access information on the other hand, can collect data passively in the background with no initiation from the user. Many applications (such as weather services and phone tracker in case of theft) require location information in order to operate and this is how user locations can be tracked.

The biggest risk in implementing this method is that it is vulnerable to infringement of privacy laws. Even if the data is anonymized, it is susceptible to leaks of personally-identifiable information. Therefore, it is critical to ensure the safe and secure use of data only for peacekeeping purposes.

2. Satellite Imagery

Satellite images enable peacebuilding agencies to map changes over time geographically. It is particularly useful in mapping remote as well as security-constrained areas from where it is difficult to obtain any data. Nevertheless, the general impression surrounding geospatial data in the peacebuilding community is that it is expensive to obtain the images and requires a high level of technical expertise to interpret the data and explain findings to produce actionable intelligence.

There are several ways around these problems. The resolution of images and the frequency with which they are to be captured will determine the cost incurred. The image resolution of the pictures can vary from 30 cm to 30m, covering areas ranging from 25-100 square kilometers [5].

The following table provides cost estimates for several Satellite Imagery Providers -

Provider	Resolution	Cost	Frequency	Notes
Google Earth	Low - 15m	Free	None	Difficult to determine date of image. No historical archive.
Landsat	Low - 30m	N/A	Daily	Longest running satellite program in history.
UNOSAT	High	Free	24 - 72 hours	Only available in contexts of humanitarian crises
Low Cost (Planet)	Low to High - From 300m to 3m, highest resolution 72cm	Price determined by resolution	12 - 72 hours	On demand, real time imagery
Commercial – Archive	High - Up to 30cm	$300-500	12- 24 hours	Imagery that was already collected and is available from an archive
Commercial – Commissioned	High - Up to 30cm	$1,650-7,000	24-72 hours	On demand, real time imagery

Table 4. Satellite Imagery Providers

As shown in the table above, there are free as well as commercial options available that offer satellite images based on demand and quality required. The choice will depend upon the time frame and resolution requirements. Generally, conflict situations build up over a period of time and hence images sourced through UNOSAT or private companies like Planet provide the most feasible choice for integrating satellite imagery into peacekeeping.

The United Nations Operational Satellite Application (UNOSAT) program provides high quality geospatial data to UN Agencies for mapping, analysis, and other purposes relevant to humanitarian efforts. The most well-known use case of UNOSAT was the monitoring of Syrian grounds for four years through publicly available images. The data collected over time showed the movement of weapons to areas with anti-government opinions, and the increase in the number of cemeteries and grave sites that corresponded with that movement. Neighbouring countries were alerted of the possible population flow that may occur as a result of this precarious situation, and help avoid conflict that arises through sudden movements of large number of people.

In post-conflict environments, geospatial datasets can provide insight into the relationships, events, and patterns that bring about violent situations or conflict with the goal of effectively navigating complex situations to engage in peacekeeping deployments. Satellite Imagery is used during ceasefire and peace agreements to establish 'geo-locations for lines of disengagement, deployment, assembly points, demilitarized zones and monitoring positions' between the conflicting parties and a mediating authority[6].

Additionally, visually representing data gathered from Geographical Information Systems (GIS) can be used in the stabilization efforts for post-conflict regions [6]. Traditionally, maintaining peace in the aftermath of a conflict situation required constant patrolling and assessing the on-ground situation via military deployment. GIS data allows peacekeeping actors to assess the situation before any kind of active deployment on the ground. In this way, they can keep an active surveillance on developing situations in the area that may lead to recurrence of fighting and violence, and respond to any escalating situations in a timely manner based on real-time geospatial information.

2.1 Crowdsourcing Satellite Imagery

To overcome the cost factor of accessing geospatial data, the option of crowdsourcing can be considered. Also known as "microtasking", crowdsourcing allows volunteers from across the globe to geo-tag objects seen in a satellite image before they are input into a machine learning model. Once the machine names the object based on the geo-tagged data, it is passed to a human analyst for confirmation. Such a system not only reduces data processing costs for peacekeeping agencies, but avoids the shortcomings of both participating actors i.e. the machine processed data takes into account the context and history of the data point due to human intervention, while the machine-trained data manages to sidestep the human error in judgement that tends to enter when all the analysis is conducted by human actors.

Perhaps the only limitation for satellite images that is beyond our control are the weather conditions over the region from where a satellite image is to be captured. Cloudy conditions restricts clear access to the ground-level view even at low resolution. An alternative for such a limitation is the deployment of drones.

