

# What role do KML-files play in shaping “open source” forensic research on Google Earth?

A socio-technological affordance analysis  
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## Abstract

Google developed the free application Google Earth in 2005, and made satellite imagery visible and accessible to the general public. The standardization of Google Earth regulates how the public reads and understands these geospatial-images and literally produces our worldview. Simultaneously it provides a treasure trove of evidential information for digital forensic investigators. Google Earth has been embraced by digital forensic investigators as (an open) source for geolocation data and tool to collect potential evidence. This paper reviews how Google Earth functions as an open source forensics tool, demonstrating the socio-technological affordances of the Keyhole Markup Language (KML) files that can be created by any user to define locations, add overlays and expose rich data in novel ways – easily shared and adjusted. To demonstrate the power of the application a forensic scenario will be (re)traced.

## Keywords

Google Earth – independent digital forensics – vertical field – vertical meditation – community of practice – boundary objects – collective intelligence – open source

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# 1 | The turn of forensics

Online platforms have become a vast landscape of decontextualized representation of war, terrorism and violence: simultaneously they also became the site of *Independent Digital Forensic (IDF)* investigation. The Syrian war has an excessive online presence, the richness of graphical and accessible documentation reported by a vast range of parties like local civilians, the Islamic State (IS) and the international Coalition is exposed and brought into existence on (social) media platforms. In response to this, Tahhan and Woods initiated Airwars – a non-profit organization that monitors and archives reported civilian harm that’s allegedly a consequence of International military action.<sup>1</sup> During the offensive to reclaim Raqqa, the declared IS capital, eighty percent of the city was destroyed by thousands of international Coalition airstrikes and artillery shells.<sup>2</sup> These “precision airstrikes” – taking all measures preventing civilian casualties – as claimed by international Coalition commanders are hard to support when wide-area artillery and bombs that destroy complete housing-blocks are used. The rhetoric of precision warfare is a “far cry from reality”.<sup>3,4</sup> Airwars partnered with Amnesty International in an extensive investigation – ‘Rhetoric versus Reality’ – to produce evidence against this false rhetoric and force the Coalition to “end their denial about the shocking scale of civilian deaths and destruction caused by their offensive in Raqqa”.<sup>5</sup> The collaboration of Airwars resulted in a comprehensive body of evidence against the international military campaign.

This phenomenon of IDF investigative research – by applying *open source* investigation tools and methods– is becoming a new norm in our contemporary media landscape. Dziuban refers to the increasing normalization of this forensic practice as a present response to conflicts and political violence.<sup>6</sup> The unfolding turn towards online forensics research as a means of: data collection, analysis, interpretation and re-contextualizing information into a body of evidence of war crimes, genocides and human rights violations is essential for use in courts and international tribunals.<sup>7</sup> Platforms are increasingly shaped into enormous ‘open’ access archives; Google Earth proves itself a treasure trove of information for IDF investigators.<sup>8</sup> Weizman founder of Forensic Architecture expresses that it is in these spaces that new modes of verification and production of truth are aligned with resistance and solidarity.<sup>9</sup> The mediation of geospatial imagery on Google Earth offers the critical viewer a glance in the extensive strive for vertical hegemony

1 Airwars. "About". <https://airwars.org/about/team/>. (last accessed 12.04.2019)

2 Amnesty International Report. 2018. "War of annihilation: Devastating toll on civilians, Raqqa – Syria" <https://www.amnesty.org/download/Documents/MDE2483672018ENGLISH.PDF>. (last accessed 12.04.2019)

3 Rovera, Donatella & Walsby, Benjamin. "Precision' airstrikes kill civilians. In Raqqa we saw the devastation for ourselves: Amnesty's research reveals the huge civilian toll of bombings by the US-led coalition forces in the Syrian city" *The Guardian*. 05 June 2018. <https://www.theguardian.com/commentisfree/2018/jun/05/british-us-airstrikes-raqqa-civilians-killed>. (last accessed 12.04.2019)

