Big Data
for Peace & Security

COLUMBIA SIPA
School of International and Public Affairs

UN Peacebuilding Support Office

Lorena Escobal, Kelsey Finnegan, Hayung Kim, Hyunwoo Park, James Schalkwyk, and Asher Zlotnik

Table of Contents

I. Executive Summary

Data is reshaping our world. With new developments in internet and communications technology (ICT) and rapidly increasing mobile phone and internet penetration, the availability and volume of data is expanding at an exponential rate. For peacebuilding, this "data revolution" is creating new opportunities, as well as challenges. Using new data technology, policymakers and practitioners can make better-informed and more-timely decisions. This report has identified data-based opportunities for peacebuilding in five key areas: migration, hate speech, perceptions of exclusion, monitoring and evaluation, and early warning and prediction.

Migration

Migration is one of the most complex issues of our time. With the highest number of refugees and displaced persons ever recorded, tracking population flows in insecure environments has become a key priority for peacebuilding practitioners. New data technologies can supplement existing efforts and overcome structural challenges:

- **Call Data Records:** Analysis of call data records (CDRs) can help monitor population movements, particularly in hard to reach areas with security constraints.
- **IP Mapping:** Similarly, mapping users' unique Internet Protocol (IP) addresses can infer migration flows in the short to medium-term and identify circular or temporary migration patterns.
- **Remote Imaging:** Imagery from satellites can be used to inform programming decisions. Partnerships with agencies such as UNOSAT, as well as with voluntary technical organizations for the acquisition and crowdsourcing of image analysis can reduce otherwise prohibitive costs of satellite imagery. Alternatively, drones can be used for more precise images with a higher definition that require minimal training to analyze.

Any intervention using these technologies should, of course, be mindful of the local context, culture, and privacy concerns, and be accompanied by appropriate sensitization efforts.

Hate Speech

With the proliferation of ICT, the spread and effect of hate speech has become amplified. Fortunately, machine learning tools can identify when hate speech is occurring and where the influencers are located:

- **Voice and Image Recognition:** Radio analysis and image recognition software can be used to recognize propaganda and calls for violence, as well as map out the sources from which they originate.
- **Social Media Scraping:** Similarly, data-scraping software can be used in social media platforms to detect the use of incendiary language, and the spread of misinformation and rumors aimed at fostering mistrust between populations.
- **Local Expertise:** Because hate speech is context-specific, these tools need to be combined with human expertise to confirm veracity, nuance and sarcasm; as well as taking into account the privacy rights of users.

Perceptions of Exclusion

Pathways for Peace (P4P) identified perceptions of exclusion as a primary driver of conflict. The accessibility of perceptions data, accessibility of data in conflict zones, and gathering data in real time are all key challenges to measuring perceptions. The following technologies can help:

- **Data from Information Communication Technology (ICT) sources:** Text, image, voice and video data can be collected from radio, social media and the internet. The data from these sources can then be automatically organized into sentiment reports.
- **Data-enhanced and open access surveys:** Surveys are still a critical tool to reach certain populations. While these may sometimes require on-the-ground data collection, new technologies can help target, enhance or collect survey data in hard to reach areas.
- **Speech-to-text radio analysis:** Radio is still widely used in remote areas or conflict zones where media and social media penetration might be low. In areas with low literacy and access to technology, radio programming is indicative of local sentiments and can identify rising tensions.
- **UAV and satellite imagery:** Aerial photographs can visualize the distribution of basic services such as schools or police stations, providing new sources of information on development, enclaves of minority populations, property damage and access to resources.
- **Passively gathered digital data:** Digital "breadcrumbs" can provide information that can be collected and analyzed instantly to provide useful insights on perceptions. Speech and text recognition can analyze media in real time.
- **SMS Crowdsourcing:** Citizen-driven crowdsourcing using open source platforms is a promising method of gathering real-time exclusion data for peace and security.

Monitoring and Evaluation

New technologies can also improve monitoring and evaluation (M&E) of peacebuilding interventions. Data-driven approaches can supplement existing frameworks and demonstrate robust program impacts.

- **Systematized Data Collection:** Through practices such as systematized data collection and the creation of context and project-specific mapping platforms, we can improve access to critical information for decision-making and extrapolate lessons learned from previous interventions.
- **Mixed Method Evaluations:** Further, the use of techniques such as mixed-method evaluation approaches and the capacity of staff to systematically gather data, we can use big data to complement and improve existing M&E methods.

Early Warning and Prediction

Lastly, big data has the potential to help program officers identify conflicts before they happen, which can facilitate the decision of where to adequately prioritize and allocate funds. This is particularly relevant for the fields of early warning and prediction. Though both frameworks pursue a common goal, prediction seeks to forecast conflict over months and years, while early warning attempts to identify signs of impending violence in the shorter term.

- **Risk Indices to Forecast Conflict:** Further, this paper argues that shift away from prediction and towards forecasting "risk indices" can aid in decision-making, while avoiding inherent problems with probabilistic prediction.
- **Combine structural and event data:** Additionally, combining structural and event data through the use of big data technologies can improve predictive accuracy and time windows for warning.
- **Human-machine interface:** This should only be done with the facilitation of context experts who can correct and adjust the machine learning process, while adding their explanatory power and analysis to improve accuracy.
- **Second-order conflict drivers:** It is also important that these experts lend their expertise to help identify second-order factors that might exacerbate or mitigate the risk of violence (e.g.: the existence of conflict minerals).

General Recommendations

There is great potential for big data technologies to support peacebuilding. However, any intervention using these technologies must be mindful of the operational and ethical risks associated with using data

that can be linked to personally identifiable information. Using data responsibly in the peace and security context requires taking into consideration: i) contextual risk-benefit assessments, ii) privacy concerns and the right to be forgotten, iii) questions about informed consent, iv) data sovereignty and local legal frameworks, and v) data protection and disposal.

In addition to specific technical recommendations and ethical and privacy concerns, this report recommends the following:

1. **Create and implement strong data governance and ethical guidelines**
   Comprehensive ethics and governance guidelines for data must be developed at the outset of any project. If not properly regulated or protected, sensitive data in conflict zones can be used by malignant actors to target vulnerable populations. To prevent this, data must be anonymized, encrypted and routinely deleted.

2. **Build a culture of systematic data collection and storage**
   For data-driven decision-making, peacebuilding programs need substantial information repositories. Building these requires collecting and storing data systematically over time, so that data is classified in a consistent way allowing for comparative and longitudinal analyses. Any effort to reach the full potential of advanced data technologies should begin with building a culture of data collection along with a common appreciation of its benefits.

3. **Support national and local partners to build their own data capacity**
   The PBSO and its partners should invest in national statistics offices' capacity to systematically collect, store and manage data. Local capacity creates better datasets and more comprehensive national statistics, which peacebuilding actors can augment as necessary.

4. **Foster strong private-public collaboration**
   The PBSO should seek to develop partnerships with data organizations to pilot big data tools. The identification of appropriate partners willing to accept challenges and failure in the early stages is key, as failure is a necessary part of innovation and many big data tools only come into their own after a period of testing and machine learning.

5. **Use preexisting data sources for "quick wins"**
   Given the extraordinary amount of data already available, the PBSO should exploit preexisting datasets for "quick wins" that build confidence and familiarity with the technologies. By customizing open-source platforms, datasets can be incorporated into situational awareness platforms to build stronger information management processes across the organization. Over time, additional indicators, such as hate speech, can feed into evolving datasets.

6. **Build combined systems that incorporate human expertise**
   Big data does not obviate the need for human expertise. Machine learning can identify underlying patterns, but it still takes a human analyst to understand and contextualize those patterns to support decision-making. Particularly in under-developed conflict contexts where information is scarce, local culture must not be overlooked when developing and designing interventions.

7. **Reframe how "big data" is viewed and manage expectations:**
   Political and cultural misperceptions of big data's promise will continue to be an obstacle. The unrealistic expectations placed on big data inevitably diminish confidence when technologies fall short of expectations. Recognizing this, the conversation around big data needs to be framed in terms of filling in information gaps, and strengthening existing processes, rather than replacing them.

II. Big Data for Peace & Security

As the world has become more connected, conflicts have become more severe and increasingly complex. In the past decade, more countries have been affected by violence, an increasing number of non-state actors have become involved in conflict, and intervention is being attempted by more international actors.[1] The global rise in conflict is exacerbated by the proliferation of internet and communications technologies (ICT), which are increasingly being used to incentivize violence. However, this upsurge in ICT has led to an exponential increase in the availability, quantity, and sources of conflict data. The extraordinary amount of data available today will only continue to grow and has opened a window for leveraging new technologies to guide peacemaking and improve conflict prevention.

The opportunity to improve the data that is essential for decision-making, accountability and solving development challenges was highlighted in the Report of the High-Level Panel of Eminent Persons on the Post-2015 Development Agenda commissioned by Secretary-General Ban Ki-Moon. The report also stated that substantive actions are needed in order to improve how data is produced and used, to close data gaps to prevent discrimination, build capacity and data literacy in "small data" and big data analytics, modernize systems of data collection, liberate data to promote transparency and accountability; and develop better targets and indicators. This is particularly relevant in the field of peacebuilding, given the potential that the use of data can have to improve conflict analysis, test the effectiveness of early-warning systems, and refine program selection, design, and implementation.

Big data technologies are being increasingly leveraged in the development and humanitarian sectors. In spite of this, given its perceived complexity, lack of resources, and political constraints, the peacebuilding space has been hesitant to leverage these tools. However, with the vast and increasing amount of data available in the world, and the need for more accurate and reliable information in hard-to reach environments, advanced "Big Data" technologies represent one of the most under-utilized and promising tools for peace and security.

This report asserts that a strategic adoption of big data holds potential to overcome many of these obstacles. The advantage of big data and its associated technologies lies in its ability to make more information available to peacebuilding actors. Big data allows adaptive, people-centered peacebuilding programs to incorporate continuous feedback into their design and implementation, increasing effectiveness and adaptiveness.[2] In order to develop a more coherent UN "that draws upon its full range of tools to support Member States," Big Data can support common understanding of the major risks and opportunities involved in peacebuilding, allowing

[1] United Nations and World Bank, *Pathways for Peace: Inclusive Approaches to Preventing Violent Conflict* (2018), Washington, DC: World Bank. doi:10.1596/978-1- 4648-1162-3, 7.

[2] Kirkpatrick, Robert. "Driving a Big Data Revolution for Sustainable Development and Humanitarian Action." Presentation, New York, 2015.

for risk-informed strategies and targeted efforts to build resilience and sustain peace.[3] Such an approach would be consistent with "adaptive peacebuilding," which embraces uncertainty, focuses on processes rather than end-states, and invests in the resilience of local and national institutions to promote change.[4]

Looking Forward

To bridge the gap between big data and the UN peace and security system, this report seeks to provide tangible technical recommendations and an overview of how big data applications can be integrated into the complex field of peace and security. Drawing from existing peacebuilding initiatives as well as from successes in other fields, this report illustrates how big data can be collected and used to improve situational awareness, efficiency, decision making, and the outcomes of peacebuilding while alleviating many of the concerns noted above.

The first section of this report provides a brief overview of big data and the associated technology. The following five chapters assess the big data opportunities in five key peacebuilding challenge areas identified by the PBSO. The first three chapters describe how big data programming can address a core peacebuilding challenge: successfully measuring three drivers of conflict. These drivers are: 1) migration 2) hate speech, and 3) exclusion and perceptions of exclusion. The following two chapters consider how big data might be employed to improve two of the key processes in peacebuilding: 4) monitoring and evaluation, and 5) prediction and early warning.

Each chapter begins with an overview of the topic and its relevance to conflict, and a description of the current challenges. The relevant big data technologies are described next, along with examples where illustrative. Key recommendations and remaining challenges conclude each chapter. The paper concludes with a note on important privacy and ethics concerns and a set of high-level recommendations for applying big data within the peacebuilding system.

[3] United Nations General Assembly Security Council, "Peacebuilding and sustaining peace Report of the Secretary-General" (2018)

[4] Coning, Cedric de. "Adaptive Peacebuilding." *International Affairs* 94, no. 2 (March 1, 2018): 301–17. https://doi.org/10.1093/ia/iix251.

III. Methodology

The United Nations Peacebuilding Support Office (PBSO) identified big data as a key area of interest for peacebuilding and conflict prevention. In November 2017, the PBSO engaged a team from Columbia's School of International and Political Affairs to identify key areas where big data could be leveraged in support of peacebuilding. The work was broken into several phases: 1) a survey of the technological state of the art, 2) UN stakeholder interviews and analysis; 3) practitioner and technical interviews; 4) an iterative problem-solving approach to applying big data to peacebuilding in creative ways; 5) expert interviews to determine technical feasibility and appropriateness of solutions; and 6) formal write up of conclusions and recommendations.

With the publication of the Pathways for Peace Study in March 2018, the team centered its work on the causes of violent conflict and opportunities for prevention identified in the study. As a result, this report is grounded in Pathways for Peace's recommendation that policy makers address key risk factors for violent conflict, while engaging in people-centered and inclusive peacebuilding.

This report prioritizes recommendations that are technically sound, accessible to a non-technical audience, and sensitive to the particular needs and challenges of implementing programming in conflict or post-conflict states. To achieve this, the SIPA research team worked closely with UN peacebuilders to understand their needs, incorporated technical innovations from a variety of sectors, and describe the issues and technologies at hand in language that the average person would understand.

In particular, this report recognizes that the majority of advanced applications of big data technology are not in the peacebuilding field. Thus, the team researched data programs in neighboring fields – notably development, humanitarian aid, and private sector political risk analysis. Stakeholder interviews with members of the UN peacebuilding community allowed the team to understand the specific knowledge gaps that big data could support and apply peacebuilding-appropriate technology solutions to remedy them. By combining peacebuilding expertise with technical research and interviews, the SIPA team was able to provide high-level technical recommendations grounded in the realities of peacebuilding and the UN system.

IV. Data Overview

The increase in the amount of data created on a daily basis is fundamentally reshaping our world. More data is being generated now than at any other time in history: Over 90% of the data in the world today has been created just in last two years.[5] Much of this data is created passively, through daily human interactions and routine utilization of information technologies. Accompanying this rise in the quantity, variety, and speed at which data is generated are major advances in the technologies that store, organize and interpret it. These "big data" technologies are applied with great success in the private sector but have been slower to be implemented strategically in the public sector.

The increased presence and access to data can allow policy makers and peacebuilders alike to make more timely, informed decisions. At the same time, the sheer amount of data can potentially overwhelm decision-making processes - one of many reasons that policy makers hesitate to build big data into already complex decision-making processes.

The UN Global Pulse initiative has taken the lead in developing projects on behalf of UN offices and agencies in the field of big data; however, wider buy-in is needed in order to develop a stronger data ecosystem within the UN system, in order to build a more data-driven culture within the UN that can support the advancement of peace and security efforts. Given the extent to which UN work is driven by information, big data can offer considerable improvements in the quality of data and reductions in the costs associated with information gathering and evidence-based decision making.[6] Furthermore, as was indicated in a recent meeting with UN officials, failure to invest early on will lead to greater start-up costs in the future.

Definitions and Scope

Big Data

This report adopts an expansive definition of "big data" and its related technologies. In this sense, big data is defined as: "data that is too "big" to be handled by conventional processing approaches." This approach is aligned with that of Global Pulse, in that it conceptualizes big data in terms of *three Vs*: volume of data, variety of types of data, and the velocity at which data is collected and processed.[7] Volume of data refers to the amount of data that is being generated on a regular basis from an increasingly vast array of sources.[8] Data requires resources for storage, and large amounts are hard to process due to general limitations on processing power. Velocity refers to the increasing speed at which data is

[5] "How Much Data Does The World Generate Every Minute?" *IFLScience (July 26, 2017),* Accessed May 11, 2018. http://www.iflscience.com/technology/how-much-data-does-the-world-generate-every-minute/.

[6] UN Independent Expert Advisory Group on a Data Revolution for Sustainable Development. 2014. "A World That Counts" Retrieved from: http://www.undatarevolution.org/wp-content/uploads/2014/11/A-World-That-Counts.pdf.

[7] UN Global Pulse, "Big Data for Development: Challenges and Opportunities," (May 2012); PBSO, "Potential Big Data to Advance United Nations Sustaining Peace Agenda and the Role of Peacebuilding Support Office," (December 2017).

[8] PBSO, "Potential Big Data to Advance United Nations Sustaining Peace Agenda and the Role of Peacebuilding Support Office."

BOX 1. Machine Learning

Machine learning is a process that uses set computing processes to perform actions without explicitly being programmed to do so. The utility of these automated processes is that they "learn" based on previous actions and existing data, resulting in the program being able to predict based on the input of new information.

Supervised learning: an algorithm is trained using a dataset that is labelled by a programmer, indicating correct and false categories for each data point - thus the computer is able to learn what is correct and then correctly categorize new data points.

Unsupervised learning: the training dataset is unlabeled – the computer identifies patterns in the data in order to develop a system for categorizing the data.

Clustering: clustering is the process by which an unsupervised algorithm creates categories and subsets based on identified correlations within the data.

As computational processes, big data technologies rely on patterns and relationships between data points in order to draw inferential conclusions.

generated, which in turn requires faster processing and analysis in order to stay relevant.[9] Variety refers to data's increasing diversity: computers can now process not only numeric information, but increasingly images, writing, audio data, etc.[10] In sum, the evolution of data puts challenges not only on the processing power available to most computer systems, but also for the ways that data is collected, cleaned, and combined in the process of analysis.

Data Collection

Generally speaking, data can be collected either actively or passively. Actively-collected data is intentionally collected for human purposes, and thus is generally classified and categorized. An example of active data collection is standard survey collection: the surveyor asks questions according to a given format, collects data on the variables of interest, and draws conclusions based on analysis of this information. By contrast, passively-collected data is automatically collected by various systems, often without direct intention, and without classification in terms that are useful for a given line of questioning or analysis. An example of passive data collection is credit card data: it is created and used for the purpose of facilitating and verifying financial transactions, but can provide significant information on purchasing habits, social class, lifestyle, and more. The amount of both types of data that is currently being generated is immense. However, because this

BOX 2. Structured Data vs. Unstructured Data

Structured data
Structured data is data that can easily be ordered and processed by data mining tools because data has been already identified, organized, and classified for a further use.

