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Accessible and Interactive: New Methods of Data Visualization as Tools for Data Analysis and Information Sharing in Transitional Justice Research

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Abstract
The production and use of datasets is a growing area in transitional justice research. One constant limitation, however, is the way this data is visualized. Relying only on static graphics and tables, many of these datasets are insufficiently explored and analyzed, and remain inaccessible for other researchers. Interactive data visualization tools are an ideal method for overcoming this gap. They are able to adequately present a wide range of quantitative and qualitative data-types, such as geographic, temporal, network, and text data, and their interactive functions allow for a better exploration and understanding of the data. This article examines the visualization needs of transitional justice research, and demonstrates how interactive visualization can facilitate data analysis as well as information sharing. Presenting selected tools for different data types, the article provides hands-on methodological examples for effective handling of

[1] The opinions presented in this article are those of the authors and do not represent the views and positions of their respective organisations.

transitional justice data using, for example, GIS mapping, Google Motion Charts, and Word Trees.

Introduction

In recent years, the use of quantitative data in transitional justice and its related fields has significantly advanced, a development that will most likely continue in the near future. This has triggered the production of quantitative and qualitative datasets in this field and furthered data-based arguments on some of the current key debates. One major limitation so far has been the way results and their related data have been made accessible. From animated graphs and multi-layer data visualization to interactive mapping tools, many powerful methods are available to enhance the accessibility of datasets for both data analysis as well as result presentation. However, most publications are not taking full advantage of the potential of data visualization.[2] This has left high quality research under the radar of many scientists and practitioners, and has caused an increasingly potent analytic research tool to be ignored.

Today, the common perception of data visualization is as a tool used exclusively for quantitative datasets and primarily for result presentation. This view is long outdated. Animated interactive tools can increasingly be used to present both quantitative and qualitative data, making this technology particularly suitable for social science research. Furthermore, the initial visualization of datasets has become an essential tool of data exploration and analysis. Moreover, in light of the growing importance of 'big data' in data mining approaches,

[2] One example for this is the *Transitional Justice Research Collaborative*: https://transitionaljusticedata.com/. Having produced a very impressive dataset, the statistical results are presented in static graphics and the dataset itself can be accessed only as a whole or by selecting individual countries. Both visualisation and access could be improved using interactive visualisations, as will be exemplified further below.

visualization tools can open doors to new methods capable of making datasets accessible that formerly would have been too big to process.

This article aims to present some of the opportunities provided by new visualization tools and emphasize their importance for transitional justice research. The first part takes a brief look at the kind of data transitional justice research produces in order to see which visualization tools might be most fitting. The second part reviews the logic of visualization with an emphasis on interactive visualizations and how they help cognitive processes such as pattern discovery. Finally, the main part of this article presents tools that generate interactive visualizations. In a 'hands on' selection of examples, it is the aim to give both an overview of what is possible today as well as provide exemplary tools that in the eyes of the authors are most promising for the needs of transitional justice research. Due to the incompatibility of the print format of this publication and the interactive nature of the visualizations, the article follows a two-strand approach in presenting the examples. The benefits of the presented tools are described as best as possible in the text supported by graphics and images. At the same time, most examples are available online and can be used alongside.

Existing Datasets

When thinking about interactive visualization of data as a research tool for transitional justice, it is important to understand what types of datasets are generally used within that domain. While the nature of these datasets and the methods for their collection are investigated in more depth in other articles within this issue, this section only aims to produce a snapshot of existing datasets, their purpose and their characteristics in order to highlight implications for the process of visualizing transitional justice data. Published datasets as well as data-based research publications can be grouped in three broad categories, *research data, practice data,* and *legal data bases*. For each category, the article highlights typical characteristics of the created datasets, as well

as ways the data are presented. This exercise provides an overall picture of what transitional justice data is today and what role visualization plays for research in the field.

Research on the Causes, Functioning, and Impact of Transitional Justice Events

The most prominent set of data collected as part of transitional justice research aims to measure, compare, and evaluate the workings and success of transitional justice practice and its various tools. The work of Tricia D. Olsen, Leigh A. Payne, and Andrew G. Reiter is a good example of this type of research project. Providing a databased analysis of transitional justice measures (trials, truth commissions, amnesties, reparations, and lustration policies), their dataset lists the occurrence of various mechanisms over time and by country.[3] Based on this core dataset, the authors analyze when and under what circumstances countries implement transitional justice measures, what factors facilitate or impede the process, and, most crucially, to what extend these measures achieve the commonly postulated goals.[4] A similar approach is followed by Scott Gates, Helga M. Binningsbø, and Tove G. Lie.[5] They focus on a range of mechanisms used in internal armed conflicts and also include in the list of measures within their database what they call abstention from transitional justice measures (amnesty and exile). Studies like these two have created similar datasets of where and when transitional justice instruments have been applied. But in their coding, they face similar problems when attempting to measure the impact of transitional justice

[3] Tricia D. Olsen, Leigh A. Payne, and Andrew G. Reiter. *Transitional Justice in Balance: Comparing Processes, Weighing Efficacy* (Washington, DC: United States Institute of Peace Press, 2010).
[4] Ibid., 1.
[5] Scott Gates, Helga M. Binningsbø, and Tove G. Lie, *Post-Conflict Justice and Sustainable Peace* (The World Bank, 2007).

processes. Several studies rely on opinion polls[6] or use the occurrence of demonstrations[7] as a measurement of approval or disapproval of transitional justice processes. In doing so, they rely entirely on binary data of occurrence or non-occurrence, or turn complex social concepts like public approval of transitional justice measures into numeric values. Another influential example for data-based research in the field is the Transitional Justice Research Collaborative.[8] In contrast to the aforementioned datasets, the Collaborative does not simply list occurrence of a transitional justice measure, but includes a short descriptions, and, in many cases, links to further reading, for each entry. As a group, data bases produced for transitional justice research primarily include quantitative or logical data. But, as this core data is frequently combined with temporal, geographic, or even text data, these datasets are not purely quantitative but can be characterized as mixed datasets including a variety of data types.

As quantitative variables dominate these kinds of data bases, tables, graphs and plots are the predominant choice of visualizing the data.[9] And with the majority of these studies being published in print format or as PDFs, interactive visualization tools are not easily included to present the data within the publication.[10] While the decision of the Transitional Justice Research Collaborative to publish the database online is commendable, the way the data is presented

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[6] James L. Gibson, "Overcoming Apartheid: Can Truth Reconcile a Divided Nation?" *The Annals of the American Academy of Political and Social Science* 31.1 (2006): 82-110.

[7] Belinda Botha, *Truth Commissions and their Consequences for Legitimacy*, (Ph.D. dissertation, University of Houston, 1998).

[8] Geoff Dancy, Francesca Lessa, Bridget Marchesi, Leigh A. Payne, Gabriel Pereira, and Kathryn Sikkink, "The Transitional Justice Research Collaborative: Bridging the Qualitative-Quantitative Divide with New Data," available from www.transitionaljusticedata.com.

[9] See, for example, Olsen, Payne, and Reiter 2010, 125, 181.

[10] Yet, they can be powerful tools for exploring and analyzing the dataset, as shown below.

could be improved. At the moment, the statistical results are presented only in static graphics. Furthermore, the dataset itself can be accessed only as a PDF file showing merely a subset of the data or via drop down windows selecting individual countries within a table. So far, only a few of the produced datasets are published in a way that facilitates access for other researchers or practitioners. If the core data is published at all, it is either appended in a printed table in the annex of a book or in a format that cannot be handled easily with data processing software. This practice hinders profitable exchange of information and the growth of data knowledge. Both presentation and access could be improved using interactive visualizations. Interactive maps, timelines, or graphs, all of which are explained in detail below, are ideal options for this data and could facilitate better overview, exploration, and analysis.

Practice Data

Another strand of datasets used in transitional justice research is generated not in the analysis of its measures, but as part of, or in relation to practice. In the cases of Argentina and Brazil, examples of this research are included in this special issue. Mapping exercises, generated not in the aftermath of transitional justice processes, but alongside, or, in some cases, even before their implementation usually come from a very diverse field of research and practice. The work of Cath Collins, Lorena Balardini, and Jo-Marie Burt[11] mapping trial activity for past human rights violations can serve as an example here. Creating datasets of the ongoing processes in order to assist victim organizations in their interaction with the process makes both the methodology and the purpose of the data base distinct from the above-mentioned datasets. In terms of the format of the datasets, data

[11] Cath Collins, Lorena Balardini, and Jo-Marie Burt, "Mapping Perpetrator Prosecutions in Latin America" *International Journal of Transitional Justice* 7.1 (2013): 8-28.

are gathered both in numeric coding as well as in text format.[12] Another example of such a dataset, one that will be investigated closer below, is the conflict mapping exercise done by the International Peace Information Service (IPIS) in Central Africa.[13] Datasets created while conflicts are still ongoing are of significant benefit to transitional justice research as well as practice, once the conflict is resolved and society moves to transitional justice.

With individuals (victims/ perpetrators), legal proceedings (indictments/ arrests/ court rulings), or conflict events as entry units, the coding categories of these datasets are distinct from other datasets. They tend to be more detailed and have higher levels of qualitative data, such as geo-data, network, time- or text-based data (victim or perpetrator testimonies). Furthermore, while the primarily academic datasets discussed above are designed in order to investigate a specific research question, these more practice-oriented datasets often have a broader application and a different target audience. With the higher importance of qualitative and text-based data for these datasets, static visualization tools often are too limited to be helpful for analysis or presentation.[14] Shown in more detail below, interactive visual tools combine powerful ways for researchers to interact with the data by providing overviews as well as easy access to detailed information on single entries. While the visualizations created by IPIS are a good example of how this type of data can be visualized, this application of interactive visual tools for analysis is the exception and not the rule, and the field should adopt this approach more broadly.[15]

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[12] Ibid.

[13] International Peace Information Service, "Conflict Mapping: Maps," available from www.ipisresearch.be/home/conflict-mapping/maps.

[14] While it is difficult to know if visualization has been used only as a step in the analysis of the data, but not in its presentation, the lack of mentioning in the methodology sections leads to assume that interactive visualizations are not yet frequently used.

[15] For a very good example of conflict data see the Armed Conflict Location & Event Data Project, which codes the locations, dates and types of all reported

Legal Document Databases

A third group of datasets can be simply labelled as legal databases. Focusing on the legal strand of the field, several research projects have collated legal documents of transitional justice measures, or measures closely related to the field. One primary characteristic of these datasets is that they are predominantly text based. Most of these databases are composed of a collection of agreements in PDF format sorted by country and year.[16] Yet, more detailed databases exist, which code more levels of information: The *Peace Agreements Database* collated at the University of Ulster[17] serves as an example for these. This database does not stop at collecting the documents, but also provides summaries of the agreement's content in relation to 18 different thematic issues ranging from "Enforcement Mechanisms" to "Judicial Reform." It combines the provision of the whole text with logical variables (existence/ nonexistence) of certain topics, short text-based information, as well as temporal or geographical information. While different in aim and structure to data mentioned above, this group of datasets shows the similar pattern of including various kinds of data types (time, text, geography, etc.). For legal as well as political research and transitional justice practice, these databases can be of immense importance.

Yet, while it is commendable that the databases can be freely accessed, the way they are presented falls short of what is possible today. At present, both databases can only be searched by different criteria like *country*, *year*, or *issue*, with the output always being a table.

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conflict and protest events in over 50 countries in the developing world. http://www.acleddata.com/.

[16] See for example the peace agreement data base from the UNDPA, United Nations Department of Political Affairs, "UN Peacemaker," available from www.peacemaker.un.org.

[17] Transitional Justice Institute and International Conflict Research Institute. *The Transitional Justice Peace Agreements Database*, available from www.peaceagreements.ulster.ac.uk.

Single agreements can then be selected, revealing more details. While this provides all coded information in a suitable way for the specific agreement that is accessed, it does not facilitate a more comparative analysis. Values such as the date or location could be better presented in timelines or maps. Interactive visualizations could, for example, quickly show the geographic or historic spread of certain thematic issues being addressed in peace agreements, while still providing quick access to detailed information on single agreements.

What is Transitional Justice Data Today?

