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Designing an interactive real-time web-mapped dashboard to visualise conflict ceasefires data over COVID-19 infection rates: facilities and the way ahead

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Abstract— In March 2020, the UN Secretary General issued a call for a global ceasefire to help tackle the COVID-19 pandemic. This call was expected to result in a variety of responses from governments, diplomats, armed groups, NGOs, humanitarian actors, and mediators. Since these organizations are typically focused on specific countries and contexts, it was important to provide them and researchers of conflict and peacemaking dynamics with clear, concise, and well-presented data on the full variety of conflict parties' responses to the UNSG's call, the COVID-19 pandemic and to track the impacts of the pandemic on attempts to end armed conflict. Our tracker, called 'Ceasefires in a time of COVID-19' supports these efforts and SDG 16, i.e., promotion of just, peaceful, and inclusive societies. It features a timeline, an interactive map, and a search tool that displays qualitative data about the ceasefires and related events. This tool is unique in its application, bringing together ceasefires declarations and the COVID-19 infection rates from the Johns Hopkins COVID-19 database, and in its design, with input from the academic and practitioner communities. In this paper, we further describe the methodology used in designing the tool and argue in favor of broad interdisciplinary and cross-industry participation in dataset and user interface design, in order to reflect the requirements of the interested publics.

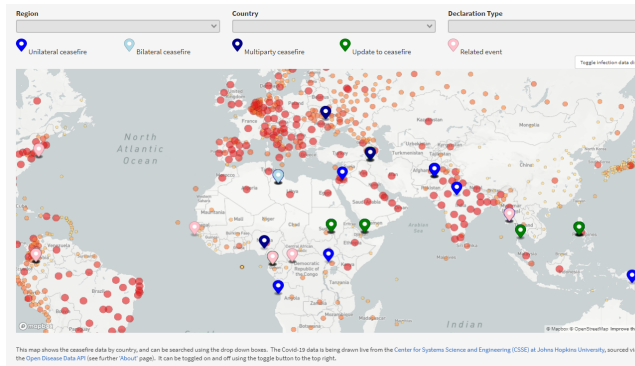
Keywords— Ceasefires, mediation, global ceasefire, UNSG, COVID-19, mapping, dashboard, tracker, API, webmap.

Political Settlements Research Programme (PSRP), University of Edinburgh, acknowledges its funders, supported by the UK Foreign Commonwealth and Development Office (FCDO). The Covid Collective is based at the Institute of Development Studies (IDS), bringing together the expertise of, UK and Southern based research partner organisations and offers a rapid social science research response to inform decision-making on some of the most pressing Covid-19 related development challenges. DB has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie COFUND grant agreement No. 801215: TRAIN@Ed: 'Transnational Research And Innovation Network At Edinburgh', and the Edinburgh and South East Scotland City Region Deal Data-Driven Innovation Initiative.

I. INTRODUCTION

At the onset of COVID-19 (CV-19) pandemic in March 2020, the UN Secretary General (UNSG) Antonio Guterres called for a global ceasefire to reduce the impact of the virus on conflict-affected populations. Following this call, states and non-state armed actors around the world responded with supportive declarations, some of which were in the form of ceasefires from parties currently engaged in armed conflict. As the Political Settlements Research Programme (PSRP), we were already collecting and tracking formal and written peace agreements and ceasefires from around the world as part of the PA-X Peace Agreement Database and Dataset [5, 6, 26]. However, given the diverse nature of the responses to the UNSG's call, including some armed-actor statements that were broadly supportive but explicitly declined to commit to a ceasefire, there was a need for a resource separate from PA-X to collect, track, and understand how parties to conflict were responding to CV-19.

In this paper, we describe the construction, components, and design of the CV-19 Ceasefires tool, followed by a discussion of its potential, impact, key findings, and future directions. We continue this Introduction with sections which cover project background and research on similar dashboards and maps; we then move onto Part II, covering the design of the ceasefires tracker and its system architecture description including the mapping dashboard. Part III discusses the Impact and the Results of this project so far. Part IV discusses the overall vision behind the endeavor and conceptualizes the global scenario shaped by a pandemic as it relates to conflict and peace, and how we can understand such complex issues in spatial terms. Finally, Part V concludes the research work narration, summarizing its positives and lacunae, along with laying down ideas for future scope of work.



(a) Ceasefires in a time of Covid-19: Submit information

Please note any personal data will be used only to verify that a person rather than other tool is responsible, and to respond regarding any queries on the data submitted. Submitting the form indicates our use to hold your name and email for these purposes.