Unstructured data
Unstructured data is data that has no identifiable internal structure. It is a massive unorganized dataset of various objects that have no use until identified and organized properly. Once this organization process has taken place, the item can be searched and categorized for gaining insights.

[9] Ibid.

[10] Ibid.

data is collected for various purposes and in a variety of ways, big data is needed to process the data into a digestible format. Some scholars restrict "big data" to passive-collection;[11] this report uses both active and passive collection of data in defining big data in order to find approaches that apply to the broadest spectrum of peacebuilding challenges.

Data Sources

The trends in data have led to increasingly larger amounts of data being made available that can be used in the peace and security sectors. Not only can big data be used to measure the physical conditions and external behavior of human beings, it can also give insight into beliefs, prejudices, and political opinions of populations.

Big Data in Conflict Settings

Big data is particularly useful in conflict settings where information is often scarce, difficult to obtain, of low quality or potentially biased due to political or economic constraints. Big data can provide alternate information sources to complement or substitute existing platforms. The various resources and tools discussed can define the problem at hand, establish trends to identify the main drivers of conflict, and prompt development of indicators that provide relevant information. At this stage, project planners should think creatively about how to proxy these indicators from (big) data sources, as a step beyond what traditional data technologies allow. The exact data that is relevant is determined by the role of the project, and can vary in terms of scope, detail, and timeframe. Furthermore, machine learning can integrate diverse forms of data, such as national GDP, local commodity prices, and satellite imagery, to create a more holistic view of conditions on the ground.

The advantage of big data and its associated technologies is that it puts far more diverse information at the hands of actors, while working to identify patterns within the data. This aligns the nature and purpose of big data with conflict prevention efforts -- by identifying patterns associated with both conflict and peace and helping actors to better target interventions.[12] Thus, the challenge facing practitioners who seek to improve their work through big data is to think critically about the type of

BOX 3. Sources of Big Data

Data Exhaust: passively collected data from use of digital services - mobile phones, transactions, web services, information collected by governments - create networked sensors of human behavior through structured data collected for specific purposes.

Unstructured Online Information and Broadcast Media: web content, news media, radio, TV, social media, etc.- indications of human intents, desires, sentiments.

Physical Sensors: satellite or infrared imagery, UAVs, security cameras, and GPS - indicate changing human activity such as population mobility or land use.

Citizen-reporting or crowdsourcing: information actively produced or submitted by citizens- actively produced, while also providing opportunity for verification and feedback.

Open online datasets: Datasets that are already operational and store data on different subjects, such as ACLED or the Uppsala Conflict Data program.

[11] "New Technology and the Prevention of Violence and Conflict." *Stability: International Journal of Security & Development* 2, no. 3 (October 29, 2013). https://doi.org/10.5334/sta.cp.

[12] Computerworld, "Big Data's Big Role in Humanitarian Aid," Accessed May 8, 2018. https://www.computerworld.com/article/3027117/big-data/big-datas-big-role-in-humanitarian-aid.html.

information they need, what is available in the community of interest, and what questions and sources can be used in order to get them their answers.

Big Data Challenges

Despite the numerous advantages that big data offers within the peace and security sector, significant technical and structural challenges need to be acknowledged. Firstly, technical limitations and a lack of data experts have understandably limited the uptake of big data technologies into core practice. The resources required, including data experts, technicians, computers, servers, etc., are costly up-front and are not always easy to source within the resource constrained UN system. These costs raise the barriers to entry, increase fear of failure, and prevent necessary risk-taking that leads to innovation. Furthermore, technical capacities often require highly skilled labor that is at a premium in the private sector. Properly utilizing this technology requires adequate training and familiarity with data, as well as an understanding of its benefits.

The siloed nature of the UN system has led to similarly siloed attempts at implementing big data projects. Global Pulse has been commendable in this regard, spearheading projects across a variety of agencies. However, in order to create an environment conducive to data sharing and innovation, big data can be taken up across the peacebuilding space and should be viewed as a core tool for peacebuilding rather than constrained to specific projects.

Additionally, because many sources of "big data" rely on access to certain levels of development, this data can by systematically biased against less-advantaged populations. The asymmetry of access to information technologies leads to what is termed the "data divide" – not just between the developed and developing world, but also within countries and local communities. The absence of populations without access to cell phones, internet, or other devices that leave a digital footprint may hinder their representation in data and thus, their adequate representation in peacebuilding programs. Furthermore, this asymmetry disproportionately empowers those individuals and groups who do have access to information technologies, leading one of our expert interviewees to comment on the fact that "access to information and representation *is* power."

The purpose of the forthcoming chapters is to demonstrate the applicability and relevance for big data technologies for peacebuilding interventions. In the interest of maximizing utility, each chapter is presented as a stand-alone overview of selected topics that can be used by program officers interested in learning about big data applications in their respective fields. The first three chapters deal with how data-driven programming can better address core issues in peacebuilding: population migration, hate speech, and perceptions of exclusion. The report then considers two additional topics: monitoring and evaluation, and prediction and early warning; both essential for the future of data-driven peacebuilding interventions.

Migration

With an estimated 258 million people residing outside of their home country, there are more displaced people and refugees now than at any other time in recorded history, and the number will likely continue to grow.[13] Increasing violent conflicts, seasonal irregularities, and scarcity have prompted waves of displacement which themselves lead to further conflict in resource-scarce environments. In order for any international framework to promote peacebuilding successfully, state and international actors must seek tools that anticipate and monitor migration to inform policy and coordination. The major challenge to achieving this relates to the quantity and quality of available data. In these contexts, in particular, policy officers have challenges accessing:

1. **Dynamic data:** Data is typically collected on settled migrants rather than active migrant flows. This prevents peacebuilders from anticipating settlement destinations or forecasting migration-related violence.

2. **Data from insecure environments:** It is extremely challenging to track population flows in insecure environments, which are often extremely remote or inaccessible due to security risks. Data on these locations is often of the highest value for peacebuilding but governments, UN agencies and organizations typically lack the tools to garner accurate real-time information.

There are several opportunities for big data to supplement existing efforts and inform policy and decision making. The four most promising big data sources are:

1. **Call Data Records** (CDRs) or text mining can provide real-time information on migration flows even in remote locations;
2. **Internet IP address geo-tagging** can monitor and predict migration patterns where the appropriate infrastructure exists;
3. **Satellite and drone imagery** can be used to track movement and changing settlements patterns in remote places; and
4. **Passively collected sensor data** can monitor risk factors and trends that lead to mass migration.

Migration and Conflict

In response to the unprecedented scale of human migration, the global community has accepted that it must work more efficiently to pre-empt, prevent and manage mass migration.[14] The scarcity of reliable and up-to-date data means that UN agencies, international organizations and national governments often lack the information needed to identify the

[13] Hayes, Sherrill, Brandon D. Lundy, and Maia Carter Hallward, "Conflict-Induced Migration and the Refugee Crisis: Global and Local Perspectives from Peacebuilding and Development," *Journal of Peacebuilding & Development* 11, no. 3 (September 1, 2016) https://doi.org/10.1080/15423166.2016.1239404.

[14] Global Migration Group (GMG). *Handbook for Improving the Production and Use of Migration Data For Development*. 2017.

triggers of migration, protect vulnerable refugees in transit, and inform policy decisions around irregular migration. These challenges are compounded due to the fact that the current availability of relevant and reliable data for migration is still very limited.[15]

Data is typically collected only on settled migrants, human trafficking, and remittances.[16] The lack of data on migration *flows*, particularly in contexts where information is less accessible means governments and international actors are usually forced to implement reactionary policies as opposed to informed ones.

To bridge this gap, the UN PBSO can help its partners develop strong information management systems and utilize big data sources that monitor migratory patterns as they happen. Real time information enables actors and policy makers to intervene, protecting vulnerable populations as they make perilous journeys, preventing migration-related destabilization that can derail peace processes.

As populations move, there are consistent indicators that provide information on the manner, scale and destination of migration. These include the assembly of temporary shelters, changes in cell phone traffic, scarcity and environmental degradation.

Big Data Technologies for Migration

1. Call Data Records (CDRs)

Of the over seven billion global mobile phone subscriptions, at least one billion subscriptions are in developing countries.[17] Mobile phone penetration has reached 69% in Africa and 89% in Asia and the Pacific, with higher growth in Africa than any other region.[18] Mobile internet use in Africa is predicted to increase twenty-fold by 2020 and voice traffic is anticipated to double.[19] Thus, call data record (CDR) analysis is one of the most promising and illuminating tools to monitor population movements, particularly in hard-to-reach areas with security constraints.

Cellular "Breadcrumbs"

Each time a user makes a phone call, sends a text message, or searches the internet on a mobile device, that data is passively created and stored in the telecommunication companies' database.[20]

BOX 4. CDRs in Disaster Settings

During the Haiti earthquake of 2010, CDRs from 2.8 million cell phone owners were used to monitor flows of people leaving Port Au Prince. Practical applications with CDRs include the analysis of 2.8 million cell owners to monitor flows of people leaving Port Au Prince following the earthquake in Haiti in 2010. Flowminder – a Sweden-based non-profit – was able to trace the flow of 400,000 people in the aftermath of the earthquake using CDRs.

The International Organization on Migration's (IOM) Displacement Tracking Matrix (DTM) used text mining tools and visualization systems to track displaced Filipinos and enable the provision of shelter and other necessities for those who were displaced by typhoon Haiyan in 2013.

Other types of cell phone usage records have been used to track the modalities and determinants of mobile money transfers in post-disaster situations.

[15] Laczko, Frank, Solveigh Hieronimus, and Lars Hartenstein, *More than Numbers How Migration Data Can Deliver Real-Life Benefits for Migrants and Governments: Final Version for World Economic Forum in Davos on 24 January 2018*, Berlin, Germany: International Organization for Migration, Global Migration Data Analysis Centre, 2018, 7. https://gmdac.iom.int/more-than-numbers.

[16] Laczko, Hieronimus, and Hartenstein, *More than Numbers, 24.*

[17] Global Migration Group (GMG). *Handbook for Improving the Production and Use of Migration Data For Development*. 2017.

[18] Ibid.

[19] Ibid.

[20] McDonald, Sean. *Ebola: A Big Data Disaster*. The Center for Internet and Society, 2016.

Location information is approximated using to the nearest cell tower. As a result, location data is more precise in urban areas where the distance between towers is shorter, but the technology is used frequently in non-urban areas as well. Mobile operators also track user location data through the Global Positioning System (GPS) which tracks location through a series of satellites. This method of tracking is more accurate but requires a more expensive GPS enabled smartphone.[21]

In addition to location, CDRs contain information on the time and duration of the call, which can indicate moments of violence or mass displacement as call length and frequency changes.[22]

Recommendations for CDR Data Use

When it comes to real-time location tracking, CDRs are the most effective and practical data source and can fill data gaps where traditional sources fail. However, because of the large amount of personal data they record, they are extremely sensitive and have a high potential for abuse. Most CDR records are anonymized, but even these records can be re-identified.

For the ethical and appropriate use of CDRs, this report recommends the following:

1. Data minimization
Any agency seeking to use CDRs to monitor population movements should minimize the amount of data it collects. The easiest way to limit the amount of personally identifiable information gathered is to monitor broad cell tower activity rather than individual call and text records.

2. Data anonymization and governance
Mathematical anonymization reduces the risk of personal data being re-identified after anonymization. An important first step, anonymization should be accompanied by strong privacy frameworks both nationally and internationally. Discussions around the institutional use of emergency mobile network data management continue to be advanced by Global Pulse, the World Economic Forum and MIT. The PBSO and its partners can join these conversations and continue to engage with these actors as the use of CDRs in conflict becomes more common.

3. Build National State capacity to collect, store and manage migration data.
To address data challenges at the source and improve national institutions, relevant and accurate statistics must to be collected by governments. To further this, the PBSO can strategically build capacity and support National Statistics Offices. This would address the data and information problem at the source and achieve PBSO's mission of supporting institution building which can lead to more inclusive, nationally owned peace processes. Encouraging partnerships between National Statistics Offices and Mobile Network Operators should be prioritized.

4. Encourage data privacy & ethics laws
Comprehensive governance laws that address privacy and ensure ethical use of data are essential to any data program. While many governments do have privacy and information management laws, few delineate the extent of emergency powers over

BOX 5. CDRs in Disaster Settings
National Statistics Offices & Mobile Network Operators Partnerships

The IOM's recently formed Migration Task Force aims to establish a dialogue between National Statistical Offices (NSO) and big data holders, such as Mobile Network Operators (MNO), to produce "trusted smart statistics" that can be used for policy making. This collaboration between NSOs and MNOs is particularly important as NSOs have a legal mandate to produce statistics, a legal basis to collect data, and a public obligation to ensure confidentiality, while MNOs hold large amounts of real-time data collected that is potentially cheaper than traditional sources.

Source: Laczko, Hieronimus, and Hartenstein, *More than Numbers, 24.*

[21] Ibid.

[22] GMG, *Handbook for Improving the Production and Use of Migration Data For Development.*

digital systems. Any program that uses CDRs for migration tracking must include a clear needs assessment and ethics and privacy guidelines to justify the release of CDRs for public benefit.

2. The Internet

Monitoring internet usage is an important tool for tracking current and future migration flows. Analysis of users' unique Internet Protocol (IP) addresses is a common strategy that yields results in several ways. The records of repeated logins to the same website over a period of time can be used to infer migration flows in the short to medium term and identify circular or temporary migration patterns.

Combining IP data with predictive modeling, one study analyzed the IP addresses of more than 100 million users of the Yahoo! Services website over one year. The authors were able to infer global mobility patterns and estimate the likelihood of a user moving to another country.[23] In looking at the mobility patterns of Yahoo! users, the authors created a statistical model to infer migration rates at the population level, and adjusted the estimates to correct for Internet penetration rates in different countries.[24] They also chose statistical parameters that would maximize the likelihood of observing official data on emigration rates for a certain number of countries. The same analysis can be done by mapping the IP addresses from where emails are sent. Publicly available social media posts that are geotagged can also be used to identify trends and be compared data to national patterns of internal or international migration.

Recommendations for Internet Data

Internet analysis has an inherent self-selection bias since it only samples internet users - this bias must be accounted for during analysis to produce meaningful results. However, the speed and availability of internet data make it valuable for migration studies. This is particularly relevant in regions with high internet penetration, such as South and Southeast Asia.

3. Satellite Imagery

Advances in satellite and imaging technology have lowered costs and enabled the growing use of satellite imagery in humanitarian, peace, and security sectors. Satellite imagery provides remote monitoring and has been successfully employed in a growing number of cases, covering the full conflict spectrum from inter-state and civil wars, to cases of counterinsurgency and organized intercommunal violence.[25]

Satellite imagery analysis is a powerful tool that can provide independent, verifiable and compelling evidence of violence, migration, and displacement in remote locations that would otherwise be impossible to access. Satellite imagery is typically used to map temporary shelters and buildings at refugee camps, and monitors changes in the number and type of structures over time. They aid in remote detection of displaced populations and are particularly relevant in environments with severe security constraints.

Unlike analysis of CDRs, satellite imagery is less likely to infringe on individual privacy rights, since individuals are unidentifiable in most images. Throughout consultations in this research, Satellites were recognized as a relevant and useful tool by the peacebuilding community, but there is a general assumption that they are inaccessible due to cost and technological capacity. In reality, there are a growing number of affordable opportunities for the UN and its partners to purchase or access satellite imagery at varying resolutions and prices, and the analysis of the imagery can easily be outsourced.

Cost and Quality

Resolutions of imagery typically range from 30cm to 30m and can cover areas between 25 to 100 kilometers. Resolution is critical when considering minimal level requirements and goals for the use of the image, as those that can capture in centimeters can

[23] Zagheni, E,Weber, I. *Inferring International and Internal Migration Patterns from Twitter Data*. 2014.
[24] Ibid.
[25] Lyons, Joshua, "Documenting Violations of International Humanitarian Law from Space: A Critical Review of Geospatial Analysis of Satellite Imagery during Armed Conflicts in Gaza (2009), Georgia (2008), and Sri Lanka (2009)." *International Review of the Red Cross* 94, no. 886 (June 2012) https://doi.org/10.1017/S1816383112000756.

TABLE 1. 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

view individual people (studies have shown that shadows of individuals or groups tend to be easier to capture) versus just buildings or large groups. A selected range of satellite imagery sources, costs, and resolutions is detailed in the chart below.

While there is free online imagery available through Google Earth, the challenge is in determining the date the image was taken, and there isn't a guarantee that the image will be available at a later date because they are repeatedly replaced by later versions. One source of low resolution imagery is through Landsat, the longest running satellite imagery project in the world. For direct orders of images, most service providers offer the option of purchasing existing high-resolution archive imagery that can be several days or weeks old.[26]

Alternatively, customers can commission new images to be taken once the satellite passes the area in question, assuming that weather conditions are suitable to capture the image. Prices for on-demand imagery from commercial services are higher, as noted in the chart above.[27] In recognizing that images are only powerful if gathered consistently and for comparative analysis, purchasing on-demand high resolution imagery can be considered to be one of the more expensive programs for tracking population movements. However, there are several ways that the PBSO and its partners can incorporate low-cost alternatives in order to build satellite into its programming, including imagery sourced through UNOSAT or private companies like Planet.

An additional challenge and misconception for utilizing satellite in conflict settings has been that on-demand satellite imagery typically takes 48 to 72 hours, which most emergency responders consider to be too late beyond the 24-hour mark of actionable crisis information. Fortunately, Planet has launched 28 micro-satellites that can get satellite imagery of anywhere in the world within hours. Though the cost-effective images by Planet tend to be lower resolution (3 to 5 meters) and thus would only be able to capture large groups moving and broader camp locations, it presents an important option for crisis imagery.

[26] The Swiss Foundation for Mine Action (FSD), "Drones in Humanitarian Action," Accessed May 9, 2018 http://drones.fsd.ch/wp-content/uploads/2016/11/Drones-in-Humanitarian-Action.pdf.

[27] The Swiss Foundation for Mine Action (FSD), "Drones in Humanitarian Action,"

BOX 6. UNOSAT : The Case of Syria

The most relevant and accessible source of satellite imagery for UN agencies is UNOSAT. Since 2003, the UN's Operational Satellite Application Program has provided high quality mapping and geospatial data production. UNOSAT accepts requests for imagery 24/7, year-round, as long as the images are requested for humanitarian operations, disaster response, human rights and the application of international humanitarian law. The geospatial support provided by UNOSAT is broad and wide ranging and is available for free to any UN agency or humanitarian organization. This includes collection and analysis of imagery, digitization, reporting, rapid mapping, evidence development, and geodatabase development. UNOSAT also provides training programs, as well as exploratory development of new sensors, data sources, and technical resources to improve service delivery by UN agencies and partners. UNOSAT accepts one-off image requests but also enters into longer-term agreements with partners.