Looking at the databases that researchers have produced, the image emerges that here, in contrast to the natural sciences, information is predominantly not numeric. Following the need to make observations countable, the majority of comparative datasets translate non-numerical information into logical or numeric formats. While this is a necessary step for statistical analysis, text-based data from legal documents or surveys are particularly difficult to translate without losing a major part of the information. Other frequent data types are temporal, geographic, or relation data that accompany logical or quantitative data. The result of this method of data collection and coding is a high number of mixed databases that combine quantitative with qualitative data.

These observations show that visualization tools that exclusively represent numeric information are not ideal for transitional justice research. In order to visualize transitional justice data, tools are needed that can combine different data types: most importantly temporal, geographic, network, and text-based data. In the following sections, this article shows how interactive visualization can help to address these challenges.

Interactive Data Visualization: Roots and Reasoning

Having identified what sort of datasets transitional justice research produces and having looked at the shortcomings of current data

visualization practice in the field, new tools and strategies need to be found that fit the demands of researchers. Interactive data visualization offers precisely these tools. The following paragraphs introduce interactive data visualization by briefly outlining the roots of data visualization and its development to interactive visual tools. Thereafter, the article outlines the cognitive advantages of these tools for data analysis and information presentation, before presenting some examples of tools and explaining how they can be used for transitional justice data.

Roots of Data Visualization

The idea of visualizing data to present information and to facilitate understanding is not new and has been applied for many years. From old representations such as Charles J. Minard's famous 1869 visualization of Napoleon's Russian campaign, mapping the shrinking of the French army on its march to and from Moscow (Figure 1), to today's frequently used charts and infographics, all follow the idea that visualization of complex information enhances human understanding.

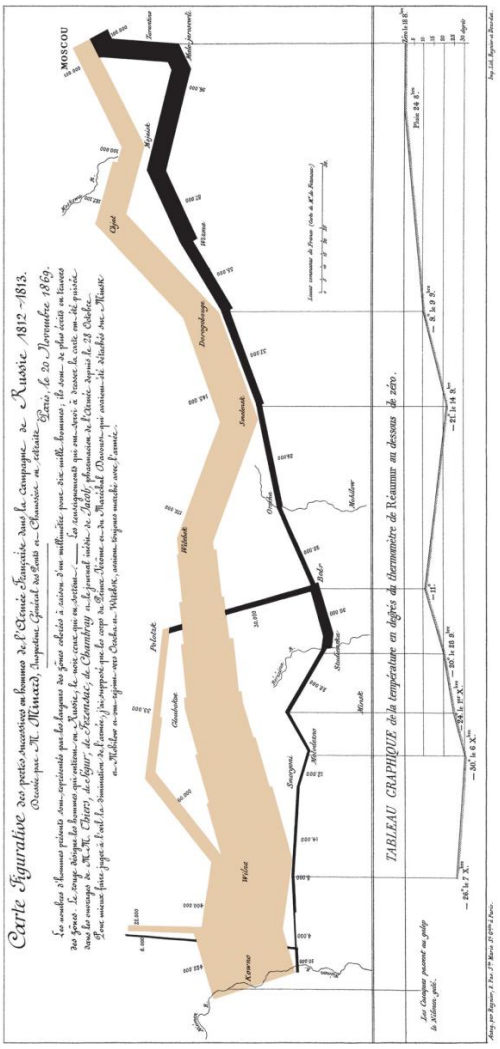

Figure 1: Charles J. Minard's map visualizes the losses of Napoleon's army in relation to time and geography. The width of the line indicates the size of the army while rivers and cities show the army's movement over time and geography.

In other words: "Visual structures are perceived directly, and don't have to be first decoded symbolically, as is the case with numbers and letters. Visual representation transforms a cognitive problem into a perceptual task, which is drastically more efficient."[18] Furthermore, it appears that society has developed what David McCandless calls "information design literacy" by being increasingly exposed to data and data visualization in everyday life.[19]

Since its early days, the basic concept of visualizing information has remained virtually the same. But its importance and application have evolved as the advent and staggering development of computer technology since the 1980s have drastically changed the field. A first step introduced digitalized visualizations. A second step, following the development and spread of powerful home PCs and increasingly vivid computer screens, made the visualizations come alive: interactive visualizations were born.[20] Subsequently, over the last decade, the development and spread of high-speed internet has made a wide range of data and interactive visualization tools available to everybody.

Interactive Visualization

While there are no clear definitions of interactive visualization, for the purpose of this article, the term is used in its simplest sense to include all forms of data visualization that give the user at least one option of modifying which data is shown or how it is visualized.

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[18] Dominique Brodbeck, Riccardo Mazza, and Denis Lalanne, "Interactive Visualization - A Survey," in Denis Lalanne and Jürg Kohlas (eds.), *Human Machine Interaction: Research Results of the MMI Program* (Berlin: Springer, 2009): 28.

[19] David McCandless, "The Beauty of Data Visualization," TED talk July 2010, available from www.ted.com/talks/david_mccandless_the_beauty_of_data_visualization#t-544901.

[20] Lev Manovich, "What is Visualisation?" *Visual Studies* 26.1 (2011): 36-49.

At its core, interactive visualization is simply a big collection of different visualizations of the same dataset that allows a user to conveniently select which versions he or she wants to view. In providing this, virtually all interactive visualization tools available today follow the *Visual Information Seeking Mantra* proposed by Ben Schneidemann:

Overview first,
zoom and filter,
then details-on-demand[21]

While in the past one would have needed different visualizations for each of these stages, interactive visualizations use the same logic of visual representation for abstract data, but provide all three stages in one view. After providing a primary *overview,* they allow the user to modify the content or the way information is displayed. Users can *zoom* in on parts of the dataset or *filter* the data, showing only selected categories. Finally, more detailed information for individual elements of a bigger dataset can be triggered upon user demand. While static visualization tools had to drastically condense or simplify the data in order to produce a comprehensible graphic, interactive visualization gives access to a vastly bigger part of a dataset by making different layers selectable. Thus, it is able to provide both overview as well as detailed information. This technological advancement yields benefits for the two main fields of application: visual data analysis and data presentation.

[21] Ben Schneideman, "The Eyes Have It: A Task by Data Type Taxonomy for Information Visualizations," Proceedings of the 1996 IEEE Conference on Visual Languages (Boulder, CO, September 3-6, 1996): 336-43.

Visual Data Analysis

Data visualization has always been a tool to support discovery of knowledge. Thus, being of primary use for the exploration and analysis of datasets, interactive visualization can be a strong advancement in this field. While static visualizations have been a sufficient tool for many decades, data mining tools and the resulting datasets have drastically changed. Usually framed under the catch all term Big Data, many immensely large and complex datasets bring traditional analytical tools to the limits of their capacity.[22] Faced with the threat of an information overload, one approach is to combine the strengths of the human in visual perception and pattern discovery with the strengths of the machine in mathematical computing and automated data analysis.[23] Interactive visualization tools serve exactly this goal. They provide an interface that allows researchers to explore the data and discover patterns that they would not be able to detect if the data was presented in spreadsheet format. The ability to zoom in and access additional information gives a deeper understanding and facilitates the discovery of interconnections between different layers within the data.

In contrast to mere presentation of a dataset, the concept of Visual Data Mining goes one step further by not restricting the computer part of the human-machine union to the visualization of the data, but including the computer's power for statistical analysis. For that purpose, Daniel Keim et al. further develop the *Visual Information Seeking Mantra* to a *Visual Analytics Mantra* including machine-based statistical analysis:

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[22] Daniel A. Keim, "Information Visualization and Visual Data Mining," *IEEE Transactions on Visualization and Computer Graphics* 8.1 (2002): 100-107.

[23] Simeon J. Simoff, Michael H. Böhlen, and Mazeika Arturas, "Visual Data Mining: An Introduction and Overview," in Simeon Simoff, Michael H. Böhlen, and Arturas Mazeika (eds.), *Visual Data Mining: Theory, Techniques and Tools for Visual Analytics* (Berlin: Springer 2008).

"Analyse first-
Show the Important -
Zoom, Filter and Analyse Further -
Details on Demand"[24]

Whether this advanced version of the *Visual Information Seeking Mantra* can be applied obviously depends strongly on the nature of the dataset, since its power applies primarily to quantitative datasets.

As the review of databases created in the field of transitional justice has shown, a vast number of datasets include several layers and different formats of data. Visualization with an interactive *details on demand* function allows for the combination of numeric, non-numeric, and text data. In combination with its ability to leverage the power of human-machine interaction for visual data analysis, it provides an ideal tool for any data-based research.

Data Presentation

Similar to the data analysis process, interactive visualization can play an important role when it comes to presentation of research results and information sharing. While academic publication remains predominantly bound to static text and graphics, private and advocacy organizations are increasingly using interactive visualizations to present results and make datasets available for other researchers or practitioners.[25] For the field of transitional justice, which is more closely linked to political practice than many others, the importance of making information available for practitioners in the field cannot be overstated. Bearing this in mind, it is surprising that few datasets are publicly accessible and even fewer are easy to use. On this issue,

[24] Daniel A. Keim, Florian Mansmann, Jörn Schneidewind, and Hartmut Ziegler, "Challenges in Visual Data Analysis," Tenth Annual Conference on Information Visualization (2006): 9-16.

[25] See, for example, The Arachnys Open Data Compass (compass.arachnys.com) or The Refugee Project (www.therefugeeproject.org).

interactive visualization can push research and practice further by making knowledge transfer more convenient and efficient.

While the main arguments for using interactive visualization are mostly the same (combination of different data types and layers, accessibility of big databases providing overview and detailed information, etc.), the element of interactivity has another benefit here: as a researcher making a database accessible, it is difficult to anticipate the individual interest or research question a user might have. With static visualization, it is only possible to provide one predefined and fixed view of the dataset. By adding the interactive element, users are able to modify the visualization to their needs, by focusing on individual segments of the dataset.

Providing easy access and high flexibility towards individual demands and use, interactive visualization of datasets can play a crucial role in advancing transitional justice research as well as transitional justice practice. The fact, as shown below, that the vast majority of today's interactive visualization tools are internet-based and usually programmed in HTML and Java further facilitates the global spread of research results by making the data available online.

Examples of Visualization Tools

When talking about data visualization, visual statistical tools such as graphics, plots, tables, charts, histograms, or tree maps quickly come to mind. These tools, used by millions of people and easily accessible, are ideal to present quantitative data such as statistics, numbers, Boolean data (True or False), occurrences, or percentage. However, as discussed above, the field of transitional justice deals with a lot of qualitative data, and complex sociological and/or political concepts that are difficult to code and visualize with simple values. Yet, quite recently, many new tools have been made easily available online to visualize and analyze more complex sets of data. This next part of the article presents some of the tools that provide the abovementioned features and could advance data-based transitional justice research.

Date and Time-Based Data Visualization

One data type that frequently is part of transitional justice datasets is time data. Visualizing historic events for comparison, timelines are a popular choice, and for good reason, as they are useful tools that facilitate the analysis of complex and overlapping datasets consisting of time-related events. To illustrate the potential of an interactive timeline visualization, we look at a simple example using the Truth Commission Digital Collection as presented by the United States Institute for Peace (USIP)[26] as an illustration dataset. With a small graph (Figure 2), the data can easily be compared by occurrence over the last lustra (few commissions until the 1990s with the biggest waves in the early 1990s and 2000s).

[26] United States Institute for Peace, "Truth Commission Digital Collection," available from www.usip.org/publications/truth-commission-digital-collection.