3. Drones

If capturing high-resolution (3.5-8 cms) images of the ground consistently over a duration of time is the end goal, drones are the best data-generating machines for the job. They can cover an area of upto 3 kilometers during a single flight, which is less than the geographical area scanned by satellite images, but the ease of deployment and minimal costs incurred make them an attractive option to consider. On the other hand, hovering drones specially in post-conflict areas are not a welcome sight and may cause panic in the local communities. Hence, there are multiple steps involved in the deployment of drones in a conflict-affected region [9]:

3.1 Preparation

The deployment of drones needs to be approved by the local government agencies, and crowds must be sensitized to the sight of drones in the area. Since drones are primarily associated with the military, it could lead to panic and tension among the locals in the area unless they are aware of its benign nature.

3.2 Data Collection

Flight routes of the drones need to be decided and should be maintained within the approved area of deployment. The equipment for data capture must also be setup in order to capture and save the data gathered during flight.

3.3 Data Processing

At this stage, the data gathered by the drones will be input into data processing systems such as machine learning models to produce a visualization or any form of depiction that makes it easier to conclude information moving forward for peacekeeping actors.

3.4 Data Analysis

The information produced in the previous step is interpreted and presented to development and peacekeeping decision-makers for analysis.

The biggest advantage of drones is that they can make data available as and when required at a relatively low cost. Drones used for mapping range from $6,500 to $20,000, while one providing live video feed will cost anywhere between $2,000 and $40,000. Technical expertise should not be a prohibiting factor in its consideration for use, since it can easily be learnt for basic operations. Despite its many merits, drones are difficult to deploy especially in conflict areas since they require deep sensitization among the crowds.

4. Social Media Analysis

Analyzing the spread of hate speech through social media has become one of the most pivotal methods of detecting the potential rise of conflict. Social networking platforms have zero cost of accessibility, and yet their reach extends to billions of users [12], making it the optimal medium for distribution of hate messages and misinformation against a person of interest or an entire community. Companies like Twitter and Facebook are setting up automated systems to identify incendiary speech terms. This involves crowdsourced labeling or machine learning models that can classify each post into a positive, neutral, or negative category. In this way, a "lexicon" of hate speech terms is created that can be used to train machine learning models to flag and remove any posts that aim to use the platforms to instigate conflict or hate.

Twitter	% posts	Whisper	% posts
I hate	70.5	I hate	66.4
I can't stand	7.7	I don't like	9.1
I don't like	7.2	I can't stand	7.4
I really hate	4.9	I really hate	3.1
I fucking hate	1.8	I fucking hate	3.0
I'm sick of	0.8	I'm sick of	1.4
I cannot stand	0.7	I'm so sick of	1.0
I fuckin hate	0.6	I just hate	0.9
I just hate	0.6	I really don't like	0.8
I'm so sick of	0.6	I secretly hate	0.7

Table 5. Top Ten Hate Intent Terms in Twitter and Whisper

A crucial facet in this source of information is the consideration of context of the situation. For example, natural language processing techniques still need to find ways to spot a sarcastic comment or a synonymous meaning. The language in which the post is written must also be taken into account before it is analysed - translation into a standardized language such as English could result in loss of original meaning and intent. In this case, human intervention (community locals in case of conflict data) can help decode the context in which

those terms are used to indicate the intensity of the situation. Such coordination between humans and natural language processing techniques can lead to better quality of data being produced for analysis.

5. Radio

Radio is still one of the primary means of information dissemination in certain developing countries, especially in remote areas where web or mobile based technologies have not yet achieved traction. The need to source data from radio arises due to the fact that it can be used as a powerful tool to shape opinions among local communities and spread misinformation that may give rise to conflict. It provides insight into the opinions and sentiments among local people. The process of radio speech analysis typically follows three steps -

5.1 Voice Sample Gathering

A voice feed obtained from live radio streaming or recorded during airtime is input into automated speech recognition software where machine learning algorithms work on removing “noise” from the source and producing a clean stream of audio.

5.2 Speech-To-Text Conversion

The speech from the clean audio sample is then converted to text with the help of voice recognition software. The speech may also be in the vernacular language and hence require translation to English, which is easier done in text form. “Radio Content Analysis” converts public radio broadcasts into a machine-readable format by converting it into text form. A popular tool of choice for this conversion is the Google Speech Advanced Programming Interface (API), which uses neural network programming to convert text to audio. Moreover, it can also process this conversion on real-time, streaming radio input using machine learning. Once the text version of the radio sample has been created, the words and phrases can be classified for analysis.