UNOSAT's rapid mapping service is highly relevant for monitoring population flows and can create mapping based on satellite imagery on remote areas. A recent example saw UNOSAT monitoring four years of violence in Syria, in partnership with the UN Office for the Coordination of Humanitarian Affairs (OCHA). UNOSAT used publicly available satellite imagery and compared images at different dates to confirm reports of deployments of armor and other heavy weapons to positions near towns and villages known to be in opposition to the government. The display of lethal force was accompanied by imagery indicating increasing number of graves and funerals in cemeteries.[1] The imagery, which was collected on an ongoing basis, was also used to map anti-government protests, army movements, and ethno-religious community concentration. The project also showed when markets had less activity and attacks or bombs on IDP camps.[1]

UNOSAT combined satellite imagery with other big data tools to corroborate violent accounts and increase informational awareness. In several cases, it analyzed posts on social media about barrel bombing and reviewed the available imagery to verify alleged damage. While this is a broader use of the tool than population flows, it can be used in critical moments to protect vulnerable populations such as IDPs and inform neighboring countries of incoming migration flows based on visual analysis of conflict or disaster-related destruction.

Source: United Nations Institute for Training and Research (UNITAR), "Syria Four Years of Human Suffering"

Crowdsourcing Satellite Analysis

The assumption that sophisticated software or technical expertise is required to analyze satellite imagery has also limited the uptake of the technology. Organizations and agencies wishing to utilize satellite imagery and sensors often assume they would be unable to analyze the images accurately. Fortunately, "voluntary technical organizations" can analyze satellite imagery quickly and at low cost through crowdsourcing.

Using crowdsourcing in this way is referred to as "microtasking." For imagery analysis, microtasking platforms enable volunteers across the globe to geo-tag objects in various satellite images. The tags are then fed into a system, such as CrowdRank, to identify tagged features that have the highest level of consensus. Once a tag reaches 90% consensus, the image is passed to experts in the company (such as DigitalGlobe) for further analysis.

In addition to reducing cost and expertise required to analyze images, crowdsourcing actually improves the accuracy of machine learning because it gives a program more data to test its prediction algorithms against. Recognizing this, UNOSAT is building crowdsource platforms on Pybossa, an open-source platform, as well as piloting a "GeoTagC" project on Citizen Cyberlab with the EU. This marriage between machine learning and human analysts to improve analysis is an important means to address human error, as well as technology's indifference towards context and history.

BOX 7. Microtasking Satellite Analysis

Tomnod is a microtasking platform that is used exclusively for satellite imagery. The platform was first used to identify plane debris after the plane went missing in Malaysia, but was then used in Somalia in 2010 to aid relief efforts. In Somalia, as mass displacement and migration grew as result of impending famine, the UN refugee agency realized that it would take them two months to track displacement and identify shelters. Through Tomnod, the "Standby Volunteer Task Force" (SBTF) was able to analyze 4,000 micro-satellite images and identify over a quarter million shelters.[1] From that, the Crowdrank algorithm was able to accurately identify 44,000 shelters in Somalia.[1]

Source: Meier, Patrick, *Digital Humanitarians*, CRC Press. 2015

Challenges and Limitations: Satellite Imagery

Many of the challenges and limitations of satellite have already been mentioned: pricing, technical capacity for analysis, and differences in resolution quality. Crucially, even high-resolution imagery simply cannot see through clouds or dense tree-cover and are thus geographically and seasonally limited in many regions of the world.28 One means of addressing this is through the use of radar sensors (known as synthetic aperture radar or SAR), which do not have the same weather-based limitations. These sensors are attached to satellites and detect electromagnetic energy either reflected or emitted from a surface. Unfortunately, SAR requires a higher level of expertise and most analysts are still concentrated in military or intelligence agencies.

Another frequently encountered limitation is that very high-resolution satellites do not collect imagery automatically and continuously over the world but are rather tasked over specific areas based on commercial or humanitarian value.29 Additionally, because of the limits of resolution, it may still be difficult to identify the movement of smaller irregular groups.

Other sensors can be used to passively gather data on environmental degradation due to mass migration or conflict, can monitor ambient noise levels of groups moving or propaganda, monitor electricity distribution, as well as seasonal irregularities and drought that may lead to violence or displacement. Sensors can also be used to monitor boat traffic through large scale population displacements.

4. Drones

Unlike satellites, commercial drones are much more accessible and can fly below cloud cover. Although more limited in geographic range, many drones can cover up to 3 kilometers per day. The image resolution of drones is much more clear and precise at 3.5 to 8 cm, they are easier to deploy rapidly, and they can collect imagery routinely. Mapping inaccessible areas and collecting visuals of IDP camps are among the more common uses of drones in the non-military sector. Drones tend to be lightweight, consumer friendly, and do not require high levels of technical knowledge.

Since the 2010 earthquake, IOM has institutionalized the use of drones for camp management in Haiti. Other examples include humanitarian use by OCHA and UN agencies in countries that are not in active conflict, or by the UN peacekeeping mission in DRC. While the rapidly evolving market and the specific conditions will determine the costs of drone deployments, a number of factors typically influence the budget:[30]

- **Preparation** – applying for national licenses, negotiating with ministries or competent authorities, and engaging with local communities for sensitization.
- **Data collection** – preparing flight plans, piloting and equipment maintenance.

[28] Lyons, J. *Documenting Violations of International Humanitarian Law From Space: a critical review of geospatial analysis of satellite imagery during armed conflicts in Gaza, Georgia and Sri Lanka.*"

[29] Ibid.

[30] FSD, "Drones in Humanitarian Action."

- **Data processing** – uploading, processing, and rendering collected data to create mosaics, base maps, and 3D models where access to power, internet and processing platforms may be restricted.
- **Data analysis** – obtaining actionable information from data analyzed by specialists

As prices drop and the technology becomes easier to use, drones will likely become more common in peacebuilding contexts. For recurring and consistent imagery, drones are more cost effective than satellite and the data is available immediately. Not including the costs of licenses and data analysis which will vary by context, models used for mapping range from $6,500 to $20,000, whereas a live video feed multi-rotor drone may cost between $2,000 and $40,000. Because drone imagery is more precise and has higher resolution, analysis of the images is simple and requires minimal training and practice.

Drone Challenges and Regulations

The greatest challenge of using drones for monitoring population movements is their association with the military. In conflict or post-conflict zones, this association may traumatize and frighten local populations. As a result, the majority of individuals consulted throughout this research believed that drones were not appropriate for use in active conflict zones.

As a result of their military affiliation, drones usually require approval by local and national authorities and are often tied to strict regulations. While some governments are open to the use of drones for humanitarian and peace purposes, many require convincing and the establishment of regulations to govern their use.

While these challenges will persist, many mapping drones are actually bird-sized and weigh less than a kilogram, making their use more feasible than often realized. The risks and potential complications of drone use in conflict or post-conflict zones must be carefully monitored, but their use in the right environments should nonetheless be considered. These challenges can be mitigated with training and sensitization of local populations, as well as support from governments and donor communities.

Recommendations for Migration

There are several promising tools and data sources that can be utilized to monitor migration in real-time. By incorporating advanced big data technologies, policy makers and program officers will be better able to anticipate irregular migration, support government preparation for mass influxes of people, and prevent regional destabilization before it occurs. While some of the technologies require higher levels of expertise than others, this expertise should not be seen as a barrier to entry given mitigating measures that can be put in place. Three key recommendations are:

1. **Invest in the use of Call Data Records for population movement tracking**. In doing so, prioritize resources to capacity building and strengthening of National Statistics Offices' ability to gather and manage data. This should include the creation of comprehensive governance, privacy and ethics regulations.

2. **The PBSO and its partners should explore low-cost options for satellite imagery, including UNOSAT and private companies.** Given the extraordinary utility of satellite imagery, satellite imagery should be included in migration-related projects on a consistent basis for comparative analysis.

3. **Combine machine learning and human evaluation to analyze satellite imagery.** Crowdsourced "microtasking" should be explored to improve analysis, contextual awareness, and reduce costs associated with the technology.

Hate Speech

From radio programming to propaganda, hate speech has been used to spread divisive rhetoric and promote violence for over a century. However, as social media becomes more widely accessible and technology advances, the prolific spread of hate speech to fuel violence in developing countries is rising. Most recently, studies have found direct links between posts on social media and violent conflicts in South Sudan, Myanmar, and Sri Lanka.

The use of mass media to mobilize mass violence is not new: the link between hate speech and mass violence was first brought to international attention when media figures used prolific radio messaging to incite genocide in Rwanda. Since then, international actors have sought to improve efforts to identify hate speech and stem its spread before it catalyzes violence, but these efforts have not been able to keep up with advances in technology.

Growing access to the internet and social media provides unprecedented access to information and connects rural communities to the world, but it can also be manipulated by those wishing to incite violence for personal and political ends. As communication tools become more democratized, increased access to media also allows actors to broadcast rumors and hate to wider audiences, breeding mistrust within fragile communities.

Despite rapidly growing internet access and the proliferation of mobile phones, radio is still the dominant media form used in developing countries. Though key for spreading information and reaching populations in rural areas, radio is also one of the most commonly used vehicles to spread rumors and misinformation, particularly in conflict zones. The damaging effects of hate speech are exacerbated with propaganda in the form of posters and graffiti, all of which can contribute to rising tensions and violence.

To address these growing challenges, national and international actors must go beyond typical surveying methods to identify, monitor and counter hate speech before it becomes damaging. Key challenges that traditional methods have struggled to overcome include:

1. Identifying hate speech from multiple sources.
2. Tracking the prevalence of hate speech and adapting to an evolving lexicon of hate.
3. Anticipating when hate speech leads to specific incidents of violence.

The uptake and utilization of big data represents one of the greatest opportunities to address issues of hate speech, as big data tools have already provided meaningful insights on this issue in a number of countries. In particular, big data technology can monitor and analyze hate speech through three important tools:

- **Social Media Scraping:** Algorithms that automatically download and analyze publicly available social media posts and identify hate speech based on an evolving lexicon of hate terms.
- **Voice Recognition:** Speech-to-text technology has advanced far enough that it can analyze radio, gauge emotion, and other speech for pre-identified hate terms.
- **Image Recognition:** Hate is spread through images as well as words and social media posts. Real-world images including propaganda posters and graffiti can be analyzed for hateful content.

Technology

1. Social Media Scraping

Where institutions are weak and underdeveloped, hate speech through social media can amplify dangerous tendencies, tapping into users' identity to belong, and promoting messaging that divides the world into "us" versus "them." Facebook's newsfeed algorithm is designed to maximize user time on site, immediately shifting whatever wins the most attention to the top of the page. Posts that tap into negative, primal emotions such as anger or fear, studies have found, produce the highest engagement, and so they proliferate.[31]

In developing countries, such as Myanmar, Facebook is seen as being synonymous with the internet. In fragile contexts where reputable news sources are scarce, emotionally charged rumors run rampant, inevitably feeding directly into violence. Citizens who don't feel that their national police can keep them safe due to weak security systems are much more prone to panic over a perceived threat and are more likely to take matters into their own hands. This was demonstrated in Myanmar, where hate speech and rumors on Facebook directly resulted in widening longstanding ethnic divisions and stoking violence against the Rohingya.[32]

In Sri Lanka, viral Facebook rumors claiming that Muslims were actively working to sterilize and destroy the Sinhalese majority resulted in large scale violence against Muslims and damaged property. This, as well as numerous other examples, demonstrate how rumors and hate speech can exploit fears and spark violence even within communities that lived relatively peacefully among one another. In contexts where tensions lay just under the surface, the mass sharing of these rumors can spark "the embers beneath the ashes."[33]

Social Media Scraping Process & the Case of South Sudan

While South Sudan may seem an unlikely country to pilot this technology in due to its limited internet penetration, it is also one of the countries with the most prolific occurrences of hate speech. Recognizing this, PeaceTech Labs facilitated a groundbreaking 2013 study that analyzed negative twitter and Facebook posts on social media in South Sudan.[34] The project aimed to address the methodological gap that exists in current efforts to tackle hate speech and its effects on communities in conflict zones.

Through its analysis, PeaceTech Labs were able to identify numerous key words and the "influencers" responsible for spreading fake content intended to incite violence. An example of an unexpected hate term identified through this analysis was the expression "MTN." MTN is a large telecommunications company with a well-known slogan, "*Everywhere You Go*." Beginning with on-the-ground surveys and local consultations, and then further developed using machine learning analysis, the study found that some Equatorian South Sudanese were using the term "MTN" as code for the Dinka people, many of whom viewed the Dinka as encroaching on their land and dominating positions in society. By using the stereotype that Dinka are '*everywhere you go*' the word "MTN" was used to target Dinka across South Sudan. Following these posts on social media, vehicles began to be stopped to see if "MTN were in the cars." By 2016, the term had evolved specifically to signify coordinated attacks against the ethnic Dinkas.[35]

The process used in South Sudan, which can be applied to any context to identify hate speech on social media, followed these phases:[36]

[31] Taub, Amanda, and Max Fisher, "Where Countries Are Tinderboxes and Facebook Is a Match," *The New York Times*, April 21, 2018, sec. Asia Pacific. https://www.nytimes.com/2018/04/21/world/asia/facebook-sri-lanka-riots.html.
[32] Ibid.
[33] Ibid.
[34] PeaceTech Labs. *Social Media and Conflict in South Sudan: A Lexicon of Hate Speech Terms*. December, 2016.
[35] Ibid.
[36] Ibid.

1. **Identification of online hate speech terms and development of a system to identify additional words (a "lexicon") with negative connotations.**
    a. The first step is to identify specific terms within the social and political context that are deemed offensive, inflammatory or dangerous. To identify the proper key words, local knowledge, expertise and surveying is required.
    b. As part of this first step, PeaceTech Labs conducted an online survey of South Sudanese and diaspora communities worldwide to identify terms that they considered to be contributing to the conflict.
    c. From this, they developed a "lexicon" of terms used online during a period of violence in order to analyze those that had contributed to direct conflict.

2. **Collect data and create data visualizations through social media monitoring.**
    a. At this stage, hate speech data is collected from social media via platforms such as Stream API. Using these systems, large quantities of data per day can be efficiently retrieved. However, since these datasets are raw data, additional processing tools (such as Apache Kafka) need to be used for preprocessing in order to become structured. Through these processing stages, non-linguistic features such as URLs, hashtags, e-mails, and use mentions will be removed, and any abbreviations will be expanded.
    b. In addition to collecting and analyzing raw data, software tools can be used to visualize hate speech to see how "influence networks" spread content.

3. **Validate the lexicon and its resulting analysis through local consultations.**
    a. The pre-processed data sets must go through a "Hate Speech Classifier" process. This will incorporate language and machine learning techniques in order to determine 'Hate' and 'No Hate' terms.
    b. After this process has been repeated several times, manual analysis by local experts is required. Once the data had been gathered in South Sudan, Peacetech Labs assembled an expert advisory board with representatives of various South Sudanese communities. These individuals helped provide insights on which terms were dangerous and interpreted the context into different local languages.

4. **Data Storage and Response**
    a. The processed and analyzed datasets are then stored in the cloud and actionable information will be visualized for stakeholders to promote policies against online hate speech, to raise awareness, and to predict and prevent possible conflicts.

Social Media Challenges

Internet Access

Internet access and minimal penetration is a challenge for the use of this technology. To increase the data that can be accessed, diaspora is sometimes included in analysis. While these are elite groups and, in many cases, represent a biased group, they are often still well-connected, powerful and may in fact be the actors fueling the violence. This was particularly the case in South Sudan, and so the inclusion of diaspora in the social media analysis was critical.

Privacy and Data Protection

Though the data that is gathered from Facebook and Twitter is open source, many consider it to be a breach of privacy. As with other privacy and ethics considerations in big data tools, efforts should be made to anonymize data, work with governments ahead of time to build in ethical frameworks and educate communities when necessary.

Veracity and "Noise"

Data from social media are generally "noisy" and contain a great deal of grammatical variance, misinformation, and mundane chatter. Due to the poor quality of such data in its raw form, its utility in conflict settings can be more challenging. However, there is a room for advancement as machine learning technology advances in order to filter noisy data. Even with current challenges, using big data from social media can provide incredible insights into hate speech and highlight when it may develop into violence.

BOX 8. Key Software for Monitoring Hate Speech

ForSight by Crimson Hexagon
Peacetech Lab uses a software called, "ForSight," developed by Crimson Hexagon. ForSight collects and analyzes social media to uncover sentiment and emotion behind social media conversations or posts.

Hatebase
MANDOLA project uses "**Hatebase**" to monitor 'Hate Speech' on social media. "Hatebase" detects hate speech words and saves them into its database in many different languages so that government agencies, NGOs, research organizations and other philanthropic individuals and groups can access and use the data to predict regional violence.

Natural Language Toolkit (NLT)
National Language Toolkit finds 'hate speech' words and builds a lexicon of 'hate speech' by classification, tokenization, stemming, tagging, parsing, and semantic reasoning.

Nuance and Sarcasm
Another challenge for machine learning with social media is that big data tools have trouble identifying nuanced and sarcastic features of hate speech. As hate speech is highly contextual and can be written into various forms, it is hard to uncover nuanced and sarcastic data without the support of local actors. As demonstrated in the South Sudan case, human analysts can supplement the machine learning algorithm with local expertise. Moreover, machine learning can be trained over time to distinguish such nuanced and sarcastic information. This mixed approach can better provide a full understanding of hate speech on social media.

2. Voice Recognition & Radio

Despite rapidly growing internet access and the proliferation of mobile phones, radio is still the dominant mass-media used in developing countries. In countries with little reputable news sources and high illiteracy rates, radio can be used to bridge the digital divide by providing a powerful tool for information dissemination, particularly for rural populations in hard-to-reach areas. However, because community-based radio newscasters often lack regulations and training, radio has become a commonly utilized vehicle for spreading misinformation, rumors, and hate.