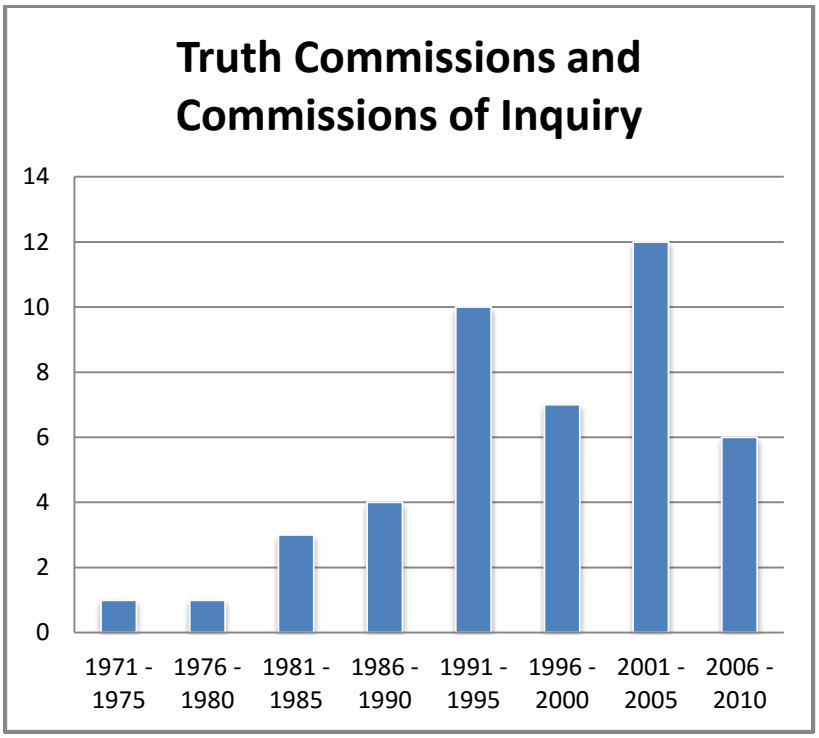

Figure 2: Number of truth commissions per lustrum

This allows users to get a rough overview showing a certain pattern with a rise in truth commissions after the end of the Cold War. However, for any analysis that goes beyond a simple overview, one would have to go back to the database and create new visualizations. Looking at the same data visualized in an interactive timeline[27] provides both an overview over the data, as well as an easy access to more focused visualizations. For this interactive visualization, the

[27] The visualization is available from www.tiki-toki.com/timeline/entry/478749/Truth-Commissions.

online visualization tool TikiToki is used.[28] TikiToki is a web application developed to create online interactive multimedia timelines. The duration of time is shown as horizontal bars with a scale at the bottom. In addition to the time, images, text, and even videos (YouTube, Vimeo, and AVIs) can be embedded in each entry and can be triggered as additional on-demand information.

[28] Tiki-Toki, "Tiki-Toki: Beautiful web-based timeline software," available from www.tiki-toki.com.

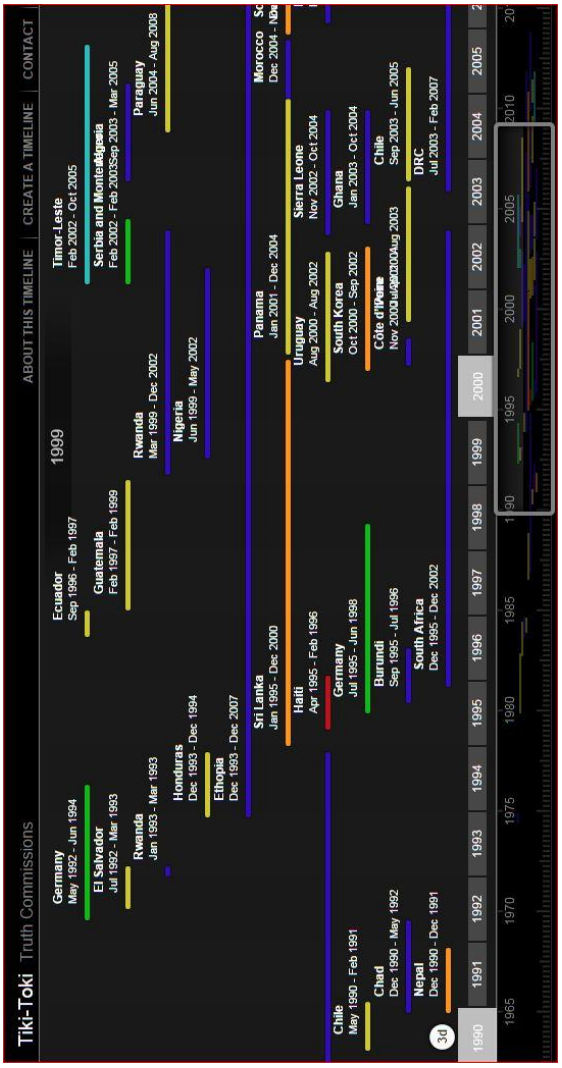

Figure 3: Timeline of truth commissions (overview)

Figure 3 shows a zoomed out view of the timeline based on the USIP database. It contains the same information as the table above, but offers two visualizations: a detailed timeline that allows for scrolling and zooming through the years, as well as an overview line at the bottom of the page. While the analysis derived from the table above can be easily made from the overview, the timeline includes further data, such as the duration of commissions or their geographical spread. Furthermore, each entry can be clicked, which opens a dialogue window that offers detailed information about the individual entry, as well as a link to the USIP webpage on this specific truth commission (Figure 4). With a few mouse clicks, additional categories (geographical area in that case) can be selected to subset the dataset to be visualized (Figure 5). This allows for further analysis of different patterns (occurrence of new commissions, simultaneity, length, repetition, etc.). This selection and subsetting function can be very helpful for big and varied datasets in particular.

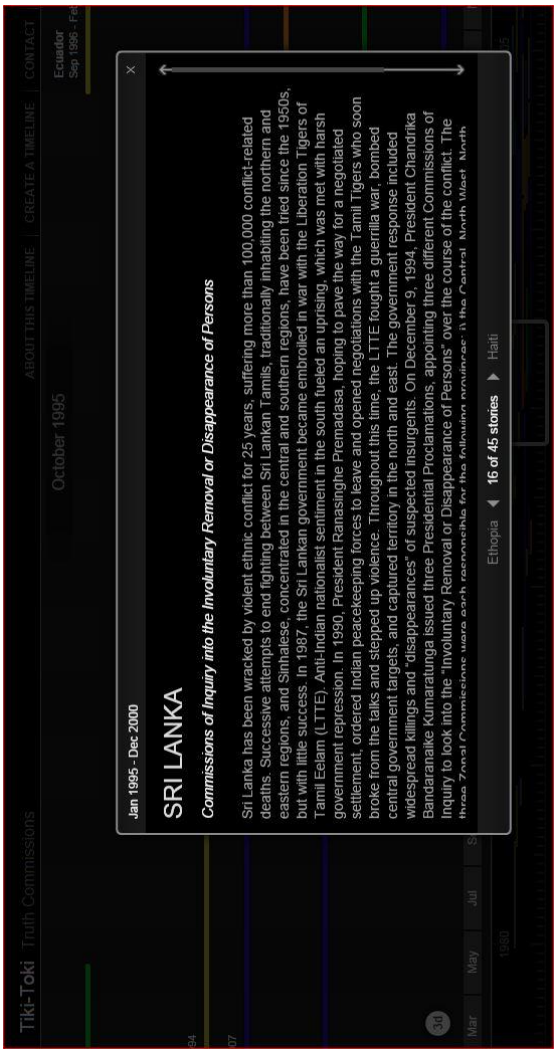

Figure 4: Additional information can be triggered on demand

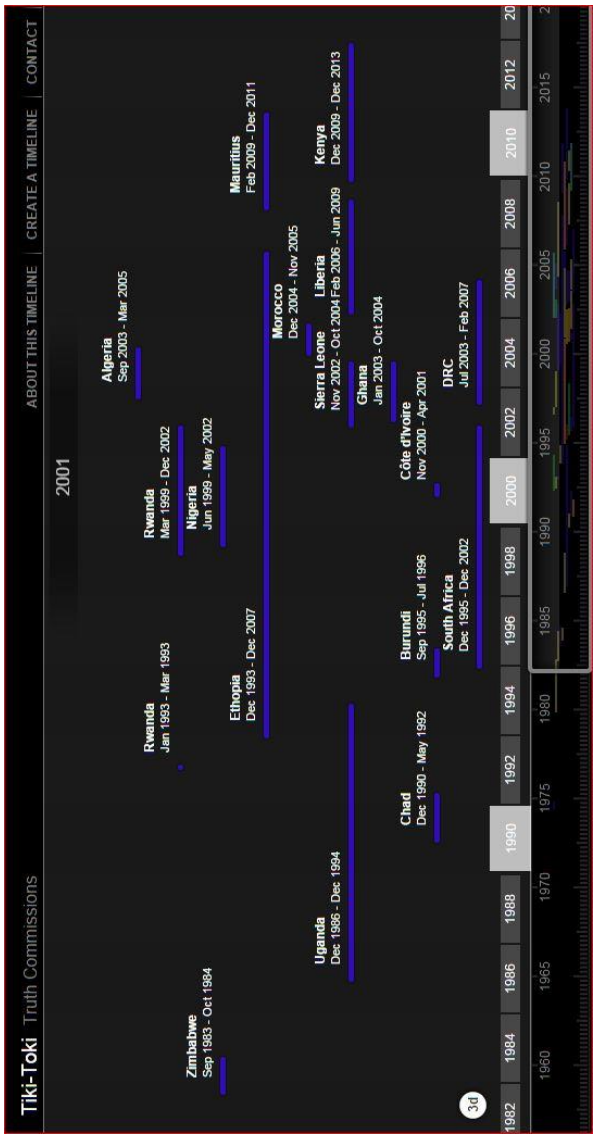

Figure 5: Truth commissions in Africa

By transferring time into horizontal bars, timelines offer visualizations that are easy to comprehend and are as suitable for exploring a dataset as a whole as they are suited to comparing individual entries or categories. The option of making additional information (e.g. text-based data) available by clicking on individual entries is a useful feature both for data analysis as well as result presentation.

In the field of transitional justice, with its focus on historic developments, the possibilities for application are numerous. As shown in the example, timelines can be used to show the temporal relation of justice mechanisms, such as truth commissions, trials, or amnesties. They can show developments and major events within the history of a conflict or a transitional justice process. For analysis as much as for data presentation or educational purposes, the combination of visual overview of historic events with details on demand makes interactive timelines a powerful tool for the field of transitional justice.

Visualization of Links, Relationships, and Networks

Another frequent, but non-numeric category of data deals with relations between individuals or groups. This can include power relations in politics or the military as well as networks of positive or negative influences within a political system or a conflict situation. Simply put, a network can be defined as a group or system of interconnected people or organizations. For example, in a conflict situation, it might be interesting to understand who the present actors are and how they are related. Such an exercise was recently conducted by the International Peace Information Service (IPIS)[29] in order to

[29] Filip Hilgert, Lotte Hoex, Steven Spittaels, and Yannick Weyns, "Mapping Conflict Motives: the Central African Republic," available from www.ipisresearch.be/publication/mapping-conflict-motives-central-african-republic-2.

visualize armed group affiliation in the ongoing conflict in the Central African Republic (Figure 6).

In the graph, an interconnection between two groups is simplified as an edge (a link) between two nodes (a source and a target). The same representative approach is used by Gephi,[30] an open-source interactive visualization and exploration platform: from a table with two columns (Source and Target), one can build very complex graphs and network visualizations. More information can be added (more attributes/columns) that will be displayed in a pop-up window by clicking on individual nodes. Furthermore, Gephi can include a timeline to reflect changes over time.[31]

Using Gephi, IPIS recently created a visualization of power relationships in Eastern Democratic Republic of Congo.[32] In this visualization (Figure 7), power relationships were simplified as support or oppose connections. Every node (actor or organization) received a size proportional to their importance in the network, and a color by type (armed groups, individual, political actor, international NGO, etc.).

By clicking on a node, users can highlight connections of a particular actor (Figure 8) and get access to more information contained in the attribute window (on the left of the screen). Panels on the left allow for query by type of organization, areas of intervention, communities of interest and involvement in peace negotiations.

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[30] Mathieu Bastian, Sebastien Heymann, and Mathieu Jacomy, "Gephi: An Open Source Software for exploring and Manipulating Networks," Third International AAAI Conference on Weblogs and Social Media, available from www.gephi.org/.

[31] Gephi is published under General Public License, and thus is available as a freeware tool.

[32] International Peace Information Service, "Power Mapping Tool," available from www.ipisresearch.be/home/conflict-mapping/maps/power-mapping.