5.3 Text Analysis

Text analysis methods are then applied to the text version of the radio sample, where classification techniques can be used to create and identify a database of hate speech lexicon or indications of incendiary language that could indicate a possibility of conflict.

6. Image Recognition

Images are a powerful way to promote messages that shape opinions of the public. Distributed via the Internet and social media platforms, carefully tailored images can reach out to unassuming individuals who are vulnerable to the negative messaging being shown to them. Over time, as individuals are constantly exposed to similar types of images, the effect can be the rewiring of social opinions against targeted individuals or groups.

A case in point for the spread of conflict-inducing mind programming via image distribution on social media is the ISIS propaganda. The Islamic State of Iraq and al-Sham (ISIS) used pictures published online in order to establish its basis as a religious authority. Carefully curated images were directed towards Muslim actors with the goal of recruiting them as fighters and expanding their credibility and legitimacy as an caliphate[17].

Google, Facebook, and Twitter are continuously analysing images being put up on their platforms for hate speech detection. In a process similar to radio data gathering indicated above, firstly, any text in the image is extracted and compared to the “lexicon” of hate speech already derived from training models. Objects in the image are then tagged and identified for any kind of depiction that promotes hate or violence. Verification of context from humans may be necessary to improve accuracy of such systems for image analysis.

7. Surveys

Surveys are one of the oldest methods of data gathering. It is usually in the form of questions posed to individuals, either online or in-person. The data produced in terms of responses can be classified and categorised for analysis. While surveys are not exactly "big data" sources, they can prove to be useful in identifying people's perception in conflict-affected areas. There are two major obstacles for this to be an effective data source:

1) Incentive for Participation

People may be reluctant to participate in surveys due to a variety of reasons, such as fear of social stigma or half-baked answers since they do not know how the information will be used. Therefore, they may require incentive in terms of monetary rewards or benefits for themselves or their family which may come in the form of access to information especially in conflict or post-conflict regions.

2) Bias in Sentiment

People of a community may be biased in their opinion about a particular person or group. In order to derive accurate information from survey data, it is necessary to train analytical model to identify and eliminate the bias that may find its way into the final representation and skew results.

8. Crowdsourcing

Crowdsourcing can be defined as the process of bringing together people and their capabilities to achieve a common purpose[10]. A prime example of crowdsourcing data is the Ushahidi platform used during the 2007 elections in Kenya[11]. Citizens were asked to report incidences of post-election violence occurring in their area via text-messages to the Ushahidi database, where it was then plotted on a map and made accessible to all citizens to be used for ensuring personal safety. Since each citizen was vested in the data that was being gathered, an accurate data ecosystem was created.