Voice recognition and speech-to-text big data analysis are therefore among the most contextually relevant tools for conflict and post-conflict environments. These are increasingly being used to monitor perceptions on the ground and identify misinformation. The process typically follows four steps:

1. Voice Sample Gathering
Using voice mining or automated speech recognition (ASR) software, voice data that is broadcast on the radio or online must first be extracted and analyzed. The audio data can be sourced from live or recorded samples and can be put through a pre-processing software with machine learning to filter out unnecessary content and increase accuracy.

2. Speech-To-Text Recognition
In the second step of the process, the cleaned version of the text is translated through voice recognition software. This step also includes a verification process that attempts to clear and verify the text. These analytics can help create an automated search function of radio content by topics of interest for development such as losses due to localized disasters, public service delivery or gender-based violence.[37]

This technology was used in practice by Global Pulse in Kampala, Uganda, which was identified as an ideal piloting site due to the 216 registered radio stations and support of the government to gather more information on sentiments of rural people. The

[37] UN Global Pulse, "Making Ugandan Community Radio Machine-Readable."

BOX 9. Google Speech Advanced Programming Interface (API)

Google Speech API enables to convert audio to text by applying neural network models in an easy to use API. The API recognizes 120 languages and variants, to support your global user base. This enables voice command-and control, transcribe audio from call centers. Moreover, Google Speech API can process real-time streaming, using machine learning.

"Radio Content Analysis" tool made public radio broadcasts machine-readable through the use of speech recognition technology and translation tools that transformed radio content into text. The text was converted from the local languages of Luganda and Acholi directly into English and were then filtered into the project in which the analysis would be used to inform issues of relevance for the SDGs.[38] Once converted, the text could be searched by topic of interest including health, education or employment. They could also be further broken down based on location and timeline. Importantly, the tool was being used to identify trends amongst larger groups and communities and made a point to not identify specific opinions of individuals.

3. Classification and Real-Time Analysis
Once the text has been transcribed, the unstructured data is then organized into a readable and analyzed form. Classification techniques can be applied to large quantities of text data. The last and final step is to assess the hate speech terms that came out of processing. Like the social media scraping case in South Sudan, local experts are needed to ensure the relevance and accuracy of the findings.

Challenges with Voice Recognition

Text to Phonetic Conversation
The first and primary challenge of speech to text software is the issue of language and phonetic pronunciation. While some languages are pronounced phonetically, others are tonal in nature and may be prone to errors if the system isn't designed effectively.

The "Cocktail Party Problem"
On rural community radio stations, there are often multiple voices talking at once. The challenge of analyzing a recording that has overlapping speech is referred to as the "cocktail party problem." This reduces the ability of speech recognition software to translate voice into text. To address this, the Massachusetts Institute of Technology has created and showcased a promising way to separate people's voices in analysis. In doing so, the ability to weed through different voices and identify multiple sources for analysis in one conversation becomes feasible.

3. Image Recognition

In addition to radio, propaganda through the use of posters and graffiti are one of the most common forms of messaging in the developing context, and therefore are a key under-utilized source of identifying hate speech. These images can be extremely effective in swaying public opinion and targeting certain sub-groups.

For example, ISIS is well-known for the use of imagery disseminated via the internet to draw in new recruits. The often emotional and intimidating visual media distributed has been remarkably successful in touching vulnerable and disaffected individuals, allowing terrorist training camps to evolve into internet chat rooms spread across the world. Thus, it is important to identify, monitor, and take action on hateful images which otherwise would not fall into voice or text recognition software. Facebook, Google and Twitter have invested heavily in the development of image recognition technology software. Through the use of volunteer submissions, crowdsourced either by staff or local people, images from either the internet or on the ground can be sent into a database that is then processed through image-recognition software. Key images, text and trends can be pulled from the images in order to identify hate speech.

[38] UN Global Pulse, "Making Ugandan Community Radio Machine-Readable Using Speech Recognition Technology," Accessed May 8, 2018. https://www.unglobalpulse.org/projects/radio-mining-uganda.

Technical Process: Image Recognition

Using image submissions, crowdsourced either by staff or local people, images can be sent to a database and processed. Image recognition software is able to classify objects, and identify text, allowing it to process language from images. The image recognition software will continuously monitor harmful images both online and offline, and any atypical images can be flagged automatically for examination. Similar to social media, voice and radio, the image is then processed to remove "noise" and remove unwanted distortions.

Next, the image can be segmented into multiple parts to simplify it and make it easier to analyze. Image recognition software assigns a label to each pixel in the image and tags those with similar characteristics. Throughout this process, text is then identified in images and saved into a database. Key images, text and trends can be pulled from the images in order to denote hate speech.

Recommendations

While hate speech is not a new phenomenon, technological developments are enabling its spread at a faster and more catalytic rate than ever before. The fact that radio is the most widely used mass medium to disseminate information in developing contexts warrants on-going investment in speech to text technology to identify when and how damaging misinformation is being disseminated. As such, the report recommends the PBSO and its partners:

1. **Incorporate radio analysis and image recognition software into a pilot project**, particularly in hard-to reach environments where information is scarce, and radio is widely used.

Additionally, despite the challenges with analyzing social media such as bias, and privacy concerns that arise from analyzing people's personal sentiments posted online, the use of social media will continue to grow in the developing world. As a result, it will continue to be utilized as an effective medium to fuel violence. Given the recent criticism and concern around this issue, Facebook has stated that it intends to improve the algorithms which magnify posts that elicit strong emotions such as fear and hatred. However, given the limited number of staff that Facebook has based on the extraordinary number of users on its platform, Facebook's algorithms to detect hate speech still lack the nuance and context required of particularly rural contexts to distinguish what is a fear-inducing and falsified rumor, and what speech is coded to elicit violence. As such, the second recommendation is:

2. **Monitor and track hate speech through social media scraping. Following on lessons learned through the successful pilot in South Sudan, local contextual experts should be incorporated through a mixed-method approach in any technological pilot.** This mixed method approach would incorporate machine learning, along with extensive consultations with local actors.

While there are practical examples of organizations and institutions monitoring hate speech on social media, not enough of this analysis is being done strategically or being geo-located. As such, the third recommendation is:

3. **To identify rising tensions, the UN PBSO and its partners should consider building a situational awareness platform that maps hate speech.** This mapping system could also incorporate events data on violent events and be used to not only understand where hate speech is happening, but also understand statistically at what point it becomes damaging.

Perceptions of Exclusion

Pathways for Peace identified the mobilization of perceptions of exclusion as one of the greatest risks for violence today.[39] Though exclusion of certain identity groups from political, economic, or social opportunity is an ongoing human phenomenon that exists within all societies – advanced and developing, tensions rooted in perceived inequalities are growing. Perceptions of unfairness, identities, and assigned blame of one group to another are often more catalytic for mobilizing violence than traditionally measured indicators for real inequality and exclusion. Thus, monitoring and measuring *perceptions* of exclusion is a key task for those involved in peacebuilding and conflict prevention.

Currently, three major hurdles stand in the way of measuring perceptions of exclusion and understanding how and when it might lead to violence:

1. **Measuring perceptions of exclusion accurately.** Unlike the physical manifestations of real exclusion, expressions of perceived exclusion are not often communicated freely nor easily observable. Perceptions data can sometimes be of poor quality, be culturally or socially biased, and tend to be more fluid than standard outcomes.
2. **Monitoring the indicators of exclusion in remote areas or ongoing conflict zones.** In remote and insecure environments, traditional data collection required to measure exclusion are more challenging.
3. **Collecting and using near-real-time data.** In conflict settings, government and NGO data sources are often outdated and therefore can't effectively be applied to real-time decision making. To inform decision making in emergency settings, data often needs to be produced and analyzed within a 24- to 72-hour window to be effective.

These challenges, specific to measuring the perceptions of exclusion, can be mitigated by leveraging big data tools and technologies. The first two technology recommendations focus specifically on monitoring perceptions of inclusion. The third and fourth technologies can be used to measure actual exclusion in remote areas, which is a useful proxy when perceptions data is unavailable. Lastly, the fifth and sixth technologies are designed to collect real time data that can feed into policy and programmatic decision making. These are briefly summarized below:

1. **Data from Information Communication Technology (ICT) sources:** Text, image, voice and video data can be collected from radio, social media and the internet. The data from these sources can then be automatically organized into sentiment reports.
2. **Data-enhanced and open access surveys:** Surveys are still a critical tool to reach certain populations. While these may sometimes require on-the-ground data collection, new technologies can help target, enhance or collect survey data in hard to reach areas.
3. **Speech-to-text radio analysis:** Radio is still widely used in remote areas or conflict zones where media and social media penetration

[39] United Nations and World Bank, *Pathways for Peace: Inclusive Approaches to Preventing Violent Conflict* (2018), Washington, DC: World Bank. doi:10.1596/978-1- 4648-1162-3, 7

might be low. In areas with low literacy and access to technology, radio programming is indicative of local sentiments and can identify rising tensions.

4. **UAV and satellite imagery:** Aerial photographs can visualize the distribution of basic services such as schools or police stations, providing new sources of information on development, enclaves of minority populations, property damage and access to resources.
5. **SMS Crowdsourcing:** Citizen-driven crowdsourcing using open source platforms is a promising method of gathering real-time exclusion data for peace and security.
6. **Passively gathered digital data:** Digital "breadcrumbs" can provide information that can be collected and analyzed instantly to provide useful insights on perceptions. Speech and text recognition can analyze media in real time.

Additional Context

The demonstrable link between social or political exclusion and extreme poverty has meant that efforts to identify and remedy social exclusion tend to focus primarily on poverty reduction. As identified in Pathways for Peace, a significant proportion of today's violent conflicts are rooted in group-based grievances around exclusion. These grievances often entail deeply rooted sentiments, mistrust and isolation of vulnerable groups – all of which exacerbate tensions between and within communities. Further, "when an aggrieved group assigns blame to others or to the state for its perceived economic, political, or social exclusion, then emotions, collective memories, frustration over unmet expectations, and a narrative that rouses a group to violence can all play a role in mobilization to violence."[40] When exclusion is reinforced by state repression, the risk of violent conflict increases significantly.[41] The multidimensional nature of political and social exclusion means that interventions must not only target extreme poverty, but must also be aligned with the realities of people's perceptions on the ground and address the root causes of the conflict. Thus, finding the correct indicators and strategically monitoring exclusion is instrumental for conflict prevention. Before beginning technical recommendations, several important characteristics of exclusion are outlined below.

Disaggregating Identity Data

While exclusion tends to be measured in terms of its outcomes (poverty, inequality, etc.), these may not necessarily reflect the underlying exclusionary processes that led to them. As such, successful monitoring requires a multidimensional approach that involves political, social, economic, cultural and other factors. For this, it is important to be able to disaggregate between the indicators observed. This is where data technologies have a role to play.

Big Data tools are particularly good at disaggregating data, which is necessary to provide a more nuanced picture of exclusion. Methods for gathering data are sometimes biased in favor of individuals or groups with relative power within a community, such as men and elites. Household surveys tend to bypass youth and women – an unfortunate reality given the criticality of these groups and the need to ensure adequate representation in the data. Women are disproportionately excluded from information technologies – particularly in poor communities with strong cultural barriers for inclusion.[42] To address this, big data technologies can be utilized to disaggregate exclusion data using multiple datasets and to incorporate those who are underrepresented. This can provide a more nuanced and inclusive picture of exclusion.[43]

Measuring Perceptions of Exclusion

While perceptions of exclusion may be a stronger driver of conflict, they are more difficult to measure, as they depend on individual human sentiments and cannot be assessed with common indicators or methods like tax records or access to services.

[40] United Nations and World Bank, *Pathways for Peace: Inclusive Approaches to Preventing Violent Conflict* (2018), Washington, DC: World Bank. doi:10.1596/978-1- 4648-1162-3, 7.
[41] Bakker, Hill, and Moore 2016; Piazza 2017; Stewart 2002 quoted in United Nations and World Bank, *Pathways for Peace, 7.*
[42] United Nations Department of Economic and Social Affairs. "The Report on the World Social Situation 2016: leaving no one behind- the imperative of inclusive development" (2016).
[43] Ibid.

Unlike hate speech, which is intended to be distributed broadly, feelings of exclusion are often kept secret, or discussed only within the safety of the group. This is particularly true if the group in question fears government retribution. In this case, outsiders are more likely to be viewed with suspicion, resulting in traditional survey methods being biased or partially falsified. In light of this, the challenge for peacebuilding and conflict prevention work is in finding creative ways to measure perceptions of exclusion, even when those feelings are not actively shared. Given the fact that perceptions are more accurate indicators of violence than real exclusion, this section focuses primarily with the perceptions of exclusion. However, traditionally measured exclusion is sometimes necessary as a proxy for perceptions data and is also included.

Exclusion as a Process

Fisher suggests that exclusion should be seen as a process – a "flow" variable – rather than a static condition.[44] In conflict and post-conflict settings, it is *changes* both in the real distribution or perception of fairness that present the greatest risk. To this end, it is important to include social and political polarization measurements, as well as its representation within a community's risk-level as exclusion evolves in context.[45]

The Role of Elite Exclusion

The most common measurements of exclusion typically focus on that of vulnerable and isolated groups, but in doing so omit one of the most often overlooked drivers of violence: perceptions of exclusion by the elite. Perceived inequalities, frustration over unmet expectations, and unfairness within elite groups play a large role in the mobilization of violence.[46] Importantly, changes in political patronage networks, elite resentment, cultural or ethnicity-based glass ceilings, as well as sudden changes in the distributions of power have also been shown to catalyze violence. In these cases, traditional poverty measurements may not identify risks hidden beneath the surface.

This over-emphasis on empirical measurements of exclusion misses the hidden perceptions and anxieties of groups relative to one another. Despite their high-level positioning in society relative, elites are increasingly playing a role in the perpetuation of violence due to their own self-perceived ideals. There is strong evidence that perceptions of exclusion at the elite and middle-class levels are often the driving forces behind conflict, and this can be particularly damaging when these groups have the resources to mobilize larger populations.[47] The potential for elite perceptions of exclusion to feed into direct violence was demonstrated in the South Sudan case study for hate speech. There, it was actually the elite diaspora located outside of the country who were posting and spreading rumors, in an effort to destabilize areas and target certain groups. Given that most elites are more likely to have access to information communication technologies, big data tools can uniquely monitor these perceptions, as well as identify and track networks of "influencers" who are fueling the violence.

Despite the promise of big data approaches to fill information gaps that monitor perceived exclusion, certain technological challenges exist, which must be taken into account at the outset of any big data project. Chief among these are:

- **The quantity of data available:** The quantity of data needed for effective use of big data analysis is difficult to obtain in many places. This is particularly the case for exclusion data as common populations of interest (women, minorities, the extremely poor) are often excluded from the very platforms from which data might be most easily collected.
- **Capacity constraints:** Any technology or data solution must match the resources and expertise at hand. Engaging computer scientists and software engineers is expensive, and most agencies require extensive training to run complex data systems once they are set up. Big data requires a great deal of processing power and storage space, and these are costly.

[44] Fisher, A. Resolving the Theoretical Ambiguities of Social Exclusion with reference to Polarisation and Conflict. Development Destin Studies Institute. 2008

[45] Fisher, A. Resolving the Theoretical Ambiguities of Social Exclusion with reference to Polarisation and Conflict. Development Destin Studies Institute. 2008

[46] United Nations and World Bank, Pathways for Peace: Inclusive Approaches to Preventing Violent Conflict (2018), Washington, DC: World Bank. doi:10.1596/978-1- 4648-1162-3, 116

[47] Ibid.

- **Conflict-sensitivity of data:** It is essential that information is collected and used in a conflict-sensitive manner. Perception data from excluded populations is particularly at risk for misuse by ill-meaning governments and non-state actors looking to target those critical of them. Precisely because it provides insights into patterns of resentment and exclusion, raw data and results must be encrypted and anonymized – as well as routinely deleted – to reduce the chance of retaliatory violence endangering targeted populations.

Technology

1. Information Communications Technology

In modern conflict settings, the traditional survey-driven approach of gathering data is more challenging to carry out. However, increasing internet and cellphone penetration has turned Information Communications Technologies (ICT) into a promising new source of data on feelings and perceptions. Despite – or because of – its public nature, communities experiencing real or perceived exclusion are increasingly able and willing to air their grievances online, in social media, and in radio.

The openness of most conventional social media networks allows perceptions data to be scraped and analyzed in real time. As discussed in the Chapter on Hate Speech, public internet communications on blogs, microblogs, YouTube or Facebook are excellent sources of raw sentiment data. Machine learning tools can scrape data from these sources and subsequently analyze trends in real time. After developing an adequate lexicon, an algorithm can be created to identify speech patterns that are indicative of sentiments of exclusion. For exclusion, a lexicon can be developed and refined using a process similar to the one described for hate speech above.

Identity Group Mapping Identification

Machine learning algorithms can analyze names, speech patterns and lexicons, which can be used to predict the demographic profile of a user. This allows exclusion data to be associated with a particular racial, ethnic, linguistic, age or gender subgroup. For example, researchers at Facebook have used unsupervised machine learning to identify user ethnicity relying only on usernames and US census data.[48] The results were then enhanced by inferring ethnicity through the ethnicity of a user's network. Twitter also used a similar technique in a study where they developed an algorithm to identify gender by analyzing reported names, which helped them realize that women are severely underrepresented on the platform in the US.[49] Through the use of similar technologies, data can be scraped from these social media platforms in order to monitor the perceptions of a particular racial, ethnic, linguistic, age or gender subgroups; as well as identify which subgroups are underrepresented.

More sophisticated techniques can be used to identify gender based on the content of a post rather than names. Feature categories are divided into two groups: behavior and statistical. Behavior features focus on a lexicon of terms and behavior of users through text, images and metadata, while statistical features focus on frequencies of words and characters in text.[50] For example, the use of punctuation, emojis, personal pronouns, and average word-length have been used to infer gender through supervised machine learning.[51]

---

[48] Chang, Jonathan, Itamar Rosenn, Lars Backstrom, and Cameron Marlow, "EPlaribus: Ethnicity on Social Networks," *Facebook*, n.d., 8.

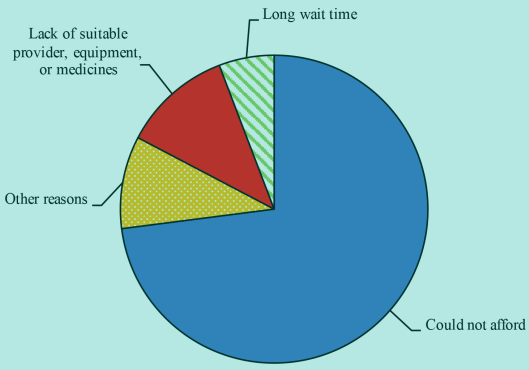
[49] Mislove, Alan et al., "Understanding the Demographics of Twitter Users," In *Proceedings of the International Conference on Weblogs and Social Media*. (2011), 4.