Name*
 Surname
 First name

Institution
 Institution
 Email
 Email

Country*
 Country

Actions
 Actions

Information
 Information

Document
 Document

Signature*
 Signature

CEASEFIRES IN A TIME OF COVID-19

Region

Country

Declaration Type

Temporary

Showing 80 ceasefires and related events from 23 countries:

(United Nations)

Related events

Headline

UN Secretary General calls for global ceasefire

Declaration date

23rd March 2020

Declaration type

Related event

Actors

UN Secretary General António Guterres

Acter types

Non-state

Reciprocated

No

Headline

UN Security Council adopts resolution backing global ceasefire call

Declaration date

1st July 2020

Declaration type

Related event

Actors

UN Security Council (UNSC)

Acter types

Non-state

Reciprocated

No

Information

On 23 March 2020, United Nations Secretary General António Guterres called for a global ceasefire to stop violent conflict in support of the fight against the COVID-19 pandemic.

Sources

Source 1

Information

More than three months after UN Secretary General (UNSG) António Guterres called for a global ceasefire, the UN Security Council (UNSC) unanimously voted in favour of a resolution backing the call. The newly adopted Resolution 2532 (2020) stated that the UNSC's call upon conflict parties to engage in a "sustainable humanitarian pause", which should last for at least 90 days, excluded from this call are operations against Council-designated terrorist groups such as Da'esh, Al Qaeda and Al Nusra Front. UNSG Guterres welcomed the resolution and the UNSC's recognition of his appeal for a global ceasefire.

Text

UN/ISD-2022028.pdf

Sources

Source 1 | Source 2 | Source 3



(d) Fig. 1. (a), (b), (c), (d): Introducing the complete COVID-19 Ceasefires Dashboard components, interlinked for data retrieval, usage, and display.

A. Project background

As a research program with experience in data analysis of peacebuilding and conflict events around the world, we developed, with input from academic and practitioner collaborators, a visual dashboard ‘Ceasefires in a time of COVID-19’ (hereafter referred to as ‘CV-19 Ceasefires’), accessible openly over the internet [2, 7] and depicting the country-level timeline of conflicts and spatially mapped events, along with displaying CV-19 spread with real-time data acquired from reliable sources including Johns Hopkins University Center for System Science & Engineering Covid19 Dashboard [19, 13]. The tracker dashboard is live (<https://pax.peaceagreements.org/static/covid19ceasefires/map>) with real-time data, collated at country-level, and continuously updated by the present authors [2]. The CV-19 Ceasefires tracker [2, 7] provides an insight into ongoing and emergent armed conflicts during the pandemic. Hence, the tool envisioned an integrated structure providing country-specific ceasefire timeline information, search and filtering mechanism of ceasefire data and agreements, and a spatial map interface showing the global map of CV-19 infection rate as the backdrop for conflict ceasefires announcements and related events.

The aim of the CV-19 Ceasefires dashboard was to give an insight to peacebuilders, policymakers, researchers, and any other party interested in gauging the effects of the pandemic on armed conflict and peace processes, or a lack thereof. While based at the University of Edinburgh (UoE), the tracker received support, collaboration, and input from MediatEUR (European forum for international mediation and dialogue), Centre for Security Studies at ETH Zurich, Peace Research Institute Oslo (PRIO), Conciliation Resources, and the United States Institute of Peace. The underlying dataset of ceasefires was collected and made available online by the present authors, with input from MediatEUR. It was precisely this wide collaboration that crystallized the need for a comprehensive and comparative resource that policy practitioners, humanitarians, researchers, diplomats, and warring sides themselves could easily access and use to develop a context-specific response to ceasefire initiatives, based on experiences and arrangements made in a variety of armed conflicts. Easy access to practices and sequences of events from a variety of contexts is useful to those involved in conflict management or mediation, as it provides insight into possible routes of action and innovations as well as challenges seen in situations similar to theirs.

Fig. 1 with its components shows the various facets of the dashboards visible in the tracker such as the map in (a) that collates ceasefire locations and geo-references with CV-19 infection rates and maps them both in real-time on the world map; (b) a form with which users can anonymously submit ceasefires data to be included and displayed, upon requisite checks by the data team; (c) the qualitative data reporting the ceasefires with locations names and information sources (d) the timeline which chronologically streams the events pertaining to the ceasefires.