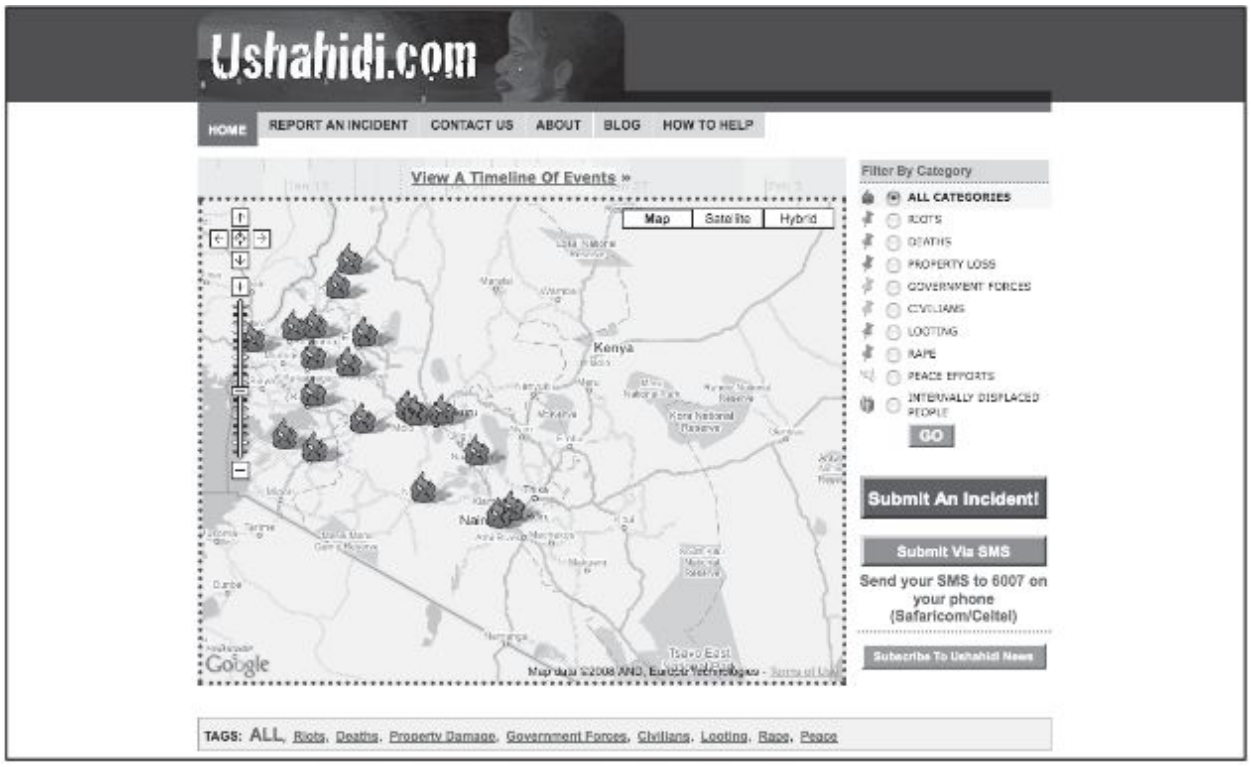

Figure 3. Ushahidi crowdsourcing platform

SMS is the tool of choice in the example above, but it is equally effective to use voice-call, email, or social media hashtags to aggregate information. This source of data is particularly useful in obtaining dynamically changing scenarios from remote and hard-to-reach areas of conflict regions. Due to some level of mobile and Internet technology penetration even in the remotest areas, it is possible to gather real-time information from the people themselves. While the data produced via crowdsourcing may be subject to bias and is not always accurate, it is the best option available to peacekeeping agencies to assess the situation on the ground where no other viable means of collecting information is possible.

Nevertheless, crowdsourced data can be disadvantageous if it is the only source of information accessible for a particular conflict situation. Remotely gathered data is often provided by elite actors who have access to a fair amount of technology, while the voices of

marginalized and vulnerable communities who are in the most need of aid post-conflict may not be majorly heard through the data[10]. Therefore, it is crucial that the data gathered via crowdsourcing be scrutinized and used in addition to on-the-ground, field sources rather than the sole source of information.

Challenges

Big data has tremendous potential in being able to answer many questions for policymakers and development stakeholders, right from early detection of conflict to efficient supply of resources in post-conflict areas. Nevertheless, the data acquisition alone has several gaps in its implementation that pose a problem in its effective use.

Firstly, it is difficult to acquire reliable data especially in regions where conflict situations have already taken place. Even the passive collection of data may require permissions from the governing body in the region at that point of time, not to mention guaranteeing the secure storage of data when in use. Secondly, the data that does manage to make its way through the conflict environments come in myriad forms - radio, satellite images, on-ground surveys and many more - which can be difficult to standardize and process.

Lastly, the use of personalised data collected from individuals across the globe walk on the thin line of violating privacy rights. The data needs to be anonymized in order to ensure safe use, and should be only used for analysis of conflict situations.

The following diagram outlines the concept of “Informed Consent” [18], where populations are informed of the purposes of data collection, a clear idea of the risks of participation, and an explanation of how the data acquired from them will be utilized. The challenge lies in the implementation of the processes outlined in the framework.

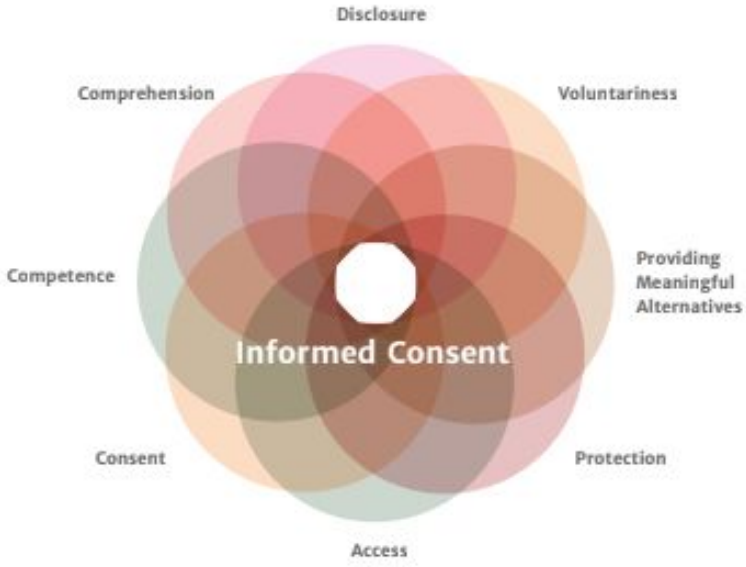

Figure 4. JustPeace Labs, "Ethical Guidelines for PeaceTech"

Once the data has been aggregated, there is a need for technical expertise to process the data using machine learning models and interpret the results for the development community in order to enable them to take action based on evidence. Such expertise is generally hard to obtain in the not-for-profit sector. That is why it is necessary to have experts from both field in an interdisciplinary effort to tackle conflict situations.