[50] Al-Ghadir, Abdul Rahman I., Abdullatif Alabdullatif, and Aqil M. Azmi., "Gender Inference for Arabic Language in Social Media:" *International Journal of Knowledge Society Research* 5, no. 4 (October 2014) https://doi.org/10.4018/IJKSR.2014100101.

[51] Adamson, Ross, et al. "Inferring Gender from Colloquial English Text: A Machine Learning Approach Using Facebook Posts." Accessed May 8, 2018. https://pdfs.semanticscholar.org/67c1/9f0de179d2a654be9d0ff1d7d371d7d07fce.pdf.

BOX 10. Case Study: Yazidi Surveyors

In November 2015, a survey was conducted to evaluate the health needs of Yazidi refugees living in 13 refugee camps. In order to be sensitive to the specific cultural needs of the Yazidi religious minority, the project employed four co-ed pairs of Yazidi interviewers to gather data from their community. Preparation involved a three-day training session which covered the questionnaire, sampling methods, data collection, using digital tablets and interview techniques. The Yazidi interviewers gathered data using the Magpi platform loaded on digital tablets and were able to interview 1,300. Only 0.7% refused to participate.



Source: Cetorelli, Valeria, Gilbert Burnham, and Nazar Shabila (2017)

Limitations and Recommendations

An important caveat is that in multi-ethnic settings, local support is needed to translate posts and help engineers train the algorithms to recognize linguistic indicators specific to certain sub-groups.

While online content created by populations who are truly excluded might be scarce because they may lack access to resources, elites are often well-connected. Thus, even in low-technology communities, ICT data can be used to measure elite perceptions. The openness of most conventional and social media is a powerful tool for mining individual data and leveraging machine learning tools to identify the perceptions of populations who might feel excluded.

Importantly, as it is often changes in elite political or economic inclusion that drives conflict, the diaspora is an interesting source of ICT data. The diaspora often echoes and reinforces perceptions of exclusion but, as with other elite data, the diaspora's disproportionate access to online resources is a mixed blessing, as they can bias the results.

2. Traditional and Open-Access Surveys

For monitoring perceptions, surveys are still one of the most effective tools to gather in-depth information and feedback on specific community-based issues that are not publicly accessible. Encouragingly, "the volumes of both traditional sources of data and new sources (mobile subscriptions per 100 people) have been rising, and openness is increasing (numbers of surveys placed online)."[52] While not strictly speaking a "big data" tool, technology can aid surveyors in several ways.

In-person surveys

For traditional household surveys, both "production and availability have increased dramatically over time and find that poorer countries now conduct more household surveys than middle-income countries and are more likely to put them in the public domain."[53] This is a promising trend.

However, one shortcoming of many traditional surveys is that they tend to be targeted at the household level and may not adequately record the responses of excluded subgroups such as youth and women. One method to overcome this limitation is to train members of the excluded community to perform surveys themselves. Such training can be quick and cheap and results in higher response rates and more candid answers.

Another limitation of surveys (traditional and other) is cultural bias. Societies have different norms associated with answering personal questions, talking to strangers, or taking impersonal online, written or telephone surveys. Automatic

[52] Data Revolution Group "A world that counts," 5.

[53] Demombynes, Gabriel, and Justin Sandefur, "Costing a Data Revolution," *SSRN Electronic Journal*, 2014. https://doi.org/10.2139/ssrn.2622756, 1.

editing processes can be used to correct for this by identifying a systematic bias across all responses; therefore, helping to provide more accurate data. Survey analysis is traditionally done by human analysts, who may miss biases in the data due to human error or may have to manually identify them within a dataset - a costly and timely process. Machine learning programming can address this and compensate for bias without human intervention. Once identified by a subject matter expert, systematic errors caused by cultural bias can be corrected across the entire data set. Random errors can both be detected and deleted more easily as outliers are easily identified within big data sets.[54]

Open-Access Surveys

As of 2015, 45% of the world had internet access.[55] Thus, while traditional surveys are not likely to be supplanted soon, more and more people are able to respond to "open access" surveys via a computer or mobile phone. However, there are two major challenges associated with open-access surveys: incentivization and opportunism.

Without proper incentives, response rates for internet or mobile-based surveys are too low to be statistically useful.[56] However, various incentives can be used, and not all of them are monetary.

Incentives to consider include small cash transfers or cellphone airtime, access to information (price, safety, social service data, situational awareness), access to food and health aid (etc.). These incentives, particularly access to information in conflict or post-conflict areas, have proven effective in incentivizing higher response rates.

Once people are incentivized to participate, the second challenge arises: ensuring the information provided is accurate. This can be done by providing participants with digital identities or linking them to phone numbers or ISP addresses. Digital identities allow for the storage of a lot of personal information. Blockchains can be used in complement to ensure that a user's single digital identity is stored in a secure and incorruptible manner.[57] As discussed above, machine learning is excellent at spotting outliers and false reports. A system can easily track responses and eventually blacklist bad actors who can be identified through digital identifiers like IP addresses, email addresses, twitter handles and cellphone numbers. At the same time, practitioners should be careful that identifiers cannot be used to personally identify individuals and potentially put them at risk.

BOX 11. Case Study: SenseMaker

In 2012, GirlHub conducted studies on societal attitudes and behaviors toward girls in Ethiopia. 350 respondents were asked to share a true story of their choice about an experience in girl's life. The stories were uploaded on Sensemaker, an analytical software that identifies patterns and trends in perceptions and behaviors. The findings found that the stories shared by storytellers were most often associated with sad or angry emotions. Moreover, one of the key findings was that girls needed the most support in achieving higher self-confidence and better access to legal services in Ethiopia. These findings were later used to inform creating storylines of a radio drama called Yegna, which aims foster a behavioral change in teenage girls in the country.

Source: Cognitive Edge, "Using SenseMaker to Understand Girls' Lives: Lessons Learnt From GirlsHub."

[54] Puts, Marco, Piet Daas, and Ton de Waal, "Finding Errors in Big Data," *Significance* 12, no. 3 (June 1, 2015) https://doi.org/10.1111/j.1740-9713.2015.00826.x.

[55] World Bank, "Individuals Using the Internet (% of Population)," Accessed May 8, 2018. https://data.worldbank.org/indicator/IT.NET.USER.ZS.

[56] Pedersen, Mogens Jin, and Christian Videb. "Improving Survey Response Rates in Online Panels: Effects of Low-Cost Incentives and Cost-Free Text Appeal Interventions," Accessed May 8, 2018. https://towardsdatascience.com/https-medium-com-shaanray-how-blockchains-will-solve-privacy-88944f3c67f0.

[57] Ray, Shaan. "Blockchains and Digital Identity." Towards Data Science, March 10, 2018. https://towardsdatascience.com/https-medium-com-shaanray-how-blockchains-will-solve-privacy-88944f3c67f0.

BOX 12. Case Study: Crowdsourcing with Ushahidi

During the 2007 Kenyan election, the platform Ushahidi was created to crowdsource and collect eyewitness reports of violence, which were then placed on a map. Users were provided access to the information in exchange for their reports. Because they had a vested interest in the data, they were incentivized to produce unbiased reports.

Source: Ushahidi

3. Radio Analysis

Radio is the primary media in many parts of the world – particularly remote areas with low levels of infrastructure investment. Particularly settings with low literacy and access to technology, radio programming is can provide insight into local sentiments and identify resentment and perceptions of exclusion. The technology behind speech-to-text radio analysis is explained more fully in the technology section of the previous chapter on Hate Speech.

4. Satellite Imaging

A primary challenge for conflict prevention is measuring exclusion in remote areas of conflict zones. Often, these areas have little internet access or data penetration so more creative methods and proxies must be relied on. These proxies can take the form of "measurable" exclusion outcomes like living conditions and access to services such a water and electricity.

In the case of other outcome indicators for which databases are either unavailable in certain countries or rely heavily on in-person surveying, satellite imaging can help provide a better picture. As mentioned before, lack of access from basic services such as electricity can be indicative of exclusion. For these cases, engaging organizations such as UNOSAT for the provision satellite imagery and related geographic information can help identify where the structures for the delivery of these services are missing. Depending on the source of the imagery (and the number and orbits of the satellites) multiple images can be taken per day, providing near-real-time sensor data, which relates to challenge three below.

For more on satellite imaging, see the technology section of the previous chapter on Hate Speech.

5. SMS Crowdsourcing

Less detailed than traditional surveys, crowdsourcing provides unrivalled immediacy in areas with any level of mobile or internet penetration. While SMS is the most ubiquitous format, users can use text, social media, email or even call to provide real-time event information. Platforms analyze and aggregate data in real time, by processing complex data quickly with "eager learning" machine learning techniques that are optimized for speed.

This people-centered approach to data collection empowers those using the platform who have access to the internet to see real time GIS visualizations of conflict or danger. Platforms that identify and geotag incidents of harassment and violence towards women have been used in Cairo, Nairobi and Mumbai and identify danger and safe zones.[58]

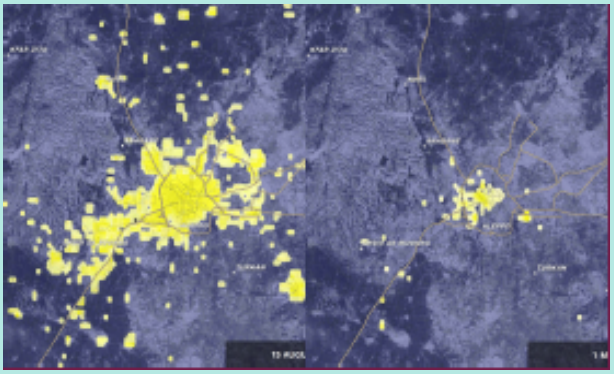
6. Call Data Records

Finally, Call Data Records (CDRs) – discussed at length in Chapter 1 – are an excellent source of passively collected data. By analyzing anonymized cellular data related to call duration, text frequency and airtime purchasing habits, it is possible to predict education, household assets, household expenditure

[58] Chant, Sylvia., Cathy McIlwaine, *Cities, Slums and Gender in the Global South: Towards a Feminised Urban Future*, (Routledge, December 10, 2015).

BOX 13. Case Study: Using satellite Imagery to Identify Excluded Populations

Lack of access to basic services like electricity is a clear indicator of exclusion. Technologies like satellite imagery can be used to identify populations who do not have access to running electricity. For example, in these before and after images taken by UNOSAT in Aleppo, Syria, it is quite easy to identify which communities no longer have electricity.



Source: United Nations Institute for Training and Research (UNITAR), "Syria Four Years of Human Suffering"

and income.[59] CDRs have been used to predict whether a conversation is political in nature, detect population movements, and monitor financial coping strategies in the face of violence or oppression. Thus, CDRs can help detect the contributing factors of conflict, like increases in economic hardship and negative political sentiments. In particular, cell phone data enhances real-time awareness by "paint[ing] a fine-grained, real-time picture of human ecosystems by unveiling digital patterns or signatures in the data."[60]

Frequency and size of airtime purchases can predict food and household expenditure with 89% accuracy and estimate the Multidimensional Poverty Index, with 80% accuracy.[61] This data can be collected and analyzed in the data center of a mobile service provider with the anonymized, aggregated results made public in the form of a "heat map" representing the dynamics of economic hardship.

Combined with other, more traditional information sources like survey and satellite data, easily interpretable visualizations of the real-time trends in poverty and exclusion could be made available to conflict agencies. This would provide "multi-dimensional recording of the flow of social dynamics" and continuous feedback into conflict and development programing.[62]

Recommendations

Despite the privacy, capacity, and infrastructure-related constraints for data collection; as well as the challenge of differentiating between actual exclusion and perceptions of it, new technologies can be a useful complement to facilitate and add value to interventions on the ground. It is important to note, however, that the dissemination of data on group perceptions of justice, security, services, resources, and power can reinforce polarization if not carefully used. Thus, practitioners should ensure that perception monitoring is undertaken with full awareness of the need for safeguards related to the security and privacy of individuals, so that the data collected to aid excluded individuals is not later used for identity-based targeting.

[59] Jakarta, Pulse Lab, "Using Big Data for Statistics to Track the SDGs," *Pulse Lab Jakarta*(blog), October 27, 2017. https://medium.com/pulse-lab-jakarta/tracking-the-sdgs-using-big-data-dad0ad351f2e.

[60] Letouzé, Emmanuel, "Can Big Data From Cellphones Help Prevent Conflict?" *IPI Global Observatory*(blog). Accessed May 8, 2018. https://theglobalobservatory.org/2012/11/can-big-data-from-cellphones-help-prevent-conflict/.

[61] Kirkpatrick, Robert. "Driving a Big Data Revolution for Sustainable Development and Humanitarian Action." Presentation, New York, 2015.

[62] Global Pulse, "Using Mobile Phone Data and Airtime Credit Purchases to Estimate Food Security," Accessed May 8, 2018. https://www.unglobalpulse.org/projects/mobile-CDRs-food-security; Kirkpatrick, Robert. "Driving a Big Data Revolution for Sustainable Development and Humanitarian Action."

Monitoring & Evaluation

Strong monitoring and evaluation (M&E) processes are critical for practitioners to understand how programs make substantive impact on the ground. The design, development, and implementation of an M&E framework affects the way in which interventions are prioritized, decisions are made, and success is measured. Data is essential for informed decision making and accountability in any monitoring and evaluation framework.[63] Given the rapidly developing contexts in which peace and security projects take place, big data can allow access to critical information in real-time and aid in decision making by determining which interventions were most effective at producing desired outcomes. In calling for the more strategic use of data in M&E, the UN Secretary General's Independent Expert Advisory Group noted, "without high-quality data providing the right information on the right things at the right time; designing, monitoring and evaluating effective policies becomes almost impossible."[64] The opportunities that new data sources and large datasets may provide is increasingly being explored in the context of M&E, as is the focus on addressing existing limitations from more traditional M&E data.[65]

Despite these benefits, many hesitate at fully embracing "big data", noting that data-driven M&E methods are only now being standardized across the UN system. This chapter seeks to identify specific entry points that can prove big data's added value to M&E. Three core challenges for incorporating big data into current M&E practice are:

- **Collection of data**: M&E relies on available and accurate data, which may be scarce in conflict zones. Without this data, effective M&E becomes impossible.

- **Organization of data:** Data that is available may not have been collected for the purpose of M&E. Unstructured data requires further processing and analytics to be incorporated into preexisting M&E frameworks.

- **Accessibility of data:** Data that is collected and organized often remains in the form of field reports in regional offices, or high-level analysis at headquarters. Effective analysis across all levels of peacebuilding requires information to be maintained and shared in an accessible manner.

Not only do these challenges hinder the effectiveness of M&E processes, they also limit broader "situational awareness" that inform program officers of evolving conditions across the lifecycle of the project. Often, projects operating in high risk environments require more evidence in order to demonstrate the utility of peacebuilding programs to donors. The inevitable challenge is that these environments often lack the conditions for evidence-based data and accurate information. In light of this, there is growing recognition that monitoring and evaluation systems can be strengthened through big data:

[63] UN Independent Expert Advisory Group on a Data Revolution for Sustainable Development. 2014. "A World That Counts."
[64] Ibid.
[65] UN Global Pulse, "Integrating Big Data into the Monitoring and Evaluation of Development Programmes" (2016), 22.

- **Opportunities for Collection:** Big data technologies can be used to collect data from a variety of sources, and machine learning may be used to validate some of this data. Issues around data ethics and informed consent arise and must be considered consistently through the use of these tools for M&E.

- **Opportunities for Organization & Impact:** Machine learning can categorize and structure data that is otherwise unprocessed and unusable. Unsupervised learning can identify patterns in data and suggest conclusions that might not otherwise have been identified.

- **Opportunities for Accessibility:** Big data can enable the creation and maintenance of larger databases that can incorporate information from various contributing offices. This allows for information to be available for evaluators throughout the life cycle of the project, and without need for extensive efforts to locate and gain access to it.

Better M&E processes improve validation of programmatic successes and lessons learned and strengthen political and financial support for peacebuilding. Big data technologies are not a full solution, nor does this chapter suggest that big data should replace existing frameworks for M&E. Rather, big data can be used to supplement M&E processes, filling in critical information gaps, building stronger contextual real-time awareness, and informing more accurate decision making in peacebuilding.

This chapter provides an overview of monitoring and evaluation as currently practiced, along with recent advances in data-driven analysis. It then illustrates challenges in the existing approach, and provides specific recommendations using big data to meet these challenges.

Overview

Monitoring – the ongoing collection and reporting of data throughout the life of a project – informs programmatic decisions and resource allocation. Evaluation assesses whether programs contributed to broad policy objectives[66] and the extent to which observed changes (improvements or otherwise) to indicators of interest can be attributed to the program's intervention.

M&E is typically carried out by an array of actors with varying skill sets. These include programmatic peacebuilding staff, enumerators, independent evaluators, and country specialists. The M&E process for the PBSO typically begins with developing criteria around questions of relevance, effectiveness, gender-responsiveness, and sustainability of the program. The process generally consists of qualitative interviews, surveys, and facilitation of focus groups in order to measure sentiments on the ground pertaining to conflict drivers, the program itself, and indicators that the program identified at the outset. Quantitative-driven methods are also included and usually involve some form of surveying, increasingly through mobile data collection software, or SMS crowdsourcing to reach larger populations.

The data collected throughout the project is largely determined based on the structures put into place during the program-design process, despite wide variation and changing contexts. The narrow nature of this pre-determined evaluation process, particularly through project indicators set at the outset of a project, means that broader impacts of the program may be missed. Big data is particularly useful in broadening the usual M&E boundaries, by identifying positive unanticipated outcomes that go beyond the planned scope of the project but contribute to wider peacebuilding.

Challenges to Monitoring and Evaluation

- **Collecting Quality Data**
  A key challenge for M&E pertains to the data that is typically used in these processes. National governments in post-conflict or conflict states often lack capacity to generate strong statistical data. As a result, it is not uncommon to

[66] United Nations Global Pulse. "Integrating Big Data into the Monitoring and Evaluation of Development Programmes."

only have access to national level data that is over ten years old. In addition, inequality in access to digital devices between social and ethnic groups raises the risk of biased sampling. In certain cases, data may be unavailable, incomplete, biased, or otherwise of poor quality. Absent and flawed data can produce entirely incorrect analysis outputs, and therefore prevents valid inferences of the program's efficiency and success as measured by M&E.