The ideas behind structuring such responses and solutions as the system in Fig. 1, are now known as the growing field of

PeaceTech, which involves the use of data, analytics, digitalization, and information technologies for peace processes [8, 17, 20, 36]. Through PeaceTech, we believe, complex peace-building efforts can be better understood and facilitated [18, 21, 27].

B. CV-19 trackers and dashboards

In this and the two subsections that follow we discuss the types of trackers and dashboards available over the world wide web and related to our research scope, which includes Covid19 trackers, and Ceasefires trackers, though we do not find any (other than our own) that track both issues. With this in mind, we give a brief overview of the features of such trackers [33].

The existing trackers available online and offering a wide variety of facilities, are incorporated in a library set-up created by one of the present authors (Bhattacharya) at <https://dbhatedin.github.io/CuratedTrackersLibrary> and the growing collection in the library are classified and categorized into several rich features of the trackers like tracker type, showing map, API, data type, domain, scope, extent and more. Most of these trackers also involve other themes of societal importance, along with the Covid19 data, such as policymaking, economy, supplies, mobility etc. but there is no tracker that presents the interplay of conflicts and ceasefires in the backdrop of Covid19 infection rates.

Almost all governments globally have published COVID19 infection rate dashboards. The most prominent of the Covid19 trackers is the JHU CSSE Covid19 tracker [19, 13]. It shows various statistics related to Covid19 globally and offers data download via APIs. Other authoritative Covid19 Trackers available online are CoronaNet [10]; COVID-AMP [11]; CCCSLCov19 [9]; ECDC [14]; Worldometer [35], to name a few. Apple Maps [3] and Google APIs have been providing very useful data on mobility patterns in Covid19 pandemic situations, and provide their infrastructure and design freely to study and devise solutions as well. Another example is the initiative known as Policy Forum [30], which provides a CV-19 interactive tool for the regions of the Pacific, Asia and in the process mapping the Pacific CV-19 response. Yet another elaborate Covid19 tracker from the medical community can be found at Arora et al. [4].

C. Ceasefires trackers and dashboards

While there is a wide range of tools available to track conflict and peace-related phenomena [12, 15, 22], there are as yet no instances of data and trackers that explicitly focus on ceasefires, apart from the tracker we present here. Some of the most prominent data resources on various forms of armed conflict focus on issues such as battle-related deaths, violent events and instances of organized armed violence, as well as peace agreements that aim to resolve the sources of conflict, but there is no single resource that tracks all instances of ceasefires at the global level. For instance, the Uppsala Conflict Data Program (UCDP), as described in [28, 29], provides an excellent online tool for tracking conflict and instances of deaths in conflict, with an intuitive and informative map and filtering system. However, these peace agreements data [29] are not fully integrated into the online tool and are limited to only such agreements that aim to resolve a key incompatibility between them. Ceasefires, however,

often aim for little but to stop fighting between the sides, even for a limited time, without necessarily resolving the underlying issues that the armed conflict concerns. Global conflict is also tracked by the ACLED project [1, 31] which similarly features an online interface, data downloads and filtering tools, but only focuses on instances of violent events, not considering ceasefires nor any other attempts to end conflict.

The PA-X Peace Agreements Database and Dataset [5, 6, 26], developed and hosted by UoE's Political Settlement Research Programme, has thus far been the only publicly available resource for comprehensive data on ceasefires, though only recording the formal, written and signed documents. While this is a valuable resource, we have also found that it does not provide us with the flexibility to record ceasefire events that lack a formally agreed ceasefire text. In the context of internal conflict in particular, ceasefires are oftentimes facing additional hurdles for formal agreement and implementation, as at least one of the sides faces the possibility of complete annihilation should the agreement be reneged on, as in Walter [34]. While formal, long-term, and wide-ranging ceasefires are thus difficult to reach, shorter arrangements to end fighting may be easier to achieve, though they may be less formal [32], less commonly written and made publicly available in full [23]. In order to have a full view of the ceasefire efforts by parties in armed conflict, we needed to track both the formally agreed and signed, and other forms of activity: informal arrangements, limited ceasefires, unilateral proclamations, announcements of no-first-strike, revocations of ceasefires, and similar. Relying on the UoE team and partners' experience in data collection and understanding of ceasefires, particularly the ongoing ceasefires data collection work at ETH Zurich (<https://css.ethz.ch/en/research/research-projects/ceasefires-mediation.html>), the UoE team developed the scope and methodology of collecting data on ceasefires during the CV-19 pandemic, described in detail in Section II.