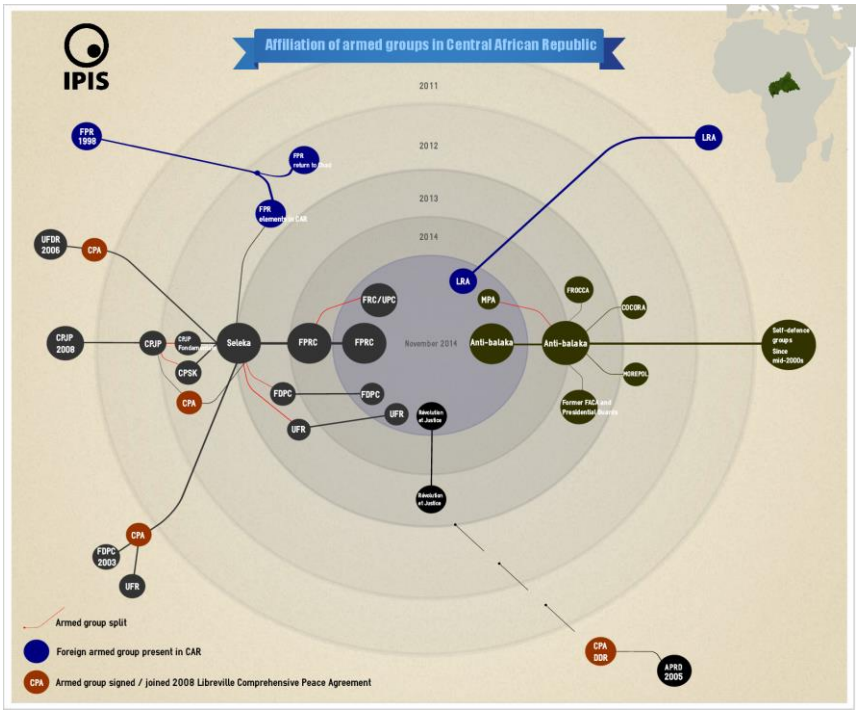

Figure 6: An example of a chronological network visualization of armed groups affiliation in CAR

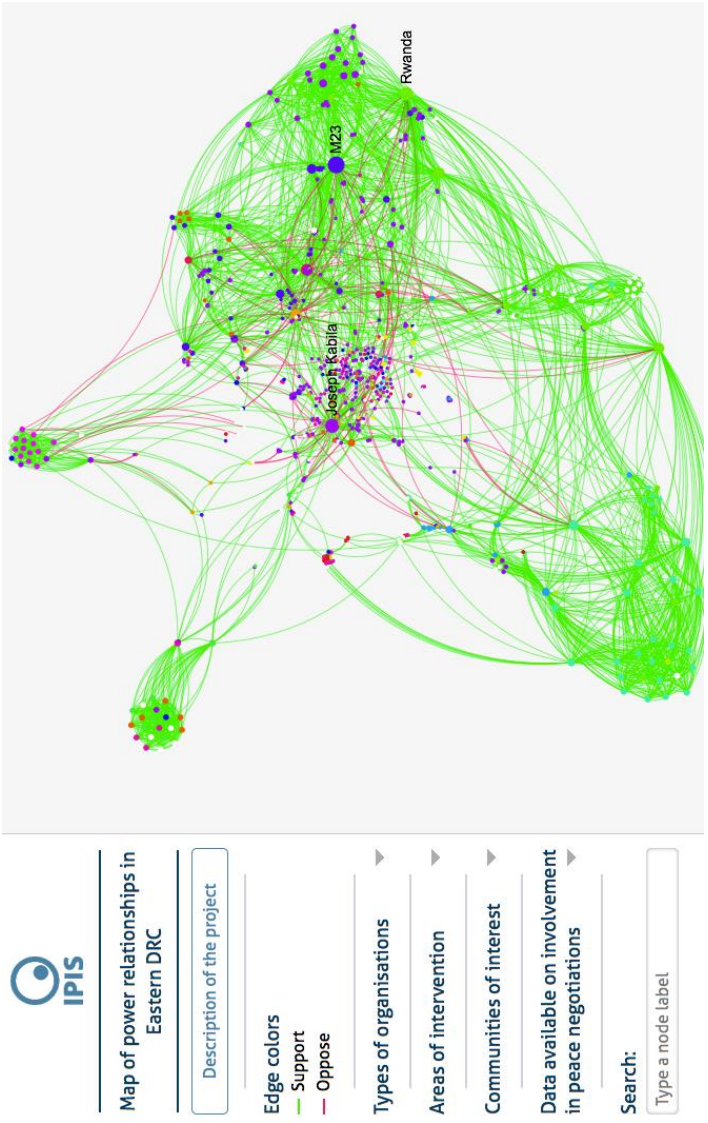

Figure 7: Map of power relationship in Eastern DRC

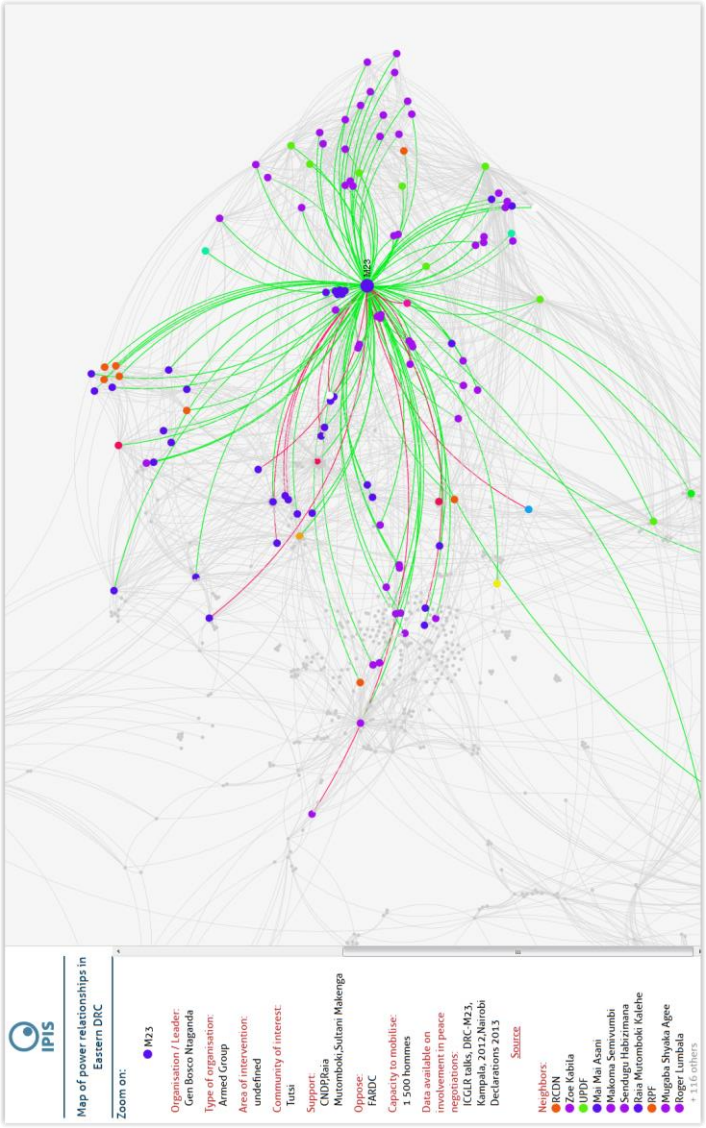

Figure 8: Zoom on M23 interconnections and specific information

In Figure 8, the node M23, a rebel group, has been selected and one can easily see its connections (who it supports, who it opposes). The names of the connected nodes will appear as one zooms into the image. On the left panel, more information about that group is available by scrolling down the bar.

Interactive network visualizations are an ideal option to visualize datasets that combine relational data with quantitative or qualitative information. This data can be presented either visually or included as on-demand information that can be triggered by users. Thus, visualizing networks as done by IPIS in the example above can give a better understanding of political or social interconnectedness in a variety of situations.

For the field of transitional justice, this visualization type offers a variety of applications. It might be used to visualize the different actors in post-conflict societies, or the relationships of negotiating parties in a peace process. Similarly, this type of visualization could be used to present assessments of the impact of transitional justice mechanisms, showing which experiences have been most influential for the development of the field. If used in comparative studies or to map out political settings, interactive network visualizations can find application both in data analysis as well as result presentation. The information-on-demand function allows them to include a wide range of related data, which makes them especially useful for the databases transitional justice practice produces.

Visualizing Spatial or Geographical Data

Mapping might be one of the best examples of the importance of visualization to analyze complex data or datasets with multiple layers of data. By combining different types of information placeholders (usually points, lines, and polygons), it facilitates the identification of clusters, similarities, outliers, or intersections. It offers a drastic advantage compared to analyzing the data in table view. One of the

first examples of spatial analysis (using spatial data not only to represent the world, but also to analyze patterns) was disease mapping, notably John Snow's work mapping an outbreak of cholera in 1854 London (Figure 9).[33] Using points to represent locations of individual cases, his map was unique by utilizing cartographic methods not only to depict, but also to analyze clusters of geographically dependent phenomena.

[33] John Snow, "Cases of Cholera in the London Epidemics of 1854," available from www.commons.wikimedia.org/wiki/File:Snow-cholera-map.jpg.

Figure 9: Map of the Soho cholera outbreak showing the clusters of cholera cases in the London epidemic of 1854

Nowadays, geographic information system (GIS)-based analysis can be integrated into every database that contains spatial or geographical data. Any variable that can be located spatially (and increasingly also temporally) can be referenced using GIS. Even qualitative data can be localized by using its metadata (where and when the qualitative data has been recorded). To use this information,

many simple and usually freeware tools such as uMap[34] or Google Charts[35] offer powerful interactive mapping solutions for both visual analysis as well as web-based result presentation.

Below is an example of a map visualization recently created by one of the authors with the Institute for Integrated Transitions (IFIT) using the freeware tool jVectorMap[36] and aimed primarily at information visualization.[37] The *Transitions Map (1945-Present)* visualizes the history of political transitions of each country since 1945, grouped into four color-coded categories (no transition out of internal armed conflict or authoritarian rule - grey; one or more periods of transition out of internal armed conflict - blue; one or more periods of transition out of authoritarian rule - yellow; one or more periods of transitions out of both internal armed conflict and authoritarian rule - green). This simple visualization of countries' transitional history does not necessarily require an interactive visualization. It can be achieved as well with a static image.[38] However, as with most static visualizations, this requires a lot of simplification and reduction of the available information. In this case, this means that any occurrence of more than one political transition of the same kind has no impact on the final visualization, and small countries might be difficult to identify. An interactive version offers an easy but powerful solution to this problem. Visualized in a standard web browser using Java, the interactive map shows additional

[34] Umap, available from umap.openstreetmap.fr/en.
[35] Google Developers, "Charts: Visualization: Map," available from developers.google.com/chart/interactive/docs/gallery/map.
[36] jVectorMap, *Why to use jVectorMap?* available from jvectormap.com, Accessed 28.06.2015.
[37] Being a web based service, jVectorMaps is coded in HTML and Java. But, due to the detailed examples and tutorials available online, only rudimentary programming knowledge is needed.
[38] Institute for Integrated Transitions, "Transition Map, 1945–Present," *Alliance Magazine* 19.4 (2014): 34.

information listing all political transitions of a country, once the user hovers the cursor over an individual country (Figure 10).[39]

Tackling the problem of information loss in the process of visualization, choosing an interactive visualization solves several other problems on the go: being based on vector graphics, the tool allows the user to zoom in and out without loss of graphical quality. Thus, countries as different in size as China and Kosovo can be shown on the same map. The information-on-demand function, allows the inclusion of additional information within the map. In this case, it is text-based data (short summaries of transitional history), but it could just as well include video or audio files, individual country statistics, or hyperlinks.

[39] To access the visualisation, see http://datavishub.blogspot.com.es/2016/02/IFIT-transitions-map.html.