- **Data Organization and Data Management**
  Data that is collected may not be organized in a coherent or systematic way, leading evaluators to be unable to use the data in their analysis. Information may be collected on an ad-hoc basis, often focusing on idiosyncratic indicators directly related to the project. Monitoring and evaluation tools are therefore often inconsistent or unstandardized across the field. Lastly, data is often siloed within different projects and agencies, resulting in redundancies of resources and time to produce data which may already exist.

- **Accessibility of Data**
  Strong monitoring and evaluation processes require access to information across regions and periods. Cross-sectional data allows evaluators to conduct comparative testing that can demonstrate program impacts, for instance demonstrating improvements against a baseline measurement. Even if data was collected and organized early into the project, it may not be accessible to evaluators later on. Data that is limited to field offices or headquarters impairs evaluators' ability to use the full range of information relevant to their work.

- **Entry Points for Big Data**
  Big data technologies hold the potential to address these challenges as complements to existing M&E methods. Advances in big data, the processes of which have been discussed throughout this paper, allow specific responses, as outlined below:

- **Collection and quality of data**
  The limited availability and quality of data can be addressed by big data technologies. For one, information from social media, satellites and UAVs, and call data records can be used to supplement and verify impact evaluations where program data may be scarce. Machine learning can be used to identify discrepancies between data sources and correct for bias.

- **Organization of data and impact**
  Big data techniques can be used to structure and organize data and can learn and improve over time as more data is added and validated. Machine learning algorithms can scan, analyze, and sort documents and images, facilitating knowledge building and decision making. In particular, unsupervised learning can provide structure to unstructured data and find patterns that would have otherwise not been found in traditional M&E processes.[67]

- **Data accessibility**
  Big data can collect data across a variety of datasets and make sense of them in context. Different data can be cleaned standardized through automated and manual quality assurance and can be visualized in an online data platform. These platforms can be accessed by actors across the peacebuilding hierarchy and facilitate information flow to the relevant offices. Integration of diverse data enables comparability of data across time and country and provides practitioners a basis for analysis and planning programs.

Technology

1. Project mapping platforms

Situational awareness platforms can integrate diverse inputs such as social media, call data records, satellite imagery, and other sources to present a holistic picture of the conditions on the ground and compare indicators over time. Situational awareness

[67] Perry, Chris, "Machine Learning and Conflict Prediction: A Use Case," (2013) Stability: International Journal of Security and Development. 2 (3), Art. 56 DOI: http://doi.org/10.5334/sta.cr.

adds value by improving the ability of field and desk officers to visibly manage and access information on the area in which they work in near real time. The collection, organization, and presentation of this data can also be used throughout the program's lifecycle to identify trends and impacts, and cross-compare indicators against different time frames.

An example of this is UNDP's recently developed Crisis Risk Dashboard, which pulls pre-existing events data from the Armed Conflict Location & Event Data Project (ACLED) dataset in order to know where violent events are happening in countries of interest. This specific dashboard focuses on violent events, along with news sources, to visualize information and support informed decision making; similar platforms can be established based on the topics of interest to a program. Dashboards can be developed through open source software such as Ushahidi and crafted to map data on any subject. This can include real-time mapping of where projects are located in-country, social and government services across a country, hate speech, and occurrences of violence, among many others.

Additionally, by broadening the scope of data available to evaluators, M&E processes can identify impact beyond what is specified as the direct indicators for the program, and in so doing "broaden" the demonstrable impact of the peacebuilding program.

2. Mixed-Methods Evaluation Approach

Big data technologies, including natural language processing and image analysis, can allow qualitative data to be quantified for analysis. For instance, surveys, interviews, and focus groups are qualitative methods used most often to measure perceptions. As this report has shown, social media analysis, among other technologies, can help measure these abstract factors with considerable accuracy.

One example of big data being used in M&E in practice is through the work of the UN Global Environment Facility (GEF). The GEF has incorporated the use of satellite imagery and remote sensors to monitor wide-scale deforestation.[68] The GEF's rigorous mixed approach incorporates a variety of datasets that are systematically analyzed with machine learning. While the use of big data in M&E is still very new, a second practical implementation of big data in M&E is being done with UN Women. UN Women's M&E program has piloted the use of social media analysis to measure voter registration beneficiaries have been participated in women's empowerment programming.

Combining traditional M&E methodologies with big data will increase the number of people who can be reached, improving inclusion and participatory monitoring. Different data sets and tools will also provide a broader understanding of the program's impact. Over time, this will reduce the amount of time required to garner large amounts of data by project officers, make sense of complex programs more easily and improve evidence-based fundraising efforts.

Recommendations

1. **Systematize Data Collection**
   Extracting actionable and analytical insight requires systematic collection of data. Big data technologies can help in this regard. Firstly, during project design, planners should think carefully and broadly about the indicators that can be relevant to their work, how these indicators can be measured, and what the valid methods are for doing so. Understanding what technologies can offer tools for data collection may help project designers be creative about what sort of information can be gathered throughout the project.

   Machine learning can also help to process raw data sources, systematizing unstructured data sources and making them more usable for analysis. However, this process still requires human validation to ensure that the patterns and categories identified by the algorithms are in fact valid and relevant to the project. A general approach should be to create guidelines for collecting data, such as the type of information that might be gathered, data collection methods that can gather required information, and available tools for data analysis. Even more broadly, a

[68] Global Environment Facility. "Satellite Monitoring for Forest Management" Retrieved from: https://www.thegef.org/project/satellite-monitoring-forest-management

culture for collecting structured and organized data will further improve program design, implementation, and M&E.

2. **Build staff capacity and invest in computing infrastructure**
   A large number of organizations and staffers do not yet have the skills to fully onboard big data. Given the field's novelty, many policymakers may lack the knowledge required to select the right combination of big data tools and analytics to monitor and evaluate their particular program.[69] It is recommended that organizations make a concerted effort to educate M&E staff on the potential utility of new technologies and train them on developing platforms. This recommendation requires upgrading agencies' computation capacity, a front-loaded cost that will reduce as big data becomes more integrated into programs. Lastly, to address the knowledge gap for big data use in the public sector, organizations should actively build relationships with the public and private sectors.[70]

[69] Raftree, Linda, and Michael Bamberger, "Emerging Opportunities: Monitoring and Evaluation in a Tech-Enabled World," 39.

[70] United Nations Global Pulse. "Integrating Big Data into the Monitoring and Evaluation of Development Programmes."

Early Warning & Prediction

Forecasting conflict through the use of big data is one of the most ambitious – and controversial – tools for conflict prevention, promising anticipatory prediction before conflict erupts. The majority of technological processes to measure incipient conflict are pursued in the near-term through "early warning" systems, while "prediction" models aim to forecast over months and years. Machine learning can improve existing methods by allowing integration of multiple data types into a predictive model and identify patterns that indicate drivers of violence. Improvements in conflict prediction and stronger early warning systems will help policymakers decide where to allocate peacebuilding resources that can build resiliencies and address tensions before they escalate. Successful implementation of early warning systems with data tools for conflict prevention can achieve peacebuilding goals at a dramatically lower cost than post-conflict reconstruction.[71] While accurate conflict prediction poses great promise for policy makers and program officers, there are three primary challenges that warrant attention:

1. **Accuracy**: Inaccurate prediction (a high rate of false positives and negatives) undermines decision makers' confidence and prevents the timely allocation of peacebuilding resources.

2. **Predictive Time Window**: Existing platforms are limited to particular prediction windows, with early warning working over hours and days, while prediction tends to predict in terms of years. Prediction must provide time windows relevant to the program at hand in order to effectively target interventions.

3. **Reliability:** Programs that extrapolate from existing data can predict events that resemble the past; they do less well with the unexpected, unique, and extreme events that are of the most interest to policymakers.

Addressing these challenges in order to improve conflict prediction and early warning does not only require technological advances and tools; it requires a shift in the way conflict prediction is framed. Rather than viewing prediction in terms of probabilities of outcomes, big data tools can be used to catalogue and track specific increases in risk factors that lead to violence. This conceptual shift away from probabilities and towards a more realistic, feasible risk framework will allow policymakers to view conflict forecasting from a risk-based perspective. In doing so, it will not only address the problem of false prediction, but also allow for a better understanding of the driving factors of conflict.

This chapter provides an overview of early warning and prediction and describes current practices. It highlights the challenges with current approaches and suggests specific programs that embody potential improvements. This chapter follows convention in distinguishing between early warning and prediction; however, it emphasizes that both seek the same end, and can be addressed and improved by an integrated approach to forecasting.

[71]Francesco Mancini, ed., "New Technology and the Prevention of Violence and Conflict." New York: International Peace Institute (April 2013), 2.

Preempting and preventing conflict not only achieves peacebuilding goals by providing actionable and accurate information ahead of violence, it is also more cost effective compared to humanitarian aid and post-conflict reconstruction.[72]

Early Warning and Conflict Prediction Overview[73]

The primary difference between early warning and prediction is the time period in which they function. This result, in part, from the type of data used.

Predictive models tend to rely on structural data regarding socioeconomic conditions and development levels, as well as the history of previous conflicts in a region. These models draw on databases usually compiled on an annual basis, and so they often adopt years as a standard time increment.[74] The nature of these data sources, paired with the conception of structural factors that are long-term and static, leads to a view that structural data is best sourced from national statistics offices, databases, and international agencies. Not only can these data sources be problematic due to variable quality and availability,[75] but big data technologies can also provide more dynamic and up-to-date measurement of these same structural factors.

Early warning platforms provide warnings several hours or days in advance,[76] using immediate indicators of violence that give policymakers a view of what is happening on the ground – otherwise known as situational awareness. Early warning efforts attempt to identify incipient crises, against which immediate intervention can be deployed. However, early warning systems are criticized for seldom providing sufficient notice for preventive intervention. The reality is that they more often reduce reaction time or collect information on conflict after it has already taken place. To be effective, preventative peacebuilding requires both greater forecasting windows for early warning systems to enable timely prevention, as well as improved predictive accuracy.

Due to their different temporal focus, early warning and conflict prediction platforms can be considered two different approaches to conflict prevention: "operational prevention (short-term efforts to forestall an incipient of escalating crisis) and structural prevention (measures for addressing root causes of violence)."[77] Program planners seeking to build preemptive and forecasting technologies into their conflict prevention frameworks should give critical thought to the timescales relevant to their project and context, as well as to the types of data that are relevant and accessible to them. While neither early warning nor prediction have perfect prediction accuracy, they can provide valuable information to communities, officials, and policy makers, who can take action in order to preempt or mitigate conflict.[78]

Types of Data Relevant to Early Warning and Prediction

As mentioned above, early warning and prediction software produce different results by relying primarily on two different kinds of data: structural and events data.

Structural Data

Structural data relates to the current and historic conditions associated with a state or society-of-interest's susceptibility to, or capacity to resist, outbreaks of conflict. This data can be collected by national statistics organs, by humanitarian actors on the ground, or otherwise compiled by researchers and scholars abroad. Vast quantities of structural

[72] Mancini, ed., "New Technology and the Prevention of Violence and Conflict."

[73] For in-depth discussion of early warning, see: Anna Matveeva, "Early Warning and Early Response: Conceptual and Empirical Dilemmas" *Global Partnership for the Prevention of Armed Conflict*, Issue Paper 1, September 2006; For approaches to conflict prediction see: O'Brien 2010, Perry, C 2013 Machine Learning and Conflict Prediction: A Use Case. Stability: International Journal of Security & Development, 2(3): 56.

[74] For instance, see Perry, Chris. "Machine Learning and Conflict Prediction: A Use Case."

[75] Mancini, ed., "New Technology and the Prevention of Violence and Conflict."

[76] For example, see African Task Force Report, "African Regional Communities and the Prevention of Mass Atrocities." Accessed May 11, 2018. http://www.genocideprevention.eu/projects/africantaskforce/atf-report/ for comparison and analysis of early warning systems in African regional organizations.

[77] Mancini, ed., "New Technology and the Prevention of Violence and Conflict," 2.

[78] PBSO, "Potential Big Data to Advance United Nations Sustaining Peace Agenda and the Role of Peacebuilding Support Office."

data are available from databases, indices, and reports compiled during international relations and development work. An extensive list of databases providing structural data can be found in the Appendix. For an example of structural data used in a predictive model, see Box 14.

BOX 14. Examples of Structural Indicators

I. Conflict History
II. Neighborhood
III. Sharing a border
IV. Characteristic (poor/rich)
V. Temporal dummies (time period)
VI. Population
VII. Education
VIII. Youth bulge (effect on conflict extension)
IX. Infant mortality
X. Oil/commodities
XI. Ethnic dominance

Source: Hegre, at al. "Predicting Armed Conflict, 2010-2050"

Structural Data Limitations

Structural data is usually aggregated and static, limiting its utility in certain contexts. Fragile and at-risk environments are dynamic, with significant change occurring between the normal intervals of large-scale data collection. Furthermore, the level of aggregation – usually at the state and national rather than the local levels – may not provide sufficiently granular information for peacebuilders, who often work in specific contexts and communities. Supplemental data collection is often necessary to gain insight into the specific factors that drive conflict.[79]

Events Data

Events data catalogs regional events over time. Any number of incident-types can be collected, but events of particular interest to peacebuilding can be inter-ethnic violence, protests, or human-driven precursors of conflict. Current systems integrate events data by collecting and processing news reports,[80] crowdsourced reports from communities on the ground,[81] and field reports from humanitarian, peacekeeping missions, and government actors.[82] An events database compiles data from all of these sources to increase the volume and variety of data and makes the information accessible across offices and actors.[83]

Events Data Limitations

Since events data records past events, the category is of limited use for forecasting conflict.[84] Events data can also be biased by financial or political motivations. Lastly, even projects that achieve much larger sample responses than traditional survey methods, through the utilization of crowdsourcing and community-based reporting methods, may require pre-existing infrastructure in order for conflict-events to be reported. These methods may be useful where violence has occurred, and program officers already have a presence on the ground but may not be able to identify flare-ups in areas where no presence is currently maintained.

---

[79] Warm, Michael D., Brian D. Creenhill and Kristin M. Bakke, "The Perils of Policy hy p-Value: Predicting Civil Conflicts," (2010) *Journal of Peace Research* 47(4): 363.

[80] One example of a platform that is able to collect data in real time, and across languages, is the *Africa Media Monitor*, used by the African Union's Continental Early Warning System and can provide updates on evolving situations. See "The Continental Early Warning System (CEWS)" African Union Peace and Security Department, Accessed May 11, 2018. http://www.peaceau.org/en/page/28-continental-early-warning.

[81] One famous project is Ushahidi, which is detailed in on page 38.

[82] One such tool is *The African Reporter*, used by CEWS to collect reports from AU field offices and liaison offices to produce indices on conflict situation. See African Task Force Report, "African Regional Communities and the Prevention of Mass Atrocities.

[83] The CEWERS program in South Sudan combines local, county, state, and national collection, aggregation, and dissemination, while also contributing information to UNDP's Crisis and Recovery Mapping and Analysis platform. See Helena Puig Larrauri in Francesco Mancini, ed., "New Technology and the Prevention of Violence and Conflict," 76-77.

[84] Kai Jager has noted that in many cases, news reporting on events of violence serves to capture the occurrence of conflict itself, and therefore it is conceptually incorrect to consider this "conflict prediction" or "early warning", given that the event has already occured. Kai Jaeger, "Not a New Gold Standard: Even Big Data Cannot Predict the Future," (2016) *Critical Review* 23:3-4.

Challenges for Early Warning and Prediction

Several challenges remain associated with conflict prediction and early warning, particularly the tendency to overpredict conflict and the inability to predict truly anomalous events:

Over-Prediction

Existing data models have a tendency to over-predict the occurrence of conflict, leading to false positives and the danger of committing scarce resources to prevent a conflict that never takes place.85 The converse is problematic as well: missed predictions – false negatives – call into question the project's usefulness by failing to meet its basic purpose: providing advance notice of conflicts that do take place.[86]

Inaccurate conflict prediction platforms inevitably undermine political support by creating skepticism as to their ability to inform policy. Early warning and conflict prediction capabilities must be careful of what they promise, and what they can deliver.

Failure to Predict Anomalous Events

Prospective forecasting falls victim to a core epistemological problem, in that prediction generally collects data on past events to inform judgements of what will happen in the future. This approach may work for events that resemble the past, but it struggles to predict "black swan events"– extreme events that occur with little warning and emerge from novel contexts. Ironically, these are where conflict prediction would be most useful.87 While not asserting complete remedy to this challenge, this chapter concludes by suggesting that in some cases, unstructured machine learning can identify patterns within large, complex datasets that may not otherwise be apparent to human analysts.

Technology

1. Dynamic Structural Data

While structural indicators are static in the short-term, taking a "big data" approach enables the incorporation of dynamic factors into analysis. For example, commodity prices are usually considered structural indicators, with economic indicators such as Purchasing Power Parity or Consumer Price Index traditionally being collected by manually compiling prices of common staple goods. However, commodity price fluctuations can also be gathered by monitoring social media and analyzing the way discourse around food prices changes over time. Global Pulse demonstrated the effectiveness of this approach in Indonesia.[88] With big data, structural data need not be static, and can instead contribute to an up-to-date picture of the peacebuilding context on the ground and to quickly identify emerging trends. Machine learning can supplement and verify data reported from national governments and humanitarian actors. It can identify discrepancies in data, highlight consistently biased data sources and – with the help of a small amount of accurate data or a human analyst – correct for them to achieve more accurate datasets.

2. Automatically Processed Events Data

Automated scraping and natural language processing can be used to make news reports accessible for data analysis, similar to the technological processes that can analyze hate speech in social media. These processes are useful in hard-to-reach areas because they do not require physical presence on the

---

[85] "GDELT and ICEWS, a Short Comparison." *Predictive Heuristics*(blog), October 17, 2013. https://predictiveheuristics.com/2013/10/17/gdelt-and-icews-a-short-comparison/.

[86] Ibid.

[87] Jager, "Not a New Gold Standard," 343.