D. Ceasefires in the backdrop of COVID19

As soon as the World Health Organization proclaimed on January 30, 2020 that the spread of this virus had indeed developed into a global pandemic, we were already interested in the effect that CV-19 would have on ongoing armed conflict. Following this announcement, we initiated our manual tracking of conflict-related events, recording multiple instances of warring sides stating that they would halt armed action so that the pandemic is not exacerbated.

On March 23, 2020, the UNSG called for a global ceasefire to take place, to facilitate the fight against the pandemic. The UNSG's call received much public attention, with numerous responses by governments, international organizations, regional organizations, non-governmental organizations, religious organizations and by the representatives of the warring sides themselves. This flurry of responses made it difficult to differentiate between ceasefires, statements of general support, and events that would have taken place regardless of the pandemic. At the same time, these responses increased interest on the part of researchers, policymakers, diplomats, and mediators, all of whom were interested in understanding the UNSG's call and any consequences it may have on the ground, in ongoing conflicts. However, as found

by Mehrl and Thurner [24], the pandemic and call to ceasefire had not stopped armed conflicts; instead, it became necessary to consider how conflicts (and with them, incentives to agree to ceasefire) were changed by the new situation. Two key questions arose: 1) Would there be significant response to the UNSG's call, and 2) How will the CV-19 pandemic and the ceasefire call jointly affect conflict dynamics in affected areas?

The ceasefires and related events that followed varied greatly, in terms of political actors that engaged in them, and in terms of the scope conditions of their announcements. We found that five types of events were both analytically relevant and found in the collected data: 1) unilateral ceasefire announcements, 2) their subset of reciprocated unilateral ceasefires, then 3) bilaterally agreed ceasefires, but also 4) updates to ceasefires, and 5) related events. The data concerning these events were tracked by the UoE CV-19 Ceasefires team, relying on a wide variety of news sources, NGO reports, armed groups' social media, and other resources developed in the process of creating the PA-X database. The information was checked and verified by the team.

Not all ceasefires agreed or announced during the pandemic can be directly attributable to the pandemic nor the UNSG's call. Nevertheless, the pandemic changes the environment within which conflict sides operate, and we see all these ceasefires and related events as inevitably affected by the pandemic [25], making this tracker a valuable tool for both conflict analysts and those with an interest in matters of public health in conflict-affected areas [2].

II. DEVELOPMENT ARCHITECTURE OF CV-19 CEASEFIRES TRACKER

The popularity of dashboards, visualizations, trackers and maps to follow the spread of CV19 has become obvious to all. This surge in popularity brings into focus the importance of map interfaces, the power and facilities of Application Programming Interface (API) and how to use them for mapping and facilitating data exchange between digital utilities and apps. We all have seen the JHU Covid19 maps [19, 13] but what we must also know is that the huge amount of data that goes into those maps are also available through their own APIs. Similar is true for the PeaceTech domain where so many data sources make their rich data available through APIs. However, not all sources will offer an API, many still only offer downloadable files, spreadsheets etc., but whenever APIs are available it enables continuous automated data accessibility. So, our tracker has been built to tap from APIs as well as occasionally read static documents fed into the system.

We program the calls to APIs to retrieve data in real time over the internet and use that data for our purposes without having to first download the data. Taking the JHU map interface as an example, the tracker deploys a map as a base layer and on top of it overlays several other layers of data pertaining Covid infection rates, population, and other statistics to convey a complete picture. Anyone can access these data, as we did for enhancing our work on ceasefires in Covid19 times, by overlaying on a map-base the global ceasefires declarations and Covid19 infection rates from JHU APIs. The CV-19 ceasefires tracker has been developed to deliver conflict ceasefires data in a meaningful way considering the effect of

CV-19 on conflicts. Hence, the tool envisioned an integrated structure providing country-specific ceasefires timeline information, search and filtering mechanism of ceasefire data and agreements, and a spatial map interface showing the global CV-19 infection rate as the backdrop for conflict ceasefires announcements, with all information on ceasefires and CV-19 pandemic in one place. Here-onwards, we describe the individual components of the dashboard, the tracker and discuss the methodology, challenges faced, and future goals, as noted above. The CV-19 ceasefires tracker dashboard is live and active with real-time data access to both CV-19 infection rates and ceasefire declarations continuously updated by the tracker team.