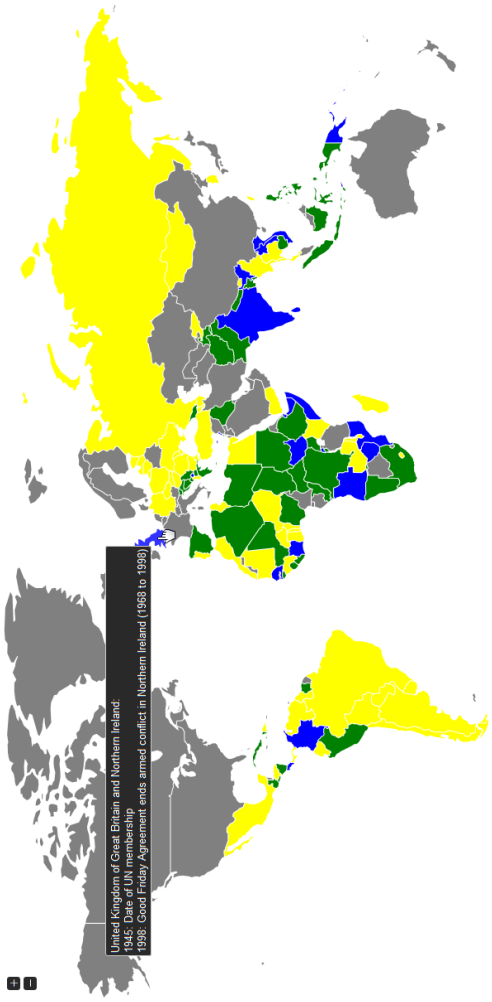

Figure 10: Transitions Map showing additional information for the United Kingdom

Advanced GIS Mapping

The mapping efforts of the International Peace Information Service (IPIS) in recent years provide a good example of a more detailed mapping approach. Through its conflict mapping research project, IPIS has developed interactive web maps to analyze and understand war motives in conflict areas.[40] In a recent study, IPIS analyzes the conflict dynamics in the Central African Republic (CAR) from the outbreak of the latest crisis in September 2012 to September 2014.

IPIS published a web map of CAR[41] (Figure 11) that presents various information layers, which can be toggled on and off, including information on security incidents, areas under control of armed groups, natural resources, poaching routes and a number of other features. As stated by involved researchers on their website, "The map is an integrated part of the research methodology and has been a crucial source for IPIS' [own] analysis."[42]

To generate this kind of webmap, a team of researchers worked on an offline version of the map with the GIS software ArcGIS.[43] Figure 12 shows a view of the same dataset from the CAR visualized on ArcMap10.3 (ArcGIS).

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[40] International Peace Information Service, "Conflict mapping: Maps," available from www.ipisresearch.be/home/conflict-mapping/maps.

[41] International Peace Information Service, "Web mapping: Central African Republic," available from www.ipisresearch.be/mapping/webmapping/car.

[42] Filip Hilgert, Lotte Hoex, Steven Spittaels, and Yannick Weyns, "Mapping Conflict Motives: the Central African Republic," available from www.ipisresearch.be/publication/mapping-conflict-motives-central-african-republic-2.

[43] ESRI, "ArcGIS," available from www.arcgis.com. While ArcGIS is a proprietary software, open-source alternatives do exist and provide for most of the same features. See, for example, QGIS, available from www.qgis.org/en/site/.

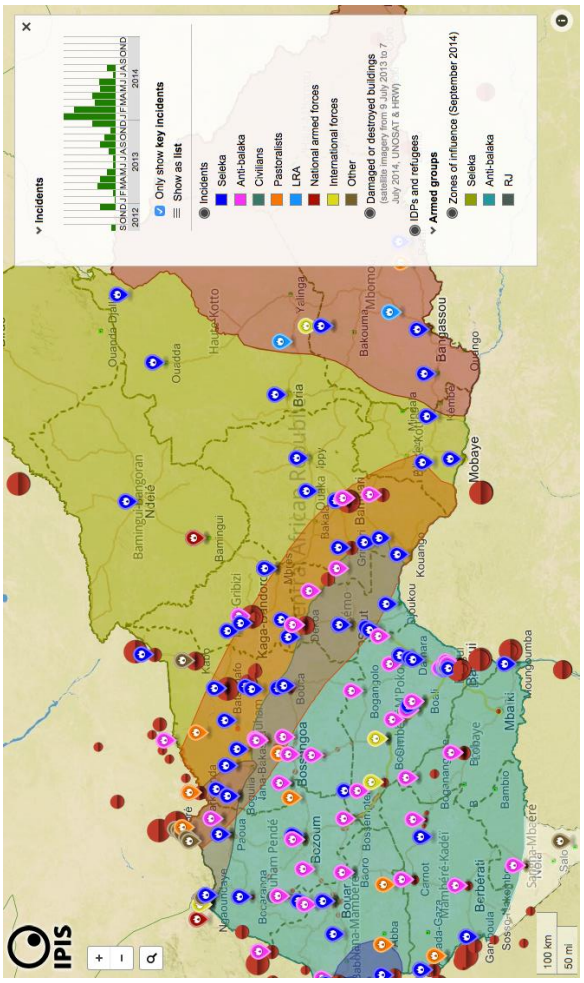

Figure 11: IPIS interactive map of CAR with key incidents by actors and by month, IDP's and refugee camps and zone of influence of main armed groups

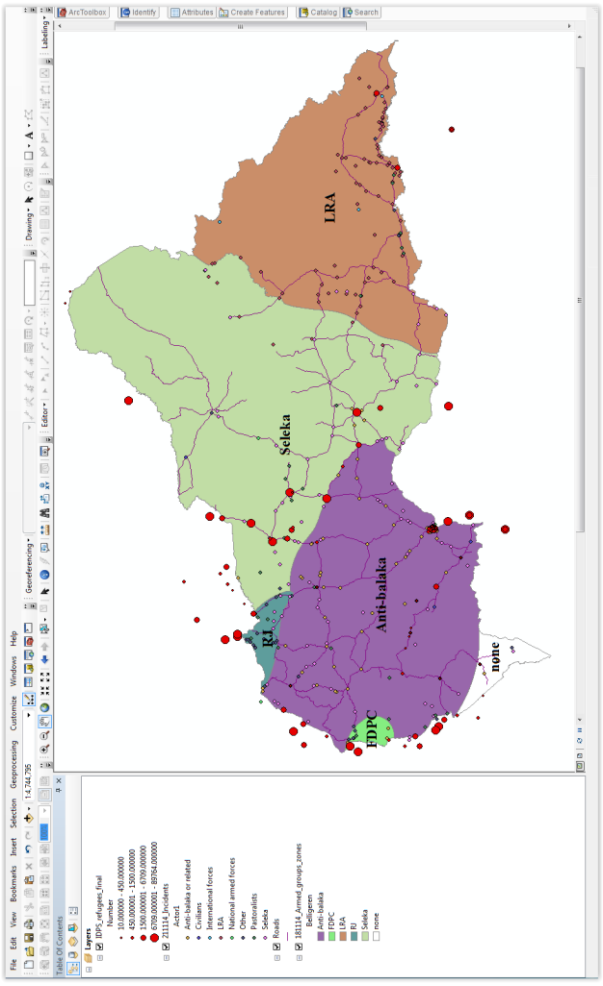

Figure 12: Visualization of refugee and internally displaced persons camps, key incidents by actors and zone of influence of main armed groups in CAR on a GIS software (ArcGIS)

Using an online web map[44] is not only a helpful tool for sharing results and to illustrate a report. In this research project, it was also used internally by IPIS researchers before the publication of the report to analyze the data that they had been collecting over several months. Adding a level of interactivity allows researchers to build their own analysis and focus on a specific area or events at their own discretion. For example, users can click on each element of the map (such as an incident; see figure 13) to access more information about it (such as date, actors involved, location, source, or description). Users can also toggle between different layers to test their own hypotheses, such as whether control of a region is linked to the presence of minerals or other natural resources (Figure 14). They can also pan or zoom to focus on some specific area and reveal more information by zooming in further (see for example Figure 15).

[44] Once the data has been collected, cleaned, and organized in a geodatabase using GIS software, one can export the data to a web server or a map hosting solutions such as Mapbox (www.mapbox.com) or CartODB (www.cartodb.com).

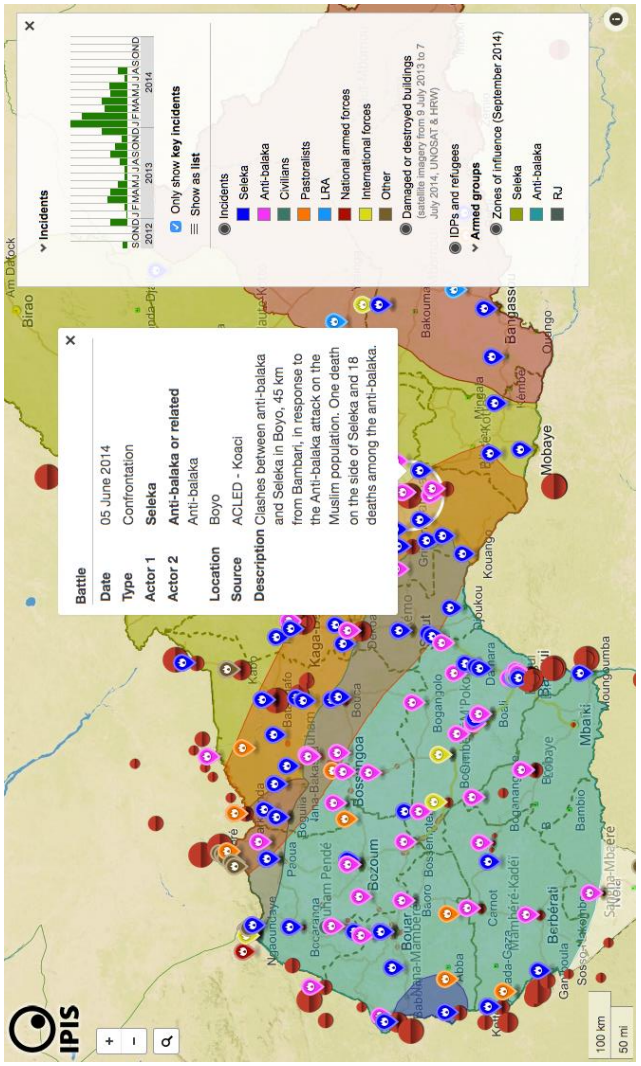

Figure 13: IPIS interactive map of CAR: users can click on every event to get more information

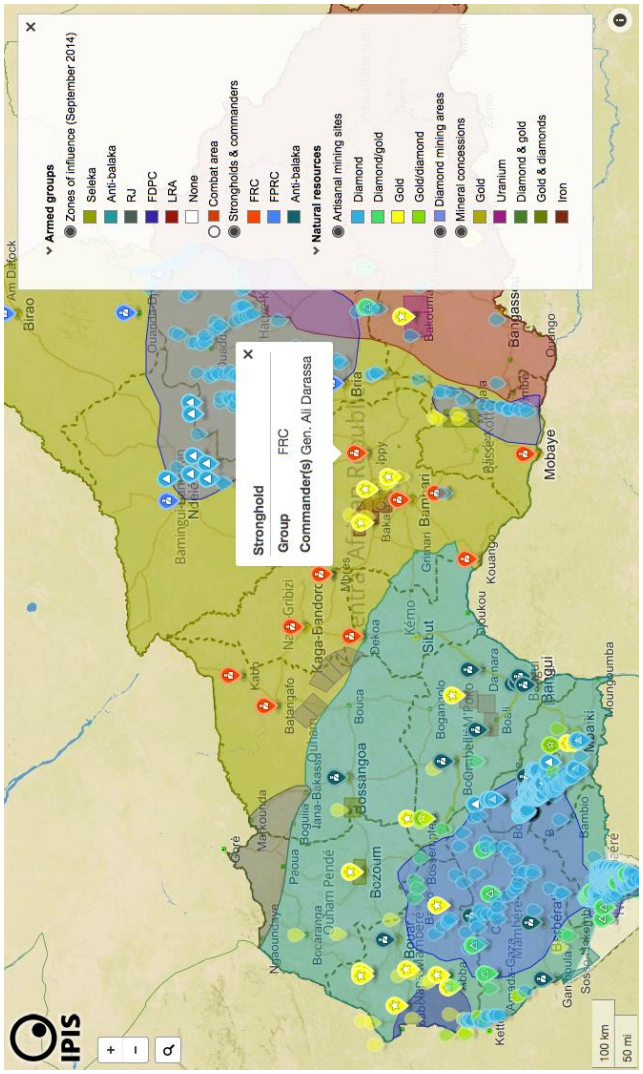

Figure 14: IPIS interactive map of CAR: users can look simultaneously at the name of main commanders in every stronghold and at the presence of natural resources in their area of command