[88] UN Global Pulse, "Feasibility Study: Crowdsourcing High- Frequency Food Price Data in Rural Indonesia", *Global Pulse Project Series* no. 17, 2015. http://www.unglobalpulse.org/sites/default/files/UNGP_ProjectSeries_Crowdsourcing_Food_Prices_2015_0.pdf.

BOX 15. Case Study: GDELT

Google's GDELT Project is a free open platform for computing on the entire world. It monitors the world's broadcast, print, and web news from every country in over 100 languages and identifies the people, locations, organizations, themes, sources, emotions, counts, quotes, images and events driving society every second of every day. It has about 300 categories of physical activities around the world, from riots and protests to peace appeals and diplomatic exchanges.[1] Data gathered from GDELT can help monitor how certain populations are represented in local and national media, as well as the grievances of excluded groups expressed in the forms of violence or protest.

Source: The GDELT Project
https://www.gdeltproject.org

ground in order to monitor events. Local print mediums that are inaccessible remotely can also be processed at scale using image and text recognition software. This does not have to be constrained to printed media; rather, actors on the ground can photograph graffiti and political posters which serve as vehicles for political communication in the absence of internet or print media. These technologies require sufficient investment in order to make them functional in context-specific languages, but the basic processes are currently well-developed and in use. ICEWS and GDELT are well-established examples of this.

Social media analysis may also give insight into *perceptions* and *sentiments*, which this paper has covered in the earlier chapters on hate speech and perceptions of exclusion. This type of data collection can give analysts insight into the social conditions of an area of interest, potentially in the advance of any events that would appear in news articles to be processed in "events data" as described above.[89] Perceptions and sentiments can be informative data points for constructing early warning and prediction platforms. However, perceptions are also fluid and can rapidly change more quickly than economic or political conditions.

Despite the differentiated tendencies of prediction and early warning as currently practiced, there is considerable room for overlap in terms of methodology and data sources. This chapter suggests a unified process that incorporates both structural and event data in order to build a comprehensive picture of at risk environments. Though Tikuisis, et al. note that work needs to be done in adjusting the weight given to structural vs. event data, big data models using machine learning can address this issue by being adjusted over time.[90]

3. Integrated Forecasting Platform

The gap between early warning platforms and predictive models point to the need for an integrated framework that can leverage the ability of big data

[89] One such approach is a partnership between Global Pulse and UNDP who used GDELT data on broadcast, print, and web news sources to track tone and sentiment of news articles surrounding the 2011 Tunisian revolution. https://www.unglobalpulse.org/projects/conflict-news-media

[90] Tikuisis, Peter, David Carment and Yiagadeesen Samy, "Prediction of Intrastate Conflict Using State Structural Factors and Events Data," *The Journal of Conflict Resolution*, Vol. 57, No. 3 (June 2013), pp. 410-444.

technology to collect, collate, categorize, code, and analyze much larger and diverse types of data than previously possible. The following recommendations are framed in reference to projects that are successfully employing them. This chapter concludes by addressing several outstanding practical and epistemological questions to consider going forward.

A frequently-cited example of a predictive analytical platform that combines event and structural data is the Integrated Crisis Early Warning System (ICEWS), developed by Lockheed Martin and supported by various US government agencies.[91] The project aims to assist political and military decision makers allocate resources by drawing their attention to a variety of "events of interest" that can be relevant to intervention response.[92] ICEWS is distinctive in that it is based on an existing database (ACLED) of structural indicators and tracks ongoing events through multi-language news collection, perception monitoring via social media, and identifying key locations and individuals in each context.[93] This system builds upon the existing database, improving predictive power over time. The current platform provides six month rolling forecasts, with accuracy above 90% via the iCast platform.[94] An open-source and publicly available version of the dataset has been made available via the Harvard Dataverse.[95]

A notable shortcoming of predictive platforms is their focus on predicting conflict as an outcome, rather than identifying the issues that drive the violence. This is critical for peacebuilding; even if an individual or entity has a good sense of when and where a conflict will occur, program officers need an idea of what is driving the conflict in order to successfully intervene.[96] Finally, as with all models using probability forecasting, false predictions undermine the confidence of those responsible for allocating the resources that can make a difference in a timely manner.

Recommendations

1. **A risk-based approach to forecasting:** Conceptualizing conflict forecasting in terms of risks rather than prediction can aid in decision-making for targeting interventions, while avoiding problems inherent to probabilistic prediction such as uncertainty and false positives. Risk indices can help expand the window for forecasting, inevitably shifting the focus of program officers towards identifying the factors that drive changes in the risk environment and suggesting targets for programmatic intervention. Risk indices also allow for easy comparison between areas under consideration for program implementation.

   One promising program is GroundTruth, which integrates not only structural data on social, crime, and environmental factors, but also ground-level data on perceptions, prices of commodities, and discourse within communities. GroundTruth adjusts the data inputs used in its models over time, improving prediction and building understanding of how certain indicators contribute to violence in particular contexts. GroundTruth's system allows for auditing and backtracking of predictions and contributes to analysts' understandings of how changes in certain factors contribute to changes in the risk assessment. This addresses the gap between theory and practice. It is critical for officers to understand what factors drive conflict, not just where and when it is likely to occur.[97]

[91] O'Brien, Sean P., "Crisis Early Warning and Decision Support: Contemporary Approaches and Thoughts on Future Research," International Studies Review, 12: 87-104 (March 9, 2010) doi:10.1111/j.1468-2486.2009.00914.

[92] Ibid.

[93] Lockheed Martin. ICEWS. Accessed May 8, 2018. http://www.lockheedmartin.com/us/products/W-ICEWS/W-ICEWS_overview.html

[94] "Lockheed Martin Advanced Technology Laboratories (ATL)." Accessed May 8, 2018. http://www.atl.external.lmco.com/programs/ICEWS/ICEWS2/icast.php.

[95] Harvard Dataverse. Accessed May 8, 2018. https://dataverse.harvard.edu/dataverse/icews.

[96] Gleditsch, Kristian and Ward, Michael. "Forecasting is Difficult, especially about the Future" Journal of Peace Research

[97] Letouze, Meier, and Vinck talks about this as the move from predictive (what will happen) to the diagnostic (why it happens), 17-18.

2. **Recognize the need for human and machine interface:**
Many critics of the big data revolution emphasize that despite the explosion in available data, some political and social phenomenon remain difficult to collect information on, or to proxy.[98] Some conflict settings may not be conducive to big data processes, and information must still be developed with traditional human-centered methods. Furthermore, even perfect prediction is only useful to a point, since it can indicate the where and when of a conflict, but not the why. In order to be relevant to interveners, early warning and prediction models using big data must build human expertise into their process.

Again, GroundTruth shows how it is possible to combine human and machine capabilities, with the understanding that the drivers of conflict often vary from context to context. GroundTruth develops networks of experts, who provide local context to their indicators, and are useful in backchecking information to ensure that the data being used is in fact accurate and valid.[99] Human experts are built in throughout the forecasting process, lending their expertise to correct and adjust the machine learning algorithm, "teaching" the machine and improving overall accuracy while also adding explanatory power and context.

3. **Consider second-order factors**
Second-order factors can contribute to or reduce the likelihood of violence through local fragility or resiliency. Accounting for these factors may help explain both false positives and negatives in forecasting models since they might not be accounted for initially. For instance, robust and accountable local police forces might be able to intercede in incipient violence, thereby decreasing ultimate levels of violence, but are difficult to account for in a predictive model. Another way of conceptualizing this is the role of spoilers who interfere with an otherwise predicted course of events.[100]

Conclusion

Conflict forecasting is one of the most exciting fields for peacebuilding. Big data may be used to improve anticipation of and response to conflict in fragile areas. Big data technologies can help reframe how conflict prediction and early warning are conducted in practice, with a view towards making platforms more useful for peacebuilders, particularly by shifting "prediction" towards monitoring risk.

One shortcoming of both early warning and conflict prediction is the limited power they give interveners to take action on the ground. The timescale necessary to implement effective peacebuilding interventions in advance of conflict must be taken into account. Models which focus on an intermediate time period of several weeks to months and can incorporate static structural factors such as macroeconomic conditions and humanitarian indicators, as well as dynamic local data such as food prices and population perceptions should be prioritized. Consideration should also be given to ensure that forecasting delivers the information relevant to peacebuilding; as previously noted, the focus should be on factors driving conflict rather than the outcome of conflict itself.

Two outstanding challenges that are not easily addressed by technical approaches should be considered. Firstly, even perfectly accurate prediction platforms still require the political will and ability to intervene successfully – forecasting systems are useful to the extent that they inform decision makers. Secondly, should practitioners one day be able to predict conflict with sufficient accuracy to justify programmatic intervention, they are likely to experience an epistemological question of validating the impact of the program. This is to say, should intervention succeed, and conflict be prevented, the model will appear to have predicted a false positive, indicating the outbreak of conflict that never occurred. Thus, it is important to consider how the non-occurrence of conflict can be determined and defined as a result of the intervention.

---

[98] PBSO. "Potential Big Data to Advance United Nations Sustaining Peace Agenda and the Role of Peacebuilding Support Office."

[99] This approach was used by PeaceTech Labs in South Sudan; the case is studied in-depth starting on page 22. PeaceTech Labs. *Social Media and Conflict in South Sudan: A Lexicon of Hate Speech Terms*. December, 2016.

[100] Himelfarb, Sheldon., "Can Big Data Stop Wars Before They Happen?" Foreign Policy, Accessed May 11, 2018. http://foreignpolicy.com/2014/04/25/can-big-data-stop-wars-before-they-happen/.

V. Ethics and Privacy

While the technologies discussed in subsequent chapters provide important opportunities for peace and security work, their use also raise wide-reaching ethical considerations and concerns regarding users' privacy and security, particularly as it concerns the rights of the world's most vulnerable citizens.[101] Before the implementation of any data-driven intervention, certain ethical and security considerations must be taken into account. While many of these obstacles may also exist in non-conflict settings, the uniquely sensitive nature of post-conflict situations exacerbates these challenges and presents a need for heightened caution.[102]

Both organizations and users face certain risks associated with the use of ICT for data collection in post-conflict situations.[103] For instance, reporting on war crimes or gender-based violence may be seen as threatening to the perpetrators, raising the possibilities of retaliation, direct physical harm, and shaming. Risks can also evolve with technology. For example, taking part in technology programs, and downloading or possessing a mobile application tend to have a higher risk of physical threats and retribution for users.[104]

Additionally, data-driven interventions are likely to be met with suspicion in countries with histories of colonial oppression, corporate exploitation, or state surveillance.[105] Thus, it is important to understand the context and culture before a program or project is implemented. Important factors to consider are: the political and regulatory environment, the risks and rights of individuals and groups, the level of literacy of users, the language requirements for the technology in use, and how the project in question may create vulnerabilities for locals. It is furthermore advisable to engage with local communities, organizations, and experts to develop an inclusive understanding of risk, local context, and local policies.

Ethical guidelines need to be developed prior to the implementation of data-driven interventions. Pre-existing ethical frameworks can prevent the reveal of potentially harmful information and reduce the risks for both field workers and locals. A good starting point is to build on the seven ethical obligations for the use of ICT in post-conflict conflicts developed by JustPeace Lab:[106]

1. **Respect**: The individuals and communities who use or benefit from the technology project should inform every decision made. They should be provided with enough information to decide whether or not to participate voluntarily in the project, as well as the right to easily access and remove their data later on.

---

[101] JustPeace Labs, "Ethical Guidelines for PeaceTech," Accessed May 11, 2018. https://www.justpeacelabs.org/blog/2017-03-27/released-ethical-guidelines-peacetech/.
[102] Ibid.
[103] Ibid.
[104] Ibid.
[105] Latonero, Mark, and Zachary Gold. "Data, Human Rights & Human Security." SSRN Scholarly Paper. Rochester, NY: Social Science Research Network, July 1, 2015. https://papers.ssrn.com/abstract=2643728; ACCESS, "Encrypt All the Things."
[106] JustPeace Labs, "Ethical Guidelines for PeaceTech," Accessed May 11, 2018.

BOX 16. Professional Standards for Protection Work

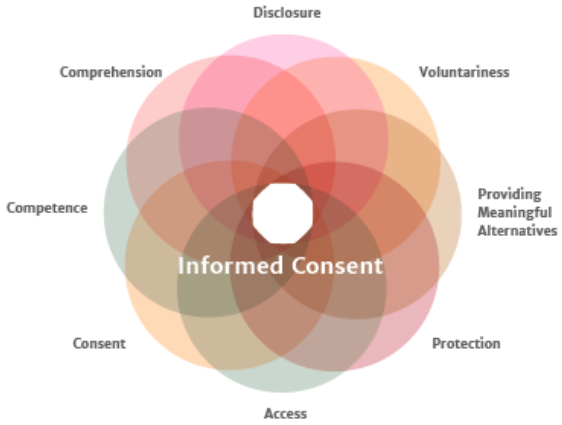
In March 2018, the International Committee of the Red Cross developed key Professional Standards for Protection Work for using technology in post-conflict Settings. These include:

- The protection of users unaware of the risks of being identified or tracked by the authorities or armed groups who might retaliate against them
- The misuse of personal data
- The risk of raising false expectations
- The inability of people who have had little or no exposure to modern information technology to give real informed consent
- The reliability/distortion of information due to bias or danger of manipulation
- The risk of favoring one-way communication from individuals to protection organizations
- The diminishing incentive for individuals to resort to more traditional face-to-face interviews with humanitarian workers
- The pressure on organizations to communicate publicly and rapidly

2. **Do No Harm**: Intervention must always do more good than harm. A risks/mitigation analysis should be conducted at the start of any project in order to identify all potential risks for users and the organization, as well as the steps needed to mitigate them. Further, the consequences of the data falling to the hands of an ill-meaning third party should be thoroughly assessed.

3. **Non-Discrimination**: Projects should actively avoid creating or replicating discriminatory structures. This entails an understanding of whether there is unequal access to technology amongst users (regionally, generationally, in terms of gender, etc.), and whether inequality creates a bias in the information collected.

4. **Informed Consent:** Populations must understand the potential benefits and risks related to collection and analysis of data. Informed consent is one of the most important and challenging obligations to fulfill, particularly when working with low-literacy or vulnerable populations who are not well versed in the use of certain technologies. Projects should be explained in a simple, easy to understand and culturally relevant way, with a clear delineation of the identified potential risks of participation, and an explanation of how the information gathered through the project will be utilized. Additional consent is also needed if the data is to be handed over to a third-party or used in a way not previously disclosed. This should all be done in consideration of relevant data protection, international human rights, and international humanitarian law.



Source: JustPeace Labs, "Ethical Guidelines for PeaceTech"

5. **Privacy:** Control of access to personal and personally-identifiable data should be limited, and the extent, circumstances, and sharing of this information should be identified in advance. Anonymization of data is an important, if only partial, step in ensuring data privacy. Data should be anonymized by default, keeping in mind the principle of minimization: collecting and keeping the minimum essential data, and deleting the data as soon as it is no longer

needed. For this, a strong understanding of the privacy capabilities and data use policies of all technologies (including partners' platforms, cloud-based services, messaging services, etc.) is needed. Even anonymized information can be used in conjunction with other measures to identify individuals, and so precaution should be taken in this regard. Finally, it is important to be aware of any existing laws that may require the disclosure of confidential data based on public safety and rule of law concerns, as well as laws that might prohibit encryption in some data communications.

6. **Security**: Precautions should be put into place to prevent the disclosure of sensitive information to unauthorized third parties, through loss, theft, unauthorized access, disclosure, copying, use or modification. Use of technology for peacebuilding also involves protecting users from physical, emotional and other harms that may be caused when data is accessed by third parties or as a result of using the project's technology. Further, the organization should be accountable at all times, and staff on the ground (at all levels) should be aware of the susceptibilities of the use of private data.

7. **Data Ownership**: When using a platform where data is traded in exchange for free services, the benefits and risks of requiring users to provide personal information should be weighted.

In addition to the ethical obligations, it is essential to manage expectations of the users. For example, providing technology for reporting human rights abuses might have the potential to set the expectation that the abuses will be tried under criminal proceedings. For this reason, organizations must be transparent at every step of the process and explain the purpose and outcomes of projects to populations.

Finally, a plan for how data will be destroyed or transferred to a trusted partner if or when the project ends should be created. All users should be informed of this plan. Additionally, it is critical to consider that, even when all precautions are taken, something may still go wrong. A crisis plan with clearly assigned responsibilities to handle any potential conflict, privacy or security risk should be created alongside the ethical guidelines.

VI. Conclusion & Recommendations

As the world becomes more connected, the amount of data generated and its potential for use in the peace and security sector will only grow. Yet, as evidenced in this study, data is "more than numbers" - it is essential to produce real-life results.[107] For peacebuilders and policy makers, advances in big data can drastically improve knowledge-driven decision-making by granting access to more data – both broad and granular – which can be collected and processed in near-real-time. Big Data tools foster and promote innovation, fill knowledge gaps, and mitigate key information challenges arising from a complex and interconnected world. By including real-time data on the circumstances and perceptions of citizens, refugees and non-state actors, big data can promote greater inclusion of vulnerable groups within peacebuilding processes.

Each of the systems covered in this report feed into stronger information management systems, enabling policy makers, governments and international actors to classify and anticipate risks for violent conflict before they occur. Aligning peacebuilding objectives with these promising data initiatives can improve the UN's capacity to identify conflict risks, notably those prioritized for intervention in *Pathways for Peace: Inclusive Approaches to Preventing Violent Conflict*.

Reframing conflict *prediction* in terms of *risk levels* will help legitimize and mainstream a useful set of data-driven predictive technologies. Following the private-sector approach, risk indices provide transparent indicators of conflict likelihood, which, when combined with other local and country-level data, can aid resource allocation. Monitoring changes in risk will help identify the specific factors that drive or forestall conflict, allowing for preventative action or timely intervention.

Monitoring and evaluation processes are often well established, so it is important to identify big data "entry points" that build on these existing frameworks. By collecting and synthesizing data from varied and dynamic sources, big data–driven situational awareness platforms can monitor and visualize changes as they evolve. By increasing the quantity of raw material – and the ability to analyze it – big data can improve accountability and strengthen traditional M&E processes.

In addition to implementing the technology and topic-specific recommendations described above, this study has several general recommendations for the uptake of data technologies in general:

1. Create and implement strong data governance and ethical guidelines:

Comprehensive ethics and governance guidelines for data must be developed at the outset of any project. If not properly regulated or protected, sensitive data in conflict zones can be used by malignant actors to target vulnerable populations. To prevent this, data must be anonymized, encrypted and routinely deleted. Programs and organizations might consider subcontracting a neutral third party to analyze and hold the data.