The UoE team worked with collaborators from MediatEUR (European forum for international mediation and dialogue), Centre for Security Studies at ETH Zurich, Peace Research Institute Oslo (PRIO), Conciliation Resources, and the United States Institute of Peace to assess the necessary system functionalities. As a group of researchers, IT specialists, and mediations practitioners, we were planning for the tool to satisfy the following core needs: 1) the information needed to be displayed in a way that allows for quick understanding of temporal and spatial dynamics, which led us to the timeline and map elements; 2) the information also needed to be detailed enough to allow any user to compare multiple countries, which led us to the filtering and search system; 3) the input of data needed to be simple enough to be available to all on the team, regardless of level of comfort with the data entry tool; 4) the data needed to be available to the core team and any interested researchers in a simple spreadsheet format, as a tidy dataset, which informed the decision to provide a direct download of data on the backend. We have also solicited feedback via a webinar meeting, which features attendance from a wide range of user groups: diplomats, researchers, mediators.

A. System architecture

The system architecture of the CV-19 Ceasefires tracker has a backend and a front-end. The front end also provides a feed to an API to directly retrieve data. Fig. 2 shows the system architecture used to deliver the CV-19 Ceasefires website. The database has classified tables of ceasefires data in specific format. The data tags, annotations, and related metadata clarify the data as well as integrate it in an interoperable way with the frontend. The interoperability is what allows many different functionalities to come out of the data in the form of timelines, maps and searchability of data. The dataset is stored in a MariaDB database. The Django framework is used to provide a backend system. The technologies to build the architecture are based on our existing infrastructure, data, user interfacing requirements, and dependencies. We have interfaced with in-house peace and conflict databases and retrieval systems and built on top of that by extending the architecture. MariaDB and Django platforms have been helpful in creating our overarching operating environment, of which Ceasefires dashboard is a part. We could have used any similar relational DB and would have made no difference (e.g. PostgreSQL,

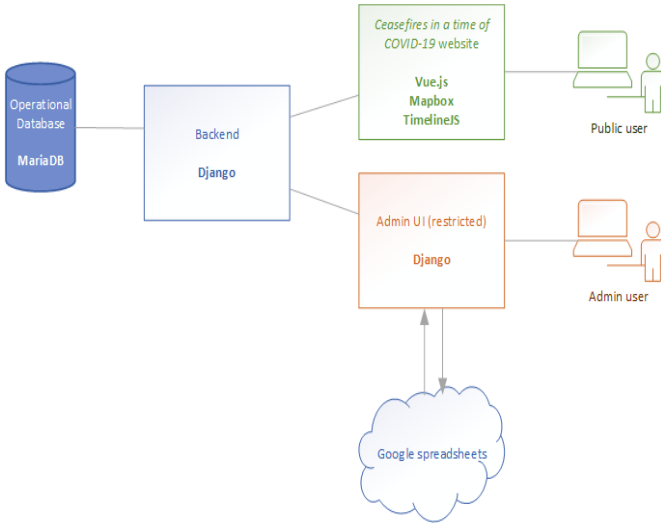


Fig. 2. System architecture for delivering the CV-19 Ceasefires Tracker dashboard over the web.

MySQL, Oracle etc.). In terms of framework Django is a good choice here because it is a Python framework and Python is a key tool in data science and can be used to build the data model, data API, and data management interface very rapidly.

B. Admin UI

The backend holds an admin interface available to authenticated users. This allows the direct entry and modification of ceasefire data and supports the import of data from Google Sheets, from Excel, or in a .csv format. These formats had been the primary data collaboration mechanism prior to the introduction of the backend. The system additionally supports exporting data back into these formats, thus allowing both direct input and bulk upload to be used simultaneously. This implementation allowed for a wide variety of users to take part in the project, as we expected that various levels of experience and comfort with direct data entry will be present in our multidisciplinary team. We also needed a mechanism which was not subject to institutional barriers, so that all collaborators could cooperate to collect the data should this be necessary. It was also important to facilitate export of data back into a simple spreadsheet format, supporting qualitative and quantitative research conducted by the UoE team and external collaborators.

C. API feed to website

To provide data to the CV-19 Ceasefires website, the backend makes available an API web service. This service uses GraphQL, which allows the website to request exactly the specific data required to generate the search result, map view, or timeline requested by the user.