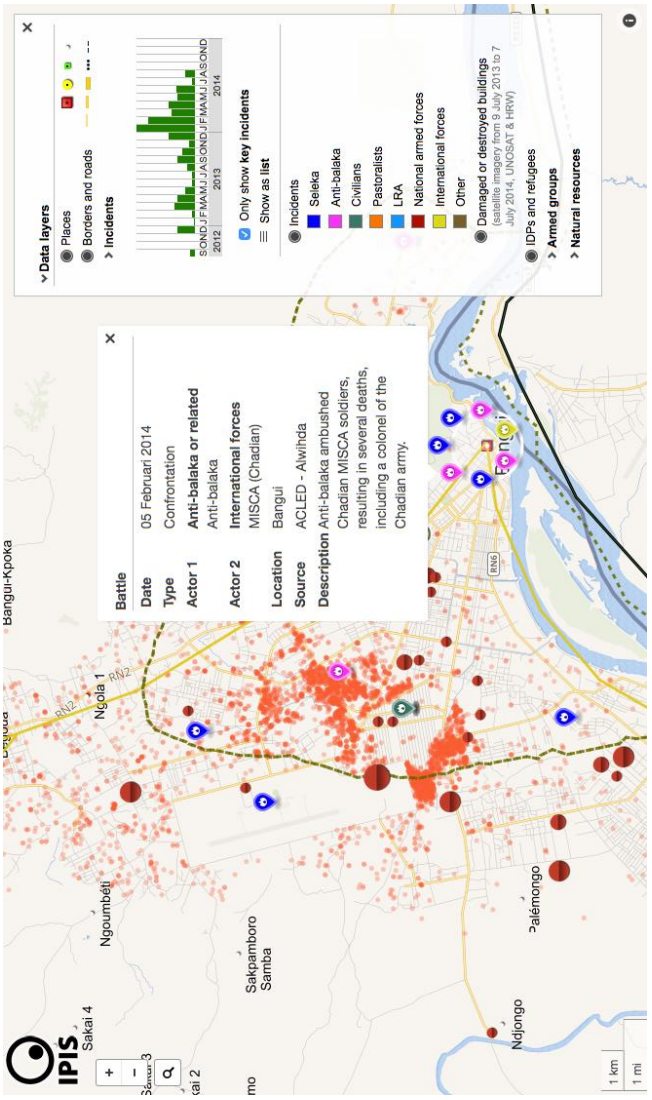

Figure 15: IPIS interactive map of CAR: users can zoom and pan the map to get detailed information, for example on Bangui

Interactive maps, be they global and comparative or regional and detailed, are ideal tools to visualize datasets with a geographic element. In light of the above mentioned datasets produced in the field, all three groups (transitional justice research, practice and legal databases) can highly profit from using interactive maps for analysis and data presentation.

Including more than just one layer of data and, more importantly, more than only one type of data, gives interactive maps an invaluable advantage over static maps. For specific use in the field of transitional justice, interactive maps could be used, for example, to visualize the *Peace Agreements Database* from the University of Ulster mentioned above. Plotting on a world map where selected thematic issues have been addressed would provide for a much better geographic overview than currently possible in the provided table format. The interactive nature of the tool would provide links to single agreement texts as well as allow users to switch between different issues. The ability to zoom from an extreme macro view (global) to a very micro view (local) gives researchers a unique chance to visually explore a dataset on both levels and identify connections that otherwise might not become visible. In a field like transitional justice, where macro and micro are that strongly connected, interactive maps can play an important analytical role.

For data presentation, both maps produced by IFIT and IPIS are good examples of how databases can be made easily accessible to other researchers and practitioners, as they allow users to interact with the visualization freely and adjust the information shown to their own needs.

Google Visualization Tools: Google Charts

While interactive visualization is a powerful tool, particularly for the inclusion of non-numeric data, its logic obviously works just as well for numeric data, which remains an important part of any data-based research. Thus, this section presents one of the best tools for

interactive and animated visualizations that focuses primarily on numeric data: Google Charts.

Google Charts is a free, web-based tool for creating interactive and animated visualizations. It offers a wide variety of visualizations including nearly all common types of charts and graphs and the somewhat unusual Google *Motion Chart*.[45] The *Motion Chart* visualizes data of at least two related numeric values in relation to time. The values are plotted as dots on a two dimensional canvas, while time is represented by the movement of these dots. The representation of time as movement allows for an easy understanding of huge datasets and facilitate data analysis as well as result presentation. All Google Charts are web-based and are coded in HTML and Java, which requires basic coding knowledge.[46]

The example below visualizes a dataset on development aid. It includes numerical information on the aid provided by some of the leading economies in the world, how the amount of aid relates to the respective economic capabilities, and how this relation developed over time. The countries included are the members of the Development Assistance Committee (DAC). Their provided development aid is plotted in relation to their Gross Domestic Product (GDP). The resulting chart (Figure 16) can easily be adjusted by applying filters, drawing trails of movement for selected items, changing the scale, or selecting the variables to be shown in relation to each other. Furthermore, by clicking on one of the icons on the

[45] The Motion Chart was originally developed by the small company Gapminder and was bought in 2007 by Google. For more information see: www.gapminder.org/about-gapminder/history; Google Developers, "Visualization: Motion Chart," available from developers.google.com/chart/interactive/docs/gallery/motionchart.

[46] To access the visualization and for a more detailed guide on how to create a Google Motion Chart without HTML coding using the R-Language see Tim Rosenkranz, "Google Motion Chart – the dots are moving!," available from www.datavishub.blogspot.com.es/2015/09/google-motion-chart.html.

top right of the visualization, the user can change the view to two different forms of visualization

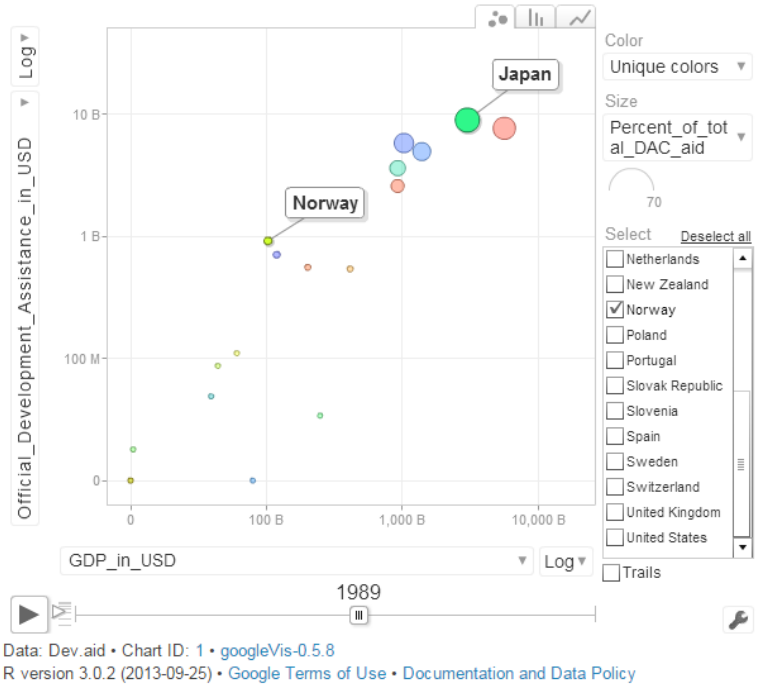

Figure 16: Google Motion Chart. Time is visualized as movement

While the example of a motion chart is exclusively used for numerical data, Google Charts also includes mapping tools and timelines, where additional text-based data can be included as on-demand information. As the analysis of transitional justice data above has shown, many studies quantify their observations in the process of gathering a dataset, and nearly all include a temporal component. While timelines, shown above, are strong in visualizing qualitative data in relation to time, the Motion Chat is ideal for visualizing

quantitative data in relation to time. For the analysis of datasets covering the impact of transitional justice measures over time, Motion Charts can be a helpful tool in discovering patterns in the dataset, as the motion facilitates the cognitive process better than several plots. The ability to flexibly pair observations together allows the user to quickly adjust the visualization to the research question. Especially as the observed timeframe since the first transitional justice measures continues to grow, this powerful way to plot numbers against time will be of increasing importance in data-based transitional justice research.

Visualization of Flows

Flows are a good example of the importance of visualization for data analysis. To illustrate this, one can look at the United Nations High Commissioner for Refugees' (UNHCR) Statistical Online Population Database[47] and, more specifically, at the destinations of the main countries of origin of refugees and people in a refugee-like situation in the world for the last ten years (Table 1). Looking directly at the table, one can easily classify and sort data to identify the main (classified as more than 50,000 people) countries of origin of refugees and people in a refugee-like situation. While the order of the main countries of origin can be relatively quickly identified: Afghanistan, Syria, Somalia, Sudan, Myanmar, etc., looking at the destination of refugees would require a line-by-line analysis and fastidious explanation if the results were to be communicated.

[47] UNHCR, "UNHCR Statistical Online Population Database," available from www.unhcr.org/pages/4a013eb06.html.

The refugee population is included in this table if the number was 5,000 or more at mid-2014. For many industrialized countries, UNHCR has estimated the refugee population based on 10 years of individual refugee recognition.
All data are provisional and subject to change.

Origin	Country/territory of asylum	Population start-2014		Population mid-2014	
		Total	*of whom: UNHCR-assisted*	Total	*of whom: UNHCR-assisted*
Afghanistan	Australia[1]	8,368	-	8,368	-
Afghanistan	Austria[1]	11,906	-	11,906	-
Afghanistan	Belgium	4,328	-	5,038	-
Afghanistan	Germany	24,203	-	25,963	10,438
Afghanistan	India	10,328	10,328	10,438	950,000
Afghanistan	Iran (Islamic Rep.)[4]	814,015	814,015	950,000	-
Afghanistan	Italy[1]	6,657	-	6,657	-
Afghanistan	Netherlands[1]	6,269	-	6,269	-
Afghanistan	Norway[1]	5,523	-	5,523	1,609,748
Afghanistan	Pakistan	1,615,876	1,615,876	1,609,748	-
Afghanistan	Sweden[1]	10,499	-	10,499	-
Afghanistan	United Kingdom[1]	9,166	-	9,166	26,117
Bhutan	Nepal	30,977	30,977	26,117	2,202
Bosnia and Herzegovina	Serbia (& Kosovo: S/RES/1244, 1999)	15,296	2,083	11,325	9,764
Burundi	D.R. Congo	9,762	9,762	9,764	10,964
Burundi	Uganda	10,587	10,587	10,964	12,512
Burundi	U.Rep. of Tanzania	35,183	12,956	34,739	-
Cambodia	France	12,560	-	12,482	-
Cameroon	U.S.A.[1]	5,714	-	5,714	

Table 1: UNHCR data on refugees and people in a refugee-like situation, excluding asylum-seekers, and changes by origin and country/territory of asylum, first half 2014[48]

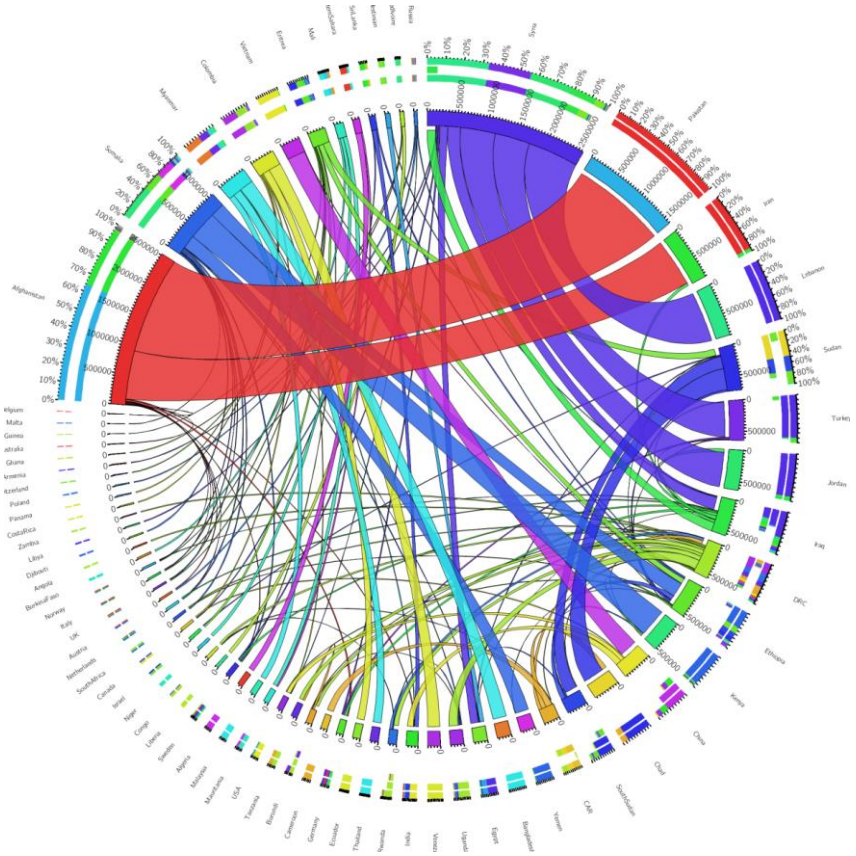

Figure 17: Main countries of origin of refugees and people in a refugee-like situation are shown on the top-left corner of this circular visualization. The destination are shown in clockwise order.[49]

[48] A refugee population is included in this table if its number was 5,000 or more at mid-2014. The Table is truncated at the bottom.