[107] UN Independent Expert Advisory Group on a Data Revolution for Sustainable Development. 2014. "A World That Counts."

2. Build a culture of systematic data collection and storage:

For data-driven decision-making, peacebuilding programs need substantial information repositories. Building these requires collecting and storing data systematically over time, so that data is classified in a consistent way allowing for comparative and longitudinal analyses. Any effort to reach the full potential of advanced data technologies should begin with building a culture of data collection along with a common appreciation of its benefits.

3. Support national and local partners to build their own data capacity:

A dearth of accurate and accessible data at the state level impedes peacebuilding efforts. **To remedy this, the PBSO and its partners should invest in national statistics offices' capacity to systematically collect, store and manage data**. Local capacity creates better datasets and more comprehensive national statistics, which peacebuilding actors can augment as necessary. Sensitization efforts should be made so that national governments understand the importance of systematic data collection efforts, and the seriousness of privacy and information security.

4. Foster stronger private-public collaboration:

While big data has exciting potential in pre and post-conflict areas, using it throughout the UN system will continue to present obstacles. Notably, these tools have relatively high initial costs, a significant challenge in the already resource-restrained UN system. While costs decrease over time as algorithms become more effective and expertise is developed, the upfront costs to its development may be prohibitive. Consequently, **the PBSO should seek to develop partnerships with other like-minded data organizations to pilot these tools.** Successful pilots can be championed and spread throughout, utilizing the UN system to achieve scale and demonstrate the value of these processes relative their costs. The identification of appropriate partners willing to accept challenges and failure in the early stages is key, as failure is a necessary part of innovation and many big data tools only come into their own after a period of testing and machine learning.

5. Use pre-existing data sources for "quick wins"

Given the extraordinary amount of data already available, **the PBSO should exploit pre-existing datasets for "quick wins" that build confidence and familiarity with the technologies.** By customizing open-source platforms like Ushahidi, datasets can be incorporated into situational awareness platforms to build stronger information management processes across the organization. Over time, additional indicators, such as hate speech, can feed into evolving datasets.

6. Build combined systems that incorporate human expertise:

A theme throughout this assessment has been the need to **combine human and computer analysis,** in recognition that big data does not obviate the need for human expertise. Machine learning can identify underlying patterns, but it still takes a human analyst to understand and contextualize those patterns to support decision-making. Particularly in under-developed conflict contexts where information is scarce, local culture must not be overlooked when developing and designing interventions.

7. Reframe how "big data" is viewed and manage expectations:

Many of the barriers to big data implementation are technical and resource-induced, but a larger barrier will continue to be political and cultural misperceptions of big data's promise. The notion that big data is a panacea, or that its implementation replaces human expertise, largely hinder its adoption. The unrealistic expectations placed on big data inevitably diminish confidence when technologies fall short of expectations. Recognizing this, the conversation around big data needs to be framed around filling in information gaps, and strengthening existing processes, rather than replacing them.

VII. Datasets

Humanitarian Data Exchange: Open sharing of humanitarian data (managed by UNOCHA)

Uppsala Conflict Data Program (UCDP): records conflict at two levels: minor and major conflict[108]

Armed Conflict Location & Event Data Project: A collection of political violence and protest data for developing states

Project on Explaining and Mitigating Electoral Violence: comparative databases of electoral violence, including cross-national macro-level dataset and a series of linked incident-based datasets at the micro level

WorldPop project: spatial demographic datasets for central and South America, Africa, and Asia

Ethnic Power Relations Dataset: identifies all politically relevant ethnic groups and their access to state power between 1946-2010

DigitalGlobe's Human Landscape: combines satellite imagery with open data sources

Planet: Members of Rapid Response Team in Planet can provide satellite images and geospatial analysis to field-based aid organizations.

Family Early Warning System (FEWS): Early warning and analysis on acute food insecurity[109]

[108] See: Dataset (Themner and Wallensteen 2011, Gleditsch et al. 2002)

[109] FEWS NET, http://www.fews.net

VIII. Bibliography

"About Ushahidi." Ushahidi. Accessed May 9, 2018. https://www.ushahidi.com/about.

African Task Force Report, "African Regional Communities and the Prevention of Mass Atrocities." Accessed May 11, 2018. http://www.genocideprevention.eu/projects/africantaskforce/atf-report/.

Al-Ghadir, Abdul Rahman I., Abdullatif Alabdullatif, and Aqil M. Azmi. "Gender Inference for Arabic Language in Social Media:" *International Journal of Knowledge Society Research* 5, no. 4 (October 2014): 1–10. https://doi.org/10.4018/IJKSR.2014100101.

ACCESS, "Encrypt All the Things," Data Security Action Plan, Accessed May 11, 2018. https://encryptallthethings.net/docs/EATT.pdf.

A/72/707–S/2018/43. "Peacebuilding and Sustaining Peace: Report of the Secretary-General." ReliefWeb. Accessed May 8, 2018. https://reliefweb.int/report/world/peacebuilding-and-sustaining-peace-report-secretary-general-a72707-s201843.

Cetorelli, Valeria, Gilbert Burnham, and Nazar Shabila. "Health needs and care seeking behaviours of Yazidis and other minority groups displaced by ISIS into the Kurdistan Region of Iraq." (2017) PLoS ONE 12(8): e0181028. https://doi.org/10.1371/journal.pone.0181028.

Chang, Jonathan, Itamar Rosenn, Lars Backstrom, and Cameron Marlow. "EPlaribus: Ethnicity on Social Networks." *Facebook*. Accessed May 8, 2018. http://cameronmarlow.com/media/chang-ethnicity-on-social-networks_0.pdf.

Chant, Sylvia., Cathy McIlwaine, *Cities, Slums and Gender in the Global South: Towards a Feminised Urban Future*, (Routledge, December 10, 2015).

Cognitive Edge. "Using SenseMaker to Understand Girls' Lives: Lessons Learnt From Girls

Hub." (May 2014) Accessed May 8, 2018. http://old.cognitive-edge.com/wp-content/uploads/2015/04/GH-SenseMaker-brief.pdf.

Computerworld. "Big Data's Big Role in Humanitarian Aid." Accessed May 8, 2018. https://www.computerworld.com/article/3027117/big-data/big-datas-big-role-in-humanitarian-aid.html.

Coning, Cedric de. "Adaptive Peacebuilding." *International Affairs* 94, no. 2 (March 1, 2018): 301–17. https://doi.org/10.1093/ia/iix251.

"The Continental Early Warning System (CEWS)." African Union Peace and Security Department, Accessed May 11, 2018. http://www.peaceau.org/en/page/28-continental-early-warning.

Data Revolution Group. "A World that Counts: Mobilizing the Data Revolution for Sustainable Development." (2014) Accessed May 8, 2018. https://www.unglobalpulse.org/IEAG-Data-Revolution-Report-A-World-That-Counts.

Demombynes, Gabriel, and Justin Sandefur. "Costing a Data Revolution." *SSRN Electronic Journal*, 2014. https://doi.org/10.2139/ssrn.2622756.

Fischer, Andrew Martin. "Resolving the Theoretical Ambiguities of Social Exclusion with Reference to Polarisation and Conflict." London: Development Studies Institute, London School of Economics, *DESTIN Working Paper* No. 08-09 (January 2008). Accessed May 8, 2018. http://www.lse.ac.uk/internationalDevelopment/pdf/WP/WP90.pdf

Francesco Mancini, ed., "New Technology and the Prevention of Violence and Conflict." New York: International Peace Institute (April 2013).

The GDELT Project Website. https://www.gdeltproject.org.

"GDELT and ICEWS, a Short Comparison." *Predictive Heuristics*(blog), (October 17, 2013). https://predictiveheuristics.com/2013/10/17/gdelt-and-icews-a-short-comparison/.

Global Migration Group (GMG). *Handbook for Improving the Production and Use of Migration Data For Development*. 2017. Accessed May 8, 2018. https://www.knomad.org/publication/handbook-improving-production-and-use-mgration-data-development-0.

GroundTruth Website. https://www.groundtruth.com.

Hayes, Sherrill, Brandon D. Lundy, and Maia Carter Hallward. "Conflict-Induced Migration and the Refugee Crisis: Global and Local Perspectives from Peacebuilding and Development." *Journal of Peacebuilding & Development* 11, no. 3 (September 1, 2016): 1–7. https://doi.org/10.1080/15423166.2016.1239404.

Hegre, Håvard et al. (2012) Predicting Armed Conflict, 2010–2050. *International Studies Quarterly*, doi: 10.1111/isqu.12007 © 2012 International Studies Association

Himelfarb, Sheldon., "Can Big Data Stop Wars Before They Happen?" Foreign Policy, Accessed May 11, 2018. http://foreignpolicy.com/2014/04/25/can-big-data-stop-wars-before-they-happen/.

"How Much Data Does The World Generate Every Minute?" *IFLScience (*July 26, 2017*),* Accessed May 11, 2018. http://www.iflscience.com/technology/how-much-data-does-the-world-generate-every-minute/.

"Inferring Gender from Colloquial English Text: A Machine Learning Approach Using Facebook Posts." Accessed May 8, 2018. https://pdfs.semanticscholar.org/67c1/9f0de179d2a654be9d0ff1d7d371d7d07fce.pdf.

Jaeger, Kai. "Not a New Gold Standard: Even Big Data Cannot Predict the Future." (2016) *Critical Review* 23:3-4.

Jakarta, Pulse Lab. "Using Big Data for Statistics to Track the SDGs." *Pulse Lab Jakarta*(blog), October 27, 2017. https://medium.com/pulse-lab-jakarta/tracking-the-sdgs-using-big-data-dad0ad351f2e.

JustPeace Labs, "Ethical Guidelines for PeaceTech," Accessed May 11, 2018. https://www.justpeacelabs.org/blog/2017-03-27/released-ethical-guidelines-peacetech/.

Kirkpatrick, Robert. "Driving a Big Data Revolution for Sustainable Development and Humanitarian Action." Presentation, New York, 2015.

Laczko, Frank, Solveigh Hieronimus, and Lars Hartenstein. *More than Numbers How Migration Data Can Deliver Real-Life Benefits for Migrants and Governments: Final Version for World Economic Forum in Davos on 24 January 2018*. Berlin, Germany: International Organization for Migration, Global Migration Data Analysis Centre, 2018. https://gmdac.iom.int/more-than-numbers.

Latonero, Mark, and Zachary Gold. "Data, Human Rights & Human Security." *SSRN Scholarly Paper*. Rochester, NY: Social Science Research Network July 1, 2015). https://papers.ssrn.com/abstract=2643728.

Letouzé, Emmanuel. "Can Big Data From Cellphones Help Prevent Conflict?" *IPI Global Observatory*(blog). Accessed May 8, 2018. https://theglobalobservatory.org/2012/11/can-big-data-from-cellphones-help-prevent-conflict/.

"Lockheed Martin Advanced Technology Laboratories (ATL)." Accessed May 8, 2018.

http://www.atl.external.lmco.com/programs/ICEWS/ICEWS2/icast.php.

Lustick, Ian., Sean O'Brien, Steve Shellman, Timothy Siedlecki, Michael Ward. "ICEWS Events of Interest Ground Truth Data Set." (2015). https://doi.org/10.7910/DVN/28119.

Lyons, Joshua. "Documenting Violations of International Humanitarian Law from Space: A Critical Review of Geospatial Analysis of Satellite Imagery during Armed Conflicts in Gaza (2009), Georgia (2008), and Sri Lanka (2009)." *International Review of the Red Cross* 94, no. 886 (June 2012): 739–63. https://doi.org/10.1017/S1816383112000756.

McDonald, Sean. *Ebola: A Big Data Disaster.* The Center for Internet and Society, 2016.

Mislove, Alan, Sune Lehmann, Yong-Yeol Ahn, Jukka-Pekka Onnela, and J Niels Rosenquist. " Understanding the Demographics of Twitter Users." In *Proceedings of the International Conference on Weblogs and Social Media*. (2011).

"New Technology and the Prevention of Violence and Conflict." *Stability: International Journal of Security & Development* 2, no. 3 (October 29, 2013): 55. https://doi.org/10.5334/sta.cp.

North, Douglass C., John Joseph Wallis, Steven B. Webb and Barry R. Weingast, "Limited Access Orders- Rethinking the Problems of Development and Violence." (1 January 25, 2011) Accessed May 11, 2018. https://www.colorado.edu/ibs/es/alston/psci4028/fall_2010/Limited%20Access%20Orders-%20Rethinking%20the%20Problems%20of%20Development%20and%20Violence.pdf

O'Brien, Sean P. "Crisis Early Warning and Decision Support: Contemporary Approaches and Thoughts on Future Research." International Studies Review, 12: 87-104 (March 9, 2010) doi:10.1111/j.1468-2486.2009.00914.x

Pedersen, Mogens Jin, and Christian Videb. "Improving Survey Response Rates in Online Panels: Effects of Low-Cost Incentives and Cost-Free Text Appeal Interventions." Accessed May 8, 2018. https://towardsdatascience.com/https-medium-com-shaanray-how-blockchains-will-solve-privacy-88944f3c67f0.

Perry, Chris. "Machine Learning and Conflict Prediction: A Use Case." (2013) . Stability: International Journal of Security and Development. 2 (3), Art. 56 DOI: http://doi.org/10.5334/sta.cr.

Puts, Marco, Piet Daas, and Ton de Waal. "Finding Errors in Big Data." *Significance* 12, no. 3 (June 1, 2015): 26–29. https://doi.org/10.1111/j.1740-9713.2015.00826.x.

PeaceBuilding Support Office. "Potential Big Data to Advance United Nations Sustaining Peace Agenda and the Role of Peacebuilding Support Office." (December 2017).

"Professional Standards for Protection Work." International Committee of the Red Cross, December 1, 2015. Accessed May 8, 2018.

https://www.icrc.org/en/publication/0999-professional-standards-protection-work-carried-out-humanitarian-and-human-rights.

Raftree, Linda, and Michael Bamberger. "Emerging Opportunities: Monitoring and Evaluation in a Tech-Enabled World." Rockefeller Foundation. https://assets.rockefellerfoundation.org/app/uploads/20150911122413/Monitoring-and-Evaluation-in-a-Tech-Enabled-World.pdf.

Ray, Shaan. "Blockchains and Digital Identity." Towards Data Science, March 10, 2018. https://towardsdatascience.com/https-medium-com-shaanray-how-blockchains-will-solve-privacy-88944f3c67f0.

Scoles, Sarah. "How the Government Controls Sensitive Satellite Data," *WIRED,* February 08, 2018, Accessed May 11, 2018. https://www.wired.com/story/how-the-government-controls-sensitive-satellite-data/.

The Swiss Foundation for Mine Action (FSD), "Drones in Humanitarian Action," Accessed May 9, 2018. http://drones.fsd.ch/wp-content/uploads/2016/11/Drones-in-Humanitarian-Action.pdf.

Taub, Amanda, and Max Fisher. "Where Countries Are Tinderboxes and Facebook Is a Match." *The New York Times*, April 21, 2018, sec. Asia Pacific. https://www.nytimes.com/2018/04/21/world/asia/facebook-sri-lanka-riots.html.

Tikuisis, Peter, David Carment and Yiagadeesen Samy, "Prediction of Intrastate Conflict Using State Structural Factors and Events Data," *The Journal of Conflict Resolution*, Vol. 57, No. 3 (June 2013), pp. 410-444.

United Nations Department of Economic and Social Affairs. "The Report on the World Social Situation 2016: leaving no one behind- the imperative of inclusive development." (2016)

United Nations Institute for Training and Research (UNITAR). "Syria Four Years of Human Suffering." (2014) Accessed May 9, 2018. http://unosat.web.cern.ch/unosat/unitar/downloads/SyriaFourYearsOfHumanSuffering/UNITAR-UNOSAT_SyriaFourYearsOfHumanSuffering.pdf.

United Nations Global Pulse. "Big Data for Development: Challenges and Opportunities." (May 2012) Accessed May 9, 2018. http://www.unglobalpulse.org/sites/default/files/BigDataforDevelopment-UNGlobalPulseJune2012.pdf.

United Nations Global Pulse. "Feasibility Study: Crowdsourcing High- Frequency Food Price Data in Rural Indonesia." *Global Pulse Project Series* no. 17, 2015. http://www.unglobalpulse.org/sites/default/files/UNGP_ProjectSeries_Crowdsourcing_Food_Prices_2015_0.pdf.

United Nations Global Pulse. “Integrating Big Data into the Monitoring and Evaluation of Development Programmes.” (2016) Accessed May 8, 2018. http://unglobal-pulse.org/sites/default/files/IntegratingBigData_intoMEDP_web_UNGP.pdf.

United Nations Global Pulse. “Making Ugandan Community Radio Machine-Readable Using Speech Recognition Technology.” Accessed May 8, 2018. https://www.unglobal-pulse.org/projects/radio-mining-uganda.

United Nations Global Pulse. “Publication: Integrating Big Data into the Monitoring and Evaluation of Development Programmes.” (2016) Accessed May 8, 2018. https://www.unglobalpulse.org/big-data-monitoring-and-evaluation-report.

United Nations Global Pulse. “Using Mobile Phone Data And Airtime Credit Purchases To Estimate Food Security.” (2015) Accessed May 8, 2018. http://www.unglobal-pulse.org/sites/default/files/UNGP_ProjectSeries_Airtimecredit_Food_2015.pdf.

United Nations and World Bank. *Pathways for Peace: Inclusive Approaches to Preventing Violent Conflict*. Washington, DC: World Bank (2018). doi:10.1596/978-1- 4648-1162-3.

Warm, Michael D., Brian D. Creenhill and Kristin M. Bakke, “The Perils of Policy hy p-Value: Predicting Civil Conflicts,” (2010) *Journal of Peace Research* 47(4): 363.

Witmer, Frank D.W. “Remote Sensing of Violent Conflict: Eyes from above.” *International Journal of Remote Sensing,* Vol 36, No 9 (2015), Accessed May 11, 2018. https://www.tandfonline.com/doi/abs/10.1080/01431161.2015.1035412.

World Bank. “Individuals Using the Internet (% of Population)” Accessed May 8, 2018. https://data.worldbank.org/indicator/IT.NET.USER.ZS.