An example of the JSON response returned by the server for a single record is shown in Fig. 3. The timestamp, event description, country details, data provenance and more can be ascertained from the data format, which is also how API calls return the data to the caller.

```

1  {
2    "data": {
3      "allCeasefires": {
4        "edges": [
5          {
6            "node": {
7              "uid": "C13-1",
8              "declarationDate": "2020-03-18",
9              "startDate": null,
10             "terminationDate": null,
11             "pdf": "",
12             "headline": "President Duterte declares unilateral ceasefire",
13             "information": "President Rodrigo Duterte declared a unilateral",
14             "media": "https://www.politicalsettlements.org/wp-content/upl",
15             "mediaCaption": "",
16             "mediaCredit": "by philwarren, licensed under CC BY 2.0",
17             "declarationType": {
18               "code": "unilateral",
19               "__typename": "DeclarationTypeNode"
20             },
21             "countriesFlat": "Philippines",
22             "__typename": "CeasefireNode"
23           },
24           "__typename": "CeasefireNodeEdge"
25         ]
26       },
27       "__typename": "CeasefireNodeConnection"
28     }
29   }
30 }
  
```

Fig. 3. The data format for Ceasefires database.

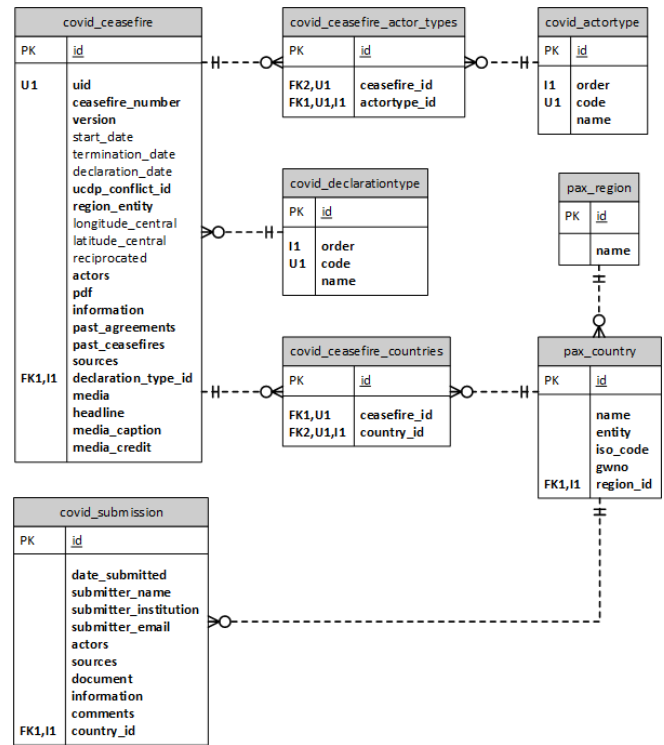


Fig. 4. Schema for Ceasefires documents database.

D. Public-facing website

The *Ceasefires in a time of COVID-19* website is implemented using a suite of JavaScript frameworks. The foundations of the site are delivered using Vue.js and NuxtJS. The timeline feature uses TimelineJS created by Northwestern University Knight Labs (<https://timeline.knightlab.com/>). The map feature uses Mapbox GL JS (www.mapbox.com).

E. Database Entity Relationship Diagram

The diagram in Fig. 4 shows the entity relationships between the data objects which make up the dataset. The scheme of classification allows for various functionalities to be embedded in the data itself, like actors, data submission guidelines, types of events, location parameters, and more.

F. Map Components

The mapping begins with the retrieval of ceasefires data from the backend and the calling upon the Covid19 data from the JHU API. The database contains data for the display onto the Timeline as well as on the Search tab. This data is also inserted onto the map in an integrated way, after matching the location components with the Covid19 data location parameters. On opening the dashboard weblink to the tracker, the main screen shows the timeline feature of the tracker upfront, with the other functionality tabs for searching, filtering and map accessible at the top of the page (including the timeline, which is the default tab). We have also added a tab for external user contributions, should users wish to suggest an instance of ceasefire or related event that is not part of the tracker. One can select any of the tabs and delve into the offered functions.

Here we start, first of all, with the description of timeline functionality, which shows the events of ceasefires declarations country- or entity- wise, for example the call for ceasefire at the advent of the Covid pandemic by the UNSG. For each country or event, further tracking of the ceasefire status is provided in the timeline. The timeline progresses with the CV-19 ceasefires and related events database for the entire world, with the ability to select a particular country or type of event. The display of CV-19 related ceasefires data in the timeline is achieved by passing the data in specific format to the API of the timeline. The challenges encountered concerned the integration of timeline with other prominent features in the dashboard, along with data related issues, wherein all data pertaining to any event have to be shown in a meaningful and attractive way. The interoperability issues and uniformity of features have been maintained. Visually, the timeline was made interesting by adding images pertaining to the country in question. Additionally, where a signed text of a ceasefire agreement was available, we provided for a downloadable pdf of it, on the timeline interface itself.