[49] To download this image in full size, go to: www.bit.ly/1EVeuSv.

Alternatively, using a circular visualization tool, such as Circos,[50] provides a good strategy for identifying potential patterns (Figure 17). Circos visualizes data in a circular layout, which is ideal for exploring relationships between large numbers of objects. From this visualization, one can see that the main countries of destination for Afghan refugees are Pakistan and Iran; Lebanon, Turkey, Jordan, Iraq and Egypt for Syrian refugees; Ethiopia, Kenya and Yemen for Somali refugees; etc. Patterns are then visible for important movements of a population due to conflict: refugees and people in a refugee-like situation go mainly to neighboring countries. Industrialized countries such as Germany and the United States only appear at the bottom left of the visualization, in 24th and 28th place of destination respectively.

While Circos so far only produces static visualizations, similar exercises have been conducted in the past and show the potential of interactive flow visualizations. The Wittgenstein Centre for Demography and Global Human Capital produced a similar, but interactive visualization titled *The Global Flow of People*.[51] It shows global migration data in an interactive circular flow chart. In the standard view, this animated visualization provides an overview of the data divided by regions. If the cursor hovers over a country, that country's migration balance is shown in a pop-up box (Figure 18). Similar to the Circos visualization, the country of origin is indicated by the distance of a line to the country name. Furthermore, individual countries can be selected to show their connection to a region or another country. If the cursor hovers over a single connection, this

[50] Martin I. Krzywinski, Jacqueline E. Schein, Inanc Biro, Joseph Connors, Randy Gascoyne, Doug Horsman, Steven J. Jones, and Marco A. Marra, "Circos: An Information Aesthetic for Comparative Genomics," *Genome Research* 19:9 (2009): 1639-45.

[51] Nikola Sander, Guy J. Abel, and Ramon Bauer, "The Global Flow of People," available from http://www.global-migration.info/.

connection is highlighted and the specific value is shown in a pop-up box (Figure 19).

This way of visualizing offers a great opportunity to explore and present flow data providing both a good overview of the dataset, as well as detailed subsetting and filtering to view only a selected part of the dataset. The inclusion of on-demand pop-up boxes allows for the inclusion of exact values.

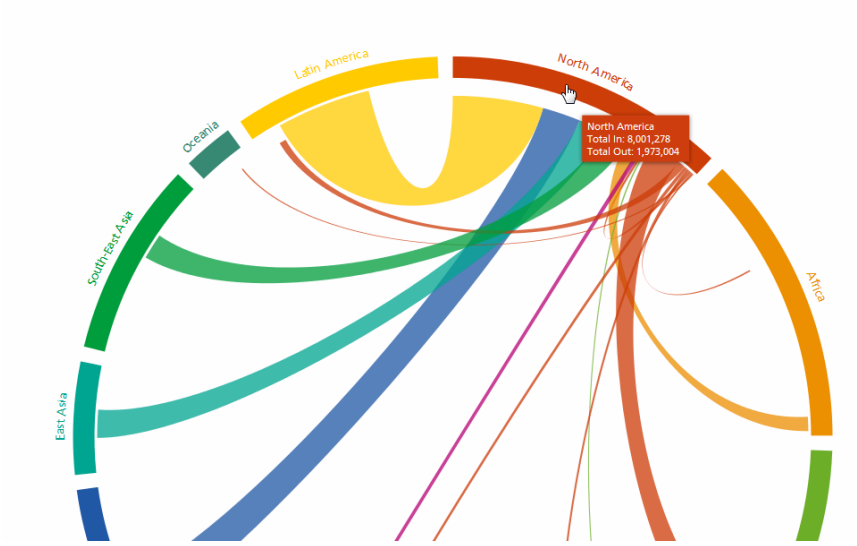

Figure 18: If the cursor hovers over a country or region total in and out migration is shown

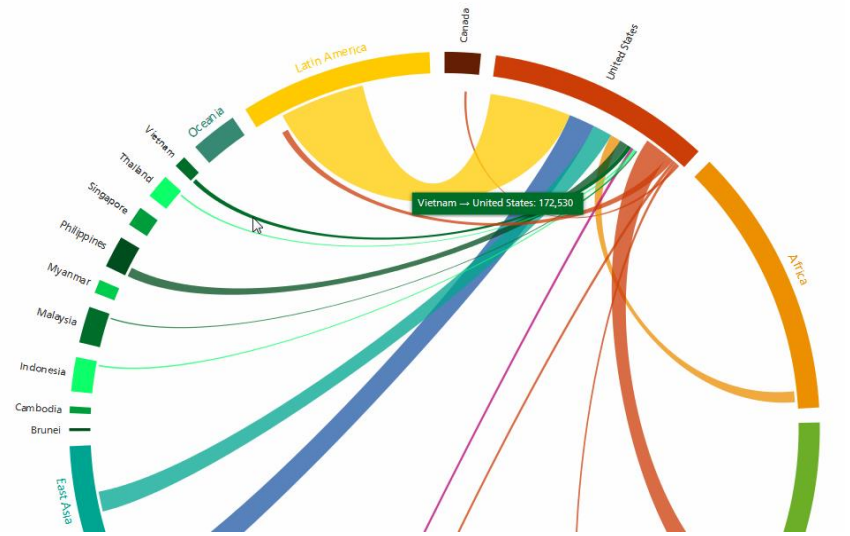

Figure 19: Countries are selectable. If the cursor hovers over a connection, individual flow values are shown

To go further into visualizing flow data, a continuous temporal dimension (timeline) and spatial reference (a map) can be included. This was beautifully done by *The Refugee Project*,[52] an initiative developed by Ekene Ijeoma and Hyperakt. The Refugee Project is an interactive map of refugee migrations around the world in each year since 1975. UN data is complemented by original histories of the major refugee crises of the last four decades, situated in their individual contexts.

[52] Deroy Peraza, Eric Fensterheim, Josh Smith, and Ambika Roos, *The Refugee Project*, available from www.therefugeeproject.org.

Figure 20: Zoom on Afghanistan data in 2012 on The Refugee Project, an interactive and chronological visualization of refugee movements from 1975

As shown in Figure 20, users can zoom in on one country to visualize the main destination of people seeking asylum from that country. They can also zoom out to a worldview and start the timeline tools seen below the image to launch an animation showing the spread and development of the main countries of origin since 1975. More information on some of the major causes of migration can be found by clicking on the small text icons when they appear. The user can also switch to see countries of destination instead of origin and toggle between raw numbers or the ratio of refugees by population.

Flow visualizations are very helpful tools for representing any type of movement data. And their benefit is largest when dealing with very big databases. For the field of transitional justice, flow visualizations could be used to make sense of human movement within a conflict. Be it refugees, fighters, or weapons, conflicts are times of movement and having good visual tools to understand these movements can be of importance in a post-conflict society. For example, one can imagine a visualization of the origins of fighters in the Syrian civil war being helpful for understanding the conflict. At the same time, flow visualizations can be used to present financial flows. For the field of transitional justice it would be interesting to visualize the flow of international aid in post-conflict societies. This could include which countries support which processes in which countries.

Text Analysis

As the initial analysis of transitional justice data has shown, and in stark contrast to the natural sciences, text represents an important part of transitional justice information and databases. Thus, the issue of visualizing databases that include texts or are even entirely text-based has to be addressed. With the development of new technologies, research, analysis, and visualization tools for text data have spread over the last few years, offering a variety of software and online services. In this field, two main principles used by most text-

mining tools can be identified: word frequency and proximity relationships.

Using the text visualization tool NVivo[53] and taking the IPIS Briefing[54] as an example of a text-only dataset, a "word cloud" can easily be created (Figure 21). In this example, the database covers more than 130 Briefings, each of them 10 to 20 pages-worth of analysis and news references, exemplifying that quantity is no longer a limiting factor in digitally analyzing texts. Visualizing word frequency by size, word clouds present the importance of a word relative to other words within a text. For the IPIS Briefing, the cloud shows that the Democratic Republic of Congo (DRC) and Uganda are mentioned more often than, for example, Sudan. At the same time, the cloud shows the importance of processing the data, as very similar words such as "mining" and "miners" appear as separate entries. Taken as a united concept instead of distinct words, mining would be shown to be of bigger importance.

Going a step further, NVivo allows the user to manually or automatically code concepts, i.e. categorize and classify words by theme or topic. That way, one can not only analyze the frequency of a word but the frequency of the concept (being the frequency of all words associated with that concept). Including the temporal element of the same dataset, it is possible to visualize how the frequencies of different concepts, here references to selected rebel groups, develop over time. As the data is now quantified, several interactive visualization tools can be used for this step, as shown in Figure 22. From this visualization, it is easy to see that, while the rebel group M23 was the dominant topic in the first half of the timeframe, its

[53] QSR, "What is Nvivo?" available from www.qsrinternational.com/what-is-nvivo.
[54] IPIS Briefing is a weekly publication on Security, Humanitarian and Justice related news in Central Africa. The used dataset includes editions between October 2012 and October 2015; International Peace Information Service, *Weekly Briefings*, available from www.ipisresearch.be/weekly-briefing.

frequency dropped thereafter. Thus, visualizing the results of word frequency analysis allows quick insights into text-based datasets.