4 Amnesty International & Airwars. Report. 2019. "Rhetoric versus Reality: How the 'most precise air campaign in history' left Raqqa the most destroyed city in modern times". <https://raqqa.amnesty.org/> (last accessed 12.04.2019)

5 Airwars. "News and Investigations". <https://airwars.org/news-and-investigations/raqqa-amnesty-airwars/>. (last accessed 12.04.2019)

6 Dziuban, Zuzanna. 2017. "Mapping the 'Forensic Turn': Engagements with Materialities of Mass Death in Holocaust Studies and Beyond". Editors, Peter Black, Gustavo Corni, Irina Scherbakowa. New Academic Press, Vienna. Page 11

7 Weizman, Eyal. 2017. "Forensic Architecture: Violence at the threshold of detectability". New York: Zone Books. Pages 30 – 33, 65, 133 – 148

8 Google Earth is one among many techniques and tools to practice forensic research in the current media-rich environments. Most conflict events require dynamic 3D modelling as they unfold in space and time, animations and audio-visual, interactive cartographies etc.

9 Weizman, Eyal. 2018. "Propositions #7/2: Counter Forensics". Utrecht: BAK, basis voor actuele kunst. Lecture, 18 October 2018. <https://www.youtube.com/watch?v=5hBYDqxURtw> (last accessed 11.01.2019)

by those in power.<sup>10</sup> Remote-sensing satellites – belonging to US federal agents and commercial companies – monitor earth’s surface to control the airspace above territories along with what takes place on the ground; Weizman describes this as “the politics of verticality”.<sup>11</sup>

*Open source* tools as Google Earth focus mostly on technological affordances such as data collection and the accessibility of geospatial imagery. I am interested in exploring the unintended use of Google Earth by IDF investigators (Google earth is not developed for gathering forensic evidence).<sup>12</sup> I reason that the practice of collecting forensic evidence through Google Earth does not only exist by technological affordances, but that geospatial imagery is used as a *boundary object* to establish a shared understanding by *Communities of Practice (CoP)*. IDF communities are working relationships practicing a shared “language” between individuals in different communities and disciplines that represents knowledge and produces social meaning.<sup>13</sup> An adopted “language” by IDF is the Keyhole Markup Language (KML) of Google Earth, that offers formats that are used to display geographic data.<sup>14</sup>

I argue that KML-files play a role in shaping an open source space on Google Earth for collectively aggregating forensic evidence. The focus in this research will lie in answering how do socio-technological affordances of KML-files enable the CoP to use Google Earth for digital forensic research? This will be accomplished by retracing the forensic case-study ‘Rhetoric versus Reality’; by conducting a socio-technological affordance analysis on original KML-files provided by Airwars – that enabled their comprehensive investigation in geolocating civilian casualties and timing the US Coalition airstrikes in Raqqa.<sup>15</sup> <sup>16</sup>By analysing their data, I will explore how these reveal the social structures of their CoP. To accomplish this, I will first explain what KML files are and what technological functionalities they have to elucidate the basic structure of the language. Secondly, I will elaborate on IDF researchers to comprehend their methodology and ethos in the context of the CoP theory. Thirdly, the socio-technological affordance analysis focuses on relationships between infrastructures of (invisible) technologies of KML-files and the IDF CoP. By conducting this analysis, I want to show how KML technology of Google Earth afford the process of meaning making in relation to IDF. Additionally, supporting visuals that add valuable information to the narrative have been collated in the Appendix from page 22 till page 37 for legibility and will be referred to in the text.