Conclusion

Data-driven peacebuilding efforts have become a possibility due to the spread of Internet and Web-based technologies into every corner of the world, and the sheer amount of data being produced simply by passive use of these technologies everyday. Not only is the size of data increasing by the minute, but also the data comes in different forms - SMS, radio samples, images on the Internet, or satellite images. Before all of this data can be analysed to produce actionable intelligence, it must be cleaned and pre-processed to eliminate bias that may have entered the data due to people perception. To produce an acute representation of the social, political, and economic factors that drive conflict, the data must be gathered from all

stakeholders involved in the scenario, including physically marginalized and vulnerable communities to ensure that peacekeeping efforts have maximum impact.

While there are certain shortcomings in the acquisition of data for reliable analysis and results, the field in itself is growing and has recently been coined as the “PeaceTech” industry by Sheldon Himelfarb, CEO of the PeaceTech Labs at United States Institute of Peace. Using data, technology, and new media for peacebuilding could be a profitable industry, with the post-conflict regions serving as economic playgrounds for new opportunities.

References

[1] DOMO, “Data Never Sleeps 5.0”, Accessed March 20, 2019, https://www.domo.com/learn/data-never-sleeps-5?aid=ogsm072517_1&sf100871281=1

[2] Kyle Taylor and Laura Silver, “Smartphone Ownership Is Growing Rapidly Around The World, but Not Equally”, Accessed March 23, 2019, https://www.pewglobal.org/2019/02/05/smartphone-ownership-is-growing-rapidly-around-the-world-but-not-always-equally/

[3] Global Migration Group (GMG), “Handbook for Improving the Production and Use of Migration Data for Development”, 2017.

[4] Gyan Ranjan et al., *Are Call Detail Records Biased for Sampling Human Mobility?* , ACM Mobile Computing and Communications Review, Vol. 16, No. 3, July 2012

[5] Lorena Escobar et al., “Big Data for Peace and Security”

[6] Elodie Convergne & Michael R. Snyder (2015) *Making Maps to Make Peace:Geospatial Technology as a Tool for UN Peacekeeping*, International Peacekeeping, 22:5, 565-586,DOI: 10.1080/13533312.2015.1094193

[7] Robert Kirkpatrick, “Digital Smoke Signals” Accessed February 27, 2019 https://www.unglobalpulse.org/blog/digital-smoke-signals

[8] Karlsrud J. (2014) *Peacekeeping 4.0: Harnessing the Potential of Big Data, Social Media, and Cyber Technologies*. In: Kremer JF., Müller B. (eds) Cyberspace and International Relations. Springer, Berlin, Heidelberg

[9] The Swiss Foundation for Mine Action (FSD), “Drones in Humanitarian Action”

[10] Suda Perera (2017) *To Boldly Know: Knowledge, Peacekeeping and Remote Data Gathering in Conflict-Affected States*, International Peacekeeping, 24:5, 803-822, DOI: 10.1080/13533312.2017.1383566

[11] “About Ushahidi”, Accessed March 9, 2019, https://www.ushahidi.com/about

[12] Mainack Mondal, *A Measurement Study of Hate Speech in Social Media*, Proceedings of the 28th ACM Conference on Hypertext and Social Media, Pg 85-94

[13] Stephen Kasiler et al., *Big Data: Issues and Challenges Moving Forward,* 2013 46th Hawaii International Conference on System Sciences, DOI: 10.1109/HICSS.2013.645

[14] United Nations Global Pulse, https://www.unglobalpulse.org/about-new

[15] Alexandra Schofield, Thomas Davidson, *Identifying Hate Speech in Social Media,* XRDS: Crossroads, The ACM Magazine for Students - Human to Human, Volume 24 Issue 2, Winter 2017

[16] Walter Dorn, “Smart Peacekeeping: Towards Tech-Enabled Peace Operations”

[17] James P. Farwell (2014) The Media Strategy of ISIS, Survival, 56:6, 49-55, DOI:10.1080/00396338.2014.985436

[18] JustPeace Labs, “Ethical Guidelines for PeaceTech”