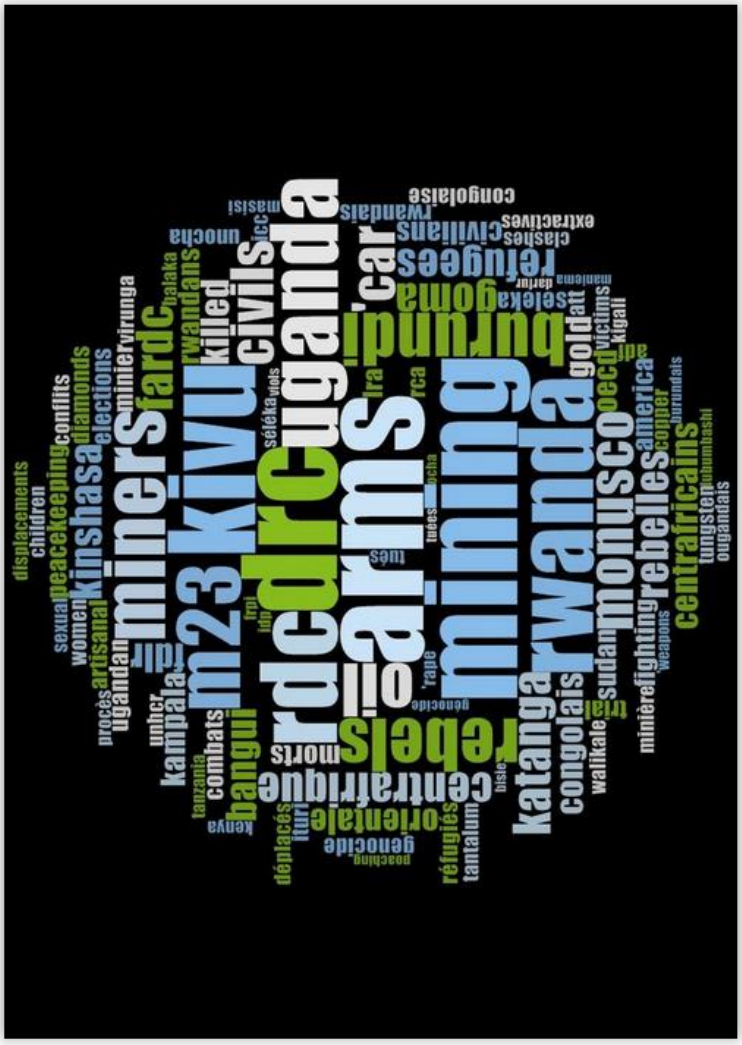

Figure 21: Word cloud of IPIS Briefing based on word frequency

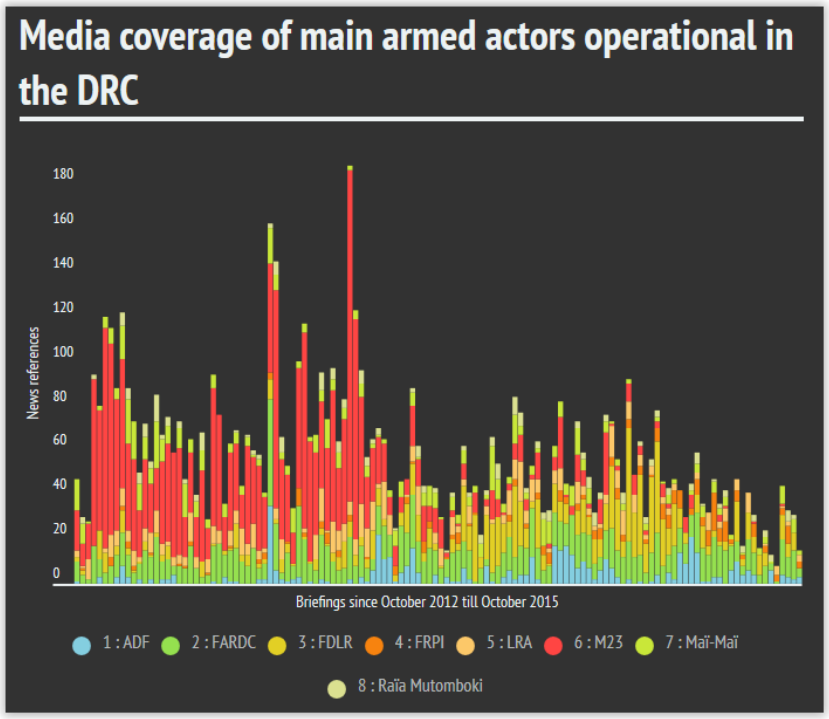

Figure 22: Interactive bar chart showing media coverage of main armed groups in DRC across IPIS Weekly Briefings from October 2012 to October 2015

Another powerful text analysis strategy is to visualize the text in an interactive word tree. Word trees reveal proximity patterns by showing the context of a word within the text. In contrast to frequency analysis, this tool directly visualizes text patterns without having to first transfer information into quantitative information and allows researchers to analyze a direct visual of the text. For the

example below, Jason Davis' online tool *Word Tree* has been used.[55] After pasting a text source, here the Universal Declaration of Human Rights, and selecting a word or a phrase to be analyzed, the tool produces a word tree. In this case, it shows all text starting with "everyone"[56] and then divides text in different branches depending on the words and phrases that follow (Figure 23).[57]

[55] Jason Davis, "Word Tree," available from www.jasondavies.com/wordtree. For more information on the word tree visualization, see Martin Wattenberg and Fernanda B. Viégas, "The Word Tree, an Interactive Visual Concordance," available from www.hint.fm/papers/wordtree_final2.pdf.

[56] "Everyone" has been selected as the result of a word frequency analysis revealing it to be among the most frequently used words, with 30 occurrences.

[57] For an online version of this Word Tree, see www.bit.ly/1RdOYDQ.

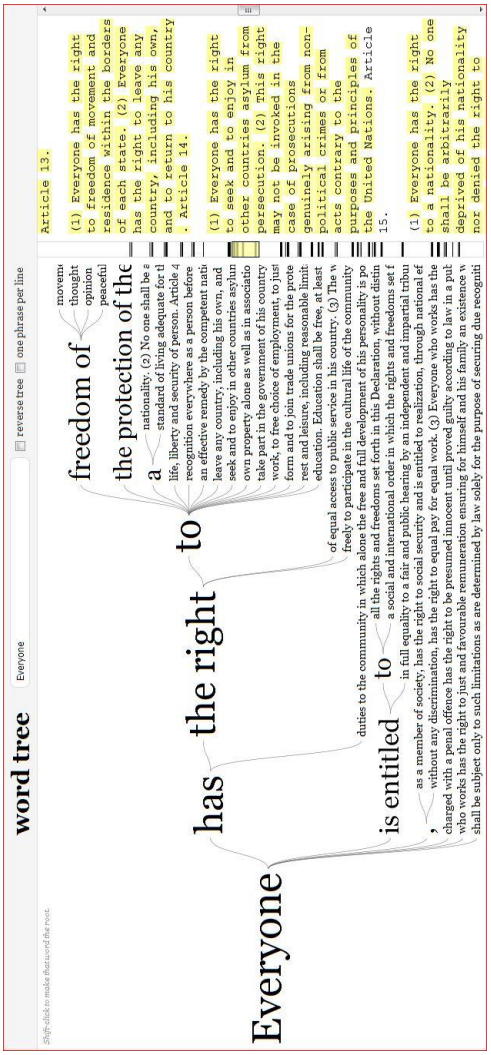

Figure 23: Word tree visualization of the Universal Declaration of Human Rights focused on the word "Everyone"

From the visualization, it can be quickly derived that the most frequently used phrases continue with "has" and "is entitled," whereby the font size represents the relative frequency of a branch. By clicking on individual branches, e.g. "is entitled," the visualization can be filtered, showing only a selected branch of the whole tree (Figure 24). On the right hand side, the whole text is displayed with the visualized parts highlighted. This allows the user to directly access a selected phrase in the wider context of the text. Additionally, the tree can be reversed, showing the same function, but facing backwards within the text.

Both frequency analysis and the visualization of proximity patterns provide valuable insights especially into long texts or bigger text-based datasets. As the example of the IPIS Briefings has shown, word frequency can be most beneficial if it can be combined with metadata, such as time or geographic information, in order to show not only the importance of a concept within the text data but also their development. While word frequency can only provide a very limited insight into texts, interactive visualizations of proximity patterns allow a much deeper analysis of recurring patterns. Tools like *Word Tree* allow for the analysis of the frequency of certain proximity patterns while retaining full access to the text as a whole. The interactive layout of the tool provides researchers with a maximum of flexibility for exploring the data and adjusting the visualization to specific questions.

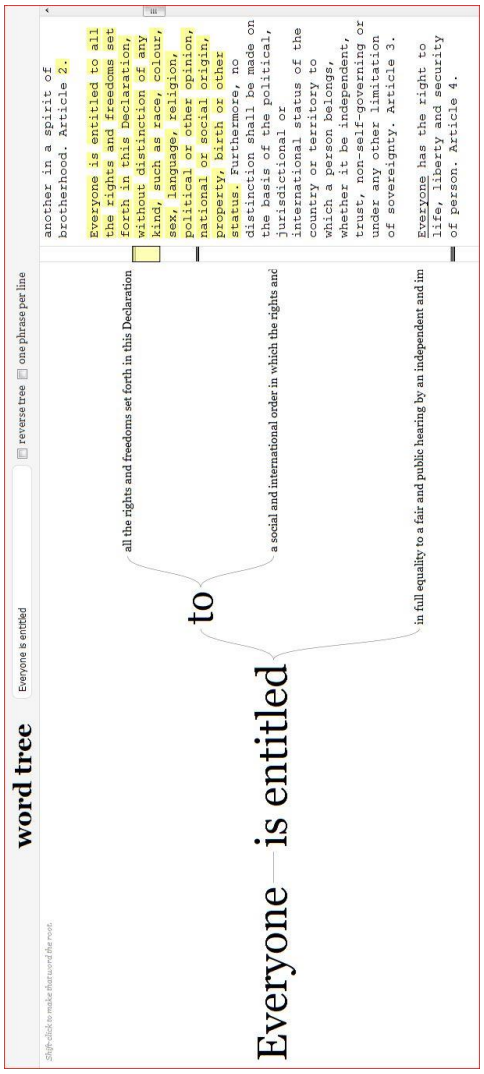

Figure 24: Individual branches can be selected showing a more focused view of the datade

As seen above, the field of transitional justice research produces data that frequently include large volumes of text. From legal documents to witness statements and from interviews to news coverage, we see a wide range of structured and unstructured texts that may or may not be accompanied by metadata. The presented interactive analysis tools can provide some help to explore the data or follow specific research questions. As done with the IPIS Briefings, analyzing frequency patterns in news coverage of specific outlets or social media could provide insights into how transitional justice measures are reported about and supported within a community. At the same time, using the word tree visualization could provide useful support when the context of a certain concept is used in a bigger set of plain text data. One example of this could be an analysis of a set of confession statements from a truth commission conducted to see the context in which specific key words such as "guilt" or "responsibility" are mentioned.

Conclusion

The preceding review of transitional justice data, as well as the other articles in this special issue, clearly demonstrate that the majority of data collected in this field are not purely numerical. While this has posed a hurdle for data visualization techniques in the past, interactive visualization offers tools to overcome this. The examples discussed above have shown that various types of data, be it geographic, relational, temporal, or flow-based information, can be turned into visualizations that facilitate the exploration, analysis, and presentation of given data.

The interactive nature of these tools with their information-on-demand function allows for the inclusion of information that usually would have been lost in any static visualization approach. Furthermore, it provides a powerful tool for data exploration, as users can individually adjust the visualization to specific research questions. Combining different types of data in one visualization makes these

tools ideal for the needs of transitional justice research as it utilizes the combined analytical strengths of human cognition and machine calculation. Thus, the outdated perception of visualization as a tool exclusively for quantitative data and result presentation has to be abandoned. Interactive visualizations should be considered as an integral part of any data-based research project, and, with the presented examples, it is the authors' hope to have inspired their use in future projects.

While all types of datasets identified in the first part of this article have been met with a corresponding visualization tool, the available pallet is not yet entirely satisfactory. It remains problematic to visually present datasets that exclusively consist of long unstructured texts such as testimonials or interviews. While summarizing text entries do not pose a problem anymore and can be included in nearly all visualizations, longer entries remain problematic. At the moment, approaches to text visualization predominantly focus on word frequency analysis and are not able to sufficiently present the dataset as a whole without reducing information to a numeric format. The word tree visualization is a helpful tool for the analysis of frequency and proximity patterns. But, unlike the other tools presented, it does not provide an overview of the whole dataset making the exploration of the data difficult. Overcoming this problem will be the big challenge for data visualization in social science generally and transitional justice specifically.

Having praised new and easy ways of visualization, it is important to note the danger of misrepresentation that is inherent in any data presentation. Interactiveness, to a certain extent, lowers the risk of biased presentation on the part of researchers, as it allows readers to explore the data themselves and make their own observations. At the same time, however, this benefit of greater flexibility includes the threat that users can decide only to see what

they want to see. When using interactive visualizations for presentation purposes, one has to be aware of this risk.[58]

Finally, as most of the approaches presented are web-based, they lend themselves perfectly for sharing information and making data accessible. In a field as closely related to political practice as transitional justice, the importance of information sharing cannot be stressed enough, and any approach to facilitate presentation and understanding of existing datasets ought to be welcomed. Online interactive visualization is the ideal tool and the authors would like to invite everybody to imagine the impact existing datasets could have if they were easier to access for both researchers as well as practitioners.

[58] This danger also exists for the researcher using interactive visualization as an analysis tool.