Not only will this research use the overarching theoretical lenses of IDF and CoP, it positions itself in the academic discourse of questioning the intricate interrelation between technological tools and social (human) constructs.<sup>17</sup> These debates revolve around the distinctions and connections between the infrastructures of (invisible) technologies and people’s interpretation and understanding of these.<sup>18</sup>

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10 Parks, Lisa. 2018. *Rethinking Media Coverage: Vertical Mediation and the war on Terror*. Routledge London. Page 102

11 Parks, Lisa. 2018. *Rethinking Media Coverage: Vertical Mediation and the war on Terror*. Routledge London. Page 102

12 Conole, Gráinne, and Martin Dyke. 2004. "Understanding and Using Technological Affordances: A Response to Boyle and Cook". *Research in Learning Technology* 12 (3).

13 Fox, Nick, J. 2011. "Boundary objects, social meaning and success of new technologies". *Sociology* 45 (1) 70-85. Sage publishers, London. Page 72

14 Developers Google. "Keyhole Markup Language: KML Tutorial". [https://developers.google.com/kml/documentation/kml\\_tut](https://developers.google.com/kml/documentation/kml_tut) (last accessed 11.03.2019)

15 The retracing will be based upon the forensic research by Airwars over the course of US Coalition strikes in Raqqa (Syria) between June and October 2017. <https://airwars.org/news-and-investigations/raqqa-amnesty-airwars/>. (last accessed 12.04.2019)

16 Amnesty International & Airwars. Report. 2019. "Rhetoric versus Reality: How the 'most precise air campaign in history' left Raqqa the most destroyed city in modern times". <https://raqqa.amnesty.org/> (last accessed 12.04.2019)

17 Winner, Langdon. 1993. "Upon Opening the Black Box and Finding It Empty: Social Constructivism and the Philosophy of Technology". *Science, Technology, & Human Values* 18 (3). Sage Publications. Pages 362-378

18 Conole, Gráinne, and Martin Dyke. 2004. "Understanding and Using Technological Affordances: A Response to Boyle and Cook". *Research in Learning Technology* 12 (3).

Winner expresses that the breaking of the arbitrary distinction between the social- and technological-spheres offers new perspectives to understand the role of technology in the human experience.<sup>19</sup> This research draws a close relation to vertical mediation appertaining to geospatial imagery. Parks explains that this mediation revolves around the invisible technical process of transforming “material phenomena and traces” into framed images on for example Google Earth.<sup>20</sup> In the field of Media Studies, the tension of invisible and highly (political and social) influential forms of technological media production must be emphasized and explored.<sup>21</sup> Research into the invisible infrastructures and processes of culturally unintelligible but integral parts of media culture needs to be conducted and become tangible. This research will contribute to exploring the intangible side of this debate, by researching invisible social structures hidden in technological affordances.

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19 Winner, Langdon. 1993. "Upon Opening the Black Box and Finding It Empty: Social Constructivism and the Philosophy of Technology". *Science, Technology, & Human Values* 18 (3). Sage Publications. Page 367

20 Parks, Lisa. 2018. *Rethinking Media Coverage: Vertical Mediation and the war on Terror*. Routledge London. Page 103

21 Art at MIT. "CAST Symposium BEING MATERIAL: INVISIBLE – Lisa Parks & Trevor Paglen". Published 28 July 2017. YouTube video, 01:56 – 03:00. <https://www.youtube.com/watch?v=SmHeSEE24sk&index=8&list=PLUwuLibTx5NnpOHsrDljsTBHlnK5zyT1x&t=0s> (last accessed 19.03.2019)

## 2 | How mediation of geospatial imagery became a shared repertoire of resources

This research is organized around the overarching concept of *CoP*, which is a component of a vast conceptual framework about learning, social dimensions and social constructs. This theory coined by Wenger explains *CoP* as “groups of people who share a concern or a passion for something they do, and learn how to do it better as they interact regularly”.<sup>22</sup> The concept has three essential characteristics: *domain*, *community* and *practice* that will be followed to structure this research.