The next functionality in the dashboard is the search and filter facility to select any event by tags, names, location or other strings. This element was fully developed by the University of Edinburgh Information Services team, with guidance and input from the PSRP researchers, based on the prior experience of working with relevant stakeholders in peace processes. Here, more detailed information about each of the events can be accessed. In particular, ceasefire events display information relevant to researchers, diplomats, mediators, policymakers, such as ceasefire type (unilateral, bilateral), reciprocation of the announcement by the other warring side(s), list of armed groups taking part in ceasefire or related event. Importantly for the validity and reliability of the data, the key information about the event is provided, as are the sources for the events data. Where available, the text of agreement or announcement is also provided. Finally, the results also direct users to further explore other agreements related to the ceasefire

announcements, as found in the PA-X Peace Agreements Database and Dataset.

The next facility, the map feature, came about with the need to comprehensively and attractively display the global situation of the CV-19 pandemic and the conflict ceasefires status, all in one screen. This could only be efficiently and effectively be achieved through a dynamically updated map interface which feeds on both sets of data – CV-19 infection rates data as well as conflict ceasefires announcements data. The map base is built on the MapBox platform and the Covid19 real-time data is pulled from an API derived from JHU-CSSE Covid19 dashboard [19, 13]. The main technical challenges in achieving this part of the dashboard were again the interoperability issues related to data transfer and acceptance between the map platform, CV-19 data provider, and the ceasefires database. The other big aspect was the visual representation of not just the data but the whole big-picture, representing infection rate and conflict. Thus, the solutions devised ranged from incorporating toggle on/off layers for Covid/Ceasefires data superimposition, hovering icons pointing to availability of additional information, pop-up boxes, clickable insets, to general graphics representations of statistics. Several interdependent complexities came up while developing map display of data that led to better design of the overall architecture of the CV-19 Ceasefires tracker. One such issue was the efficiency of the calling mechanism providing global ceasefires data in country specific calls as opposed to a single call returning continuous global data. Another aspect was the inclusion of multiple events over the same geo-location. Since the spatial tagging depends upon geoindexes (latitude/longitude, other coordinates etc.) where there is the confusion of overriding information when put over the same coordinates. Related to that, some scrolling capabilities and minimum buffer zones for events were included.

G. External user contributions form

Finally, the tool allows for direct input from the users, via the ‘Contribute’ tab, which leads to a form that the users fill in with information about any events not found in the tracker, which they believe ought to be included. The filled in forms are directed to the PSRP email address, where they are assessed by domain experts for reliability. This is only used for substantive input from users – any publicly available information about ceasefire events that the team may have missed.

III. IMPACT AND OUTCOMES.

The idea of developing the CV-19 conflict ceasefires tracker was built as part of the endeavor to ascertain the effect, if any, of the CV-19 pandemic on conflict ceasefires announcements and related events. This need led to the thinking that a tracker dashboard can provide helpful facilities like a timeline, in order to understand the temporal component of armed conflicts; easily extractable searching and filtering mechanism for ceasefires data, to provide both flexibility of the tool and greater level of detail concerning each event; and a map-based feature to all ceasefires with the CV-19 infection rate in the background. To our knowledge, such an integrated tracker did not exist, although many trackers for conflict status or CV-19 infections can be found. The important outcome of the tracker

has been the co-placement of two highly critical global developments - the CV-19 pandemic and conflict ceasefires, allowing for visual and analytical insights to be derived from them as shown below.

The tracker's design and variety of deployed features turn it into a tool that is accessible for different audiences, such as peacebuilders, policymakers or health officials. By bringing together the relevant data, it visualizes trends that were previously invisible and facilitates the analysis of complexities in conflicts during a time when the amount of information available can be overwhelming, such as during the pandemic.

We have assessed the CV-19 ceasefires tracker in two ways: 1) we are continuously monitoring its performance via Google Analytics and are finding that the site is continuously used, with more than 1800 unique users thus far; 2) we have engaged with some of our key users in diplomacy and mediation directly – either through the partners or via our funding agency - and have found that this information has indeed been useful and is being used.