First, to comprehend the relation between the *CoP* and KML-files I will explain the origin and technological functionalities of KML, before diving into the overarching theory of *CoP*. Secondly, I will elaborate on the *domain* – which entails the collective identity of a community of practice that is shaped through a shared interest. In the light of this research it includes the intrinsic motivation of open source IDF and the turn to the online sphere. Thirdly, the *community* and the *practice* – these two characteristics are extremely interwoven and will be explained following three modes of identification: *engagement*, *imagination* and *alignment*.<sup>23</sup> The strive for a shared interest in their domain drives members of the community to commonly engage in discussions, production of social meaning and a common understanding, resulting in social structures.<sup>24</sup> Drawing upon the modes of the community, the aim is to comprehend *collective intelligence* and use of *open source philosophy* within IDF. Members of a *CoP* are practitioners that develop “a shared repertoire of resources” that can be framed as: experiences, tools, methods, or stories.<sup>25</sup> I will explore how the standardization of Google Earth (KML) creates intellectual property that can be comprehended as *boundary objects*.

### 2.1 KML-files

In 2005 Google Earth was released as a free public application, changing the geospatial industry.<sup>26</sup> Google bought the digital mapping company Keyhole in 2004 and their 3D interactive mapping interface became the foundation for what we now know as Google Earth.<sup>27</sup> Satellite imagery is encoded in KML that displays geographic annotation and visualization integrated in Google Earth’s geolocation software that governs and mediates the output through: (graphic) design, computational imagery (rendering-process) and computer networks explained by Parker as *vertical mediation*.<sup>28</sup> <sup>29</sup> KML is governed by the Open Geospatial Consortium (OGC), setting an international standardized language for “web-based online and mobile maps (2d) and earth browsers (3d)”, this to maintain and enable sufficient

22 Wenger, Etienne. 2010. “Communities of Practice and Social Learning Systems: The Career of a Concept”. *Social Learning Systems and Communities of Practice*, edited by Chris Blackmore. Springer, London. Pages 180-184

23 Wenger, Etienne. 2010. “Communities of Practice and Social Learning Systems: The Career of a Concept”. *Social Learning Systems and Communities of Practice*, edited by Chris Blackmore. Springer, London. Page 184

24 Wenger, Etienne and Beverly Trayner. 2015. “Communities of practice a brief introduction”. <https://wenger-trayner.com/introduction-to-communities-of-practice/> (last accessed 11.03.2019)

25 Idem.

26 That until then was dominated by US federal agencies National Reconnaissance Office (NRO) and the National Geospatial-intelligence Agency (NGA) alongside the major commercial-remote sensing satellite operators, who collect most of their revenue through US government contracts, GeoEye and DigitalGlobe. Parker, Lisa. 2018. *Rethinking Media Coverage: Vertical Mediation and the war on Terror*. Routledge London. Pages 102–105

27 Parker, Lisa. 2018. *Rethinking Media Coverage: Vertical Mediation and the war on Terror*. Routledge London. Pages 102–105

28 KML is the international standard language, maintained by the Open Geospatial Consortium, Inc. (OGC).

29 Parker, Lisa. 2018. *Rethinking Media Coverage: Vertical Mediation and the war on Terror*. Routledge London. Pages 102–105

implementation and interoperability of sharing content and context.<sup>30</sup> KML is an XML language, therefore it is feasible to import spreadsheets (Excel) extensions.<sup>31</sup> The language additionally controls the users' navigation on Google Earth – it guides users where to “go” and where to look.<sup>32</sup> KML files offer a set of objects: placemarks, textual-descriptions, paths, and polygons (figure 01, page 22). Each data point uses longitude, latitude and altitude, specific data can create other perspectives (camera views). The system is tag-based, editable and easily shareable or hosted on a shared server within and between communities.<sup>33</sup>

## 2.2 The domain of digital forensic investigation

The collective identity of a CoP implies a strong commitment to the *domain*, which is a shared interest or ideology.<sup>34</sup> Members of the group define a shared *collective competence*, creating the possibility to distinguish members to other people outside their community.<sup>35</sup> Wenger states that the domain does not have to be acknowledged or recognized as knowledge or skills outside the CoP, it is within the community that they value their collective competence.<sup>36</sup>

IDF can be seen as an emerging domain that currently gains recognition beyond the CoP. Their distinctive knowledge and skills are now slowly used as reliable sources in journalism and brought into international courtrooms, parliamentary inquiries, United Nations assemblies and citizens tribunals.