IV. DISCUSSION

The Tracker itself provides information to all actors involved in peacemaking and mediation and is directly related to the fulfilment of the Sustainable Development Goal 16: i.e., the promotion of just, peaceful, and inclusive societies. The tracker's global scope and combination with CV-19 data provides information to those involved in peace negotiations and in support of peace processes, by contextualizing the data about ceasefires, collecting and collating these data in a manner that enables learning from a multitude of verified cases of ceasefires and related events. More broadly, this is an expert-compiled data collection and visualization project that also highlighted the complexity of conflict situations and strategic concerns of armed groups in conflict. As such, it also serves as a pilot project for a future data collection effort that would map armed actors and peace-making and mediation efforts. Several aspects of the CV-19 Ceasefires tracker have raised interesting insights on how conflict parties have responded both to the pandemic, and to the UNSG's global call.

Firstly, we can see that, despite the initial number of declarations and ceasefire responses, as the pandemic continues, the number of ceasefire declarations has decreased. This in itself does not tell us much, as depending on the nature and stages of conflicts and peace processes, there is not a standard number of how many ceasefires are usually declared per month. However, because the tracker enables researchers to access and qualitatively analyze the declaration texts as well, we can see that fewer and fewer ceasefires are referencing the CV-19 pandemic. This possibly indicates that after the first media coverage and energy surrounding the UNSG call for a global ceasefire, conflict parties are less inclined to engage with the call, as they deem there is limited strategic value in associating any moves to ceasefire with the UNSG. It also suggests that conflict parties have adapted to the initial shock and disruption of the pandemic and have now adjusted to the 'new normal', with challenges and opportunities posed by CV-19 now factored into conflict dynamics and armed actor calculations.

Secondly, the qualitative data of the CV-19 tracker shows that most of the ceasefires declared during the CV-19 pandemic have been unilateral and temporary in nature, rather than obtaining 'buy-in' from all parties to the conflict, and several were contingent on a low threshold of violations. Ceasefires that were more bilateral or comprehensive were agreed long after the UNSG's global ceasefire call (such as between Azerbaijan and Armenia, or in Libya in the autumn of 2020), and made no reference to the UNSG's call nor CV-19, and were either in response to new outbreaks of conflict or as part of pre-pandemic, longer term peace processes. Further research on these dynamics would help policymakers understand how armed actors respond to infectious diseases and pandemics as a shift in conflict dynamics, and how such events need to be factored into conflict response planning.

A particular challenge of the project was ensuring effective cooperation between the PSRP team, the UoE IS team, and a wide group of researchers across multiple organizations. The most important element in this process has been the development of the tracker backend, which allows individual approved users to upload new data in bulk via Excel or .csv files, or to add to and edit individual event records manually. The backend data also include elements to link these ceasefire announcements to conflict records, such as those in the Uppsala Conflict Data Programme [28, 29], allowing for further diversification of the tool itself and broadening the potential for research.

V. CONCLUSIONS & FUTURE DIRECTIONS

This tool provides a springboard for these and similar projects, all aimed at exploring the interaction of armed conflict, peacemaking efforts, and technology. Nevertheless, some limitations remain: ceasefires are often referring to geographic areas that cross borders, or alternatively, to areas that are within countries but locally or regionally limited. Better visualization of these geographic complexities remains a task for future iterations of the tool. Similarly, various ceasefires-related events can aggregate to broader processes of interaction among warring sides and conceptualizing and visualizing these complex relationships remains a challenge.

While this work focused on the backend and the general infrastructure, we see multiple avenues for future work to improve both the display of information and community participation. First, we are seeking effective ways to incorporate more information into our visualization and that helps us making more observations. Examples of such information includes the issues complex geographies and relationships among warring sides, the time of a peace agreement, its type, and other data from the PA-X dimension as visualized elsewhere [17]. This will help us make better high-level observations about the type of agreement and its context and help us generate hypotheses for future research. Second, adding more information will require an optimized organization of information in the visualization, potentially requiring interaction, aggregation, and filtering operations. Last, we aim to build interfaces to allow the global audience to upload their own data and allow for annotation. Annotation is a powerful means to support collaborative sensemaking with visualizations and to capture an audience's

impressions, hypotheses, comments, and observations about a data [20].

In terms of research methodology, we have found that this tool provides an interesting and intuitive platform for researching conflict and peace, and for considerations of public health in areas of armed conflict. Additionally, the model of the CV-19 Ceasefires backend, in combination with the option to contribute data via an online form, facilitates cooperation and team efforts at data collection and organization, as it allows for users of varying levels of experience to engage in data collection and provision of digital interactive tools for peacemaking practice and the study of peacemaking efforts.

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