Their mandate is to create, disseminate and engage with (digital and open source) technologies to assemble forensic evidence and intelligible presentation of the evidence.<sup>37</sup> The IDF method of using open source data for evidence of crimes by those in power is crucial in the context of international courts and tribunals. The common ideology of IDF agencies like Airwars, Bellingcat and Forensic Architecture is to gather (online) evidence in cases that violate human and environmental rights; collaborating with and representing communities that are affected by political violence.<sup>38 39 40</sup> This ideology serves as the fundamental alliance to develop the IDF CoP, and is explained by Weizman and Dziuban as the *turn of forensics*, to the online sphere which displays the complex relation and tension between those in power and civilians.<sup>41 42</sup> The pursuit of accountability and truth by IDF agencies takes place precisely on this intersection. IDF

30 It is debatable to frame KML as an OGC standard knowing that the language can only be used within Google Maps or Google Earth, this might reduce its possibilities for interoperability of geospatial data. Nevertheless, KML is standardized because of the widely accessibility and availability of Google Earth and Google Maps, due to the its features of easy sharing and displaying (visual) data to a vast range of users and audiences. The language had to meet critical standards and objectives set by the OGC. <http://www.opengeospatial.org/standards/kml/> – <http://learningzone.rpsoc.org.uk/index.php/Learning-Materials/Introduction-to-OGC-Standards/Introduction-to-OGC-Standards> (last accessed 02.06.2019)

31 eXtensible Markup Language (XML) is a software- and hardware-independent tool for storing and transporting data. Excel files and Google Sheets can be saved as .csv extensions and imported in Google Earth; these files need to contain separated tables" longitude and latitude. KML-files can also be imported into Excel of Google Sheet and will create an organized file (as long as the data has been named and structured properly in Google Earth). [https://www.w3schools.com/xml/xml\\_what\\_is.asp](https://www.w3schools.com/xml/xml_what_is.asp) (last accessed 02.06.2019)

32 Open Geospatial Consortium, Inc. (OGC). "Standards KML". <http://www.opengeospatial.org/standards/kml/> (last accessed 11.03.2019)

33 Developers Google. "Keyhole Markup Language: KML Tutorial". [https://developers.google.com/kml/documentation/kml\\_tut](https://developers.google.com/kml/documentation/kml_tut) (last accessed 11.03.2019)  
KMZ files are zipped KML files with a .kmz extension.

34 Wenger, Etienne and Beverly Trayner. 2015. "Communities of practice a brief introduction". <https://wenger-trayner.com/introduction-to-communities-of-practice/> (last accessed 11.03.2019)

35 Idem.

36 Idem.

37 Weizman, Eyal. 2017. "Forensic Architecture: Violence at the threshold of detectability". New York: Zone Books. Pages 30 – 33

38 Airwars. "About". <https://airwars.org/about/team/>

39 Bellingcat. "About". <https://www.bellingcat.com/about/>

40 Forensic Architecture. "About". <https://forensic-architecture.org/about/agency>

41 Dziuban, Zuzanna. 2017. "Mapping the Forensic Turn: Engagements with Materialities of Mass Death in Holocaust Studies and Beyond", editors, Peter Black, Gustavo Corni, Irina Scherbakowa. New Academic Press, Vienna. Page 11

Weizman, Eyal. 2017. "Forensic Architecture: Violence at the threshold of detectability". New York: Zone Books. Pages 30 – 33

42 For a detailed description on the turn of forensics; secondary appendix 2 on page 47

agencies explain that forensic investigators must perceive and understand more than the perpetrator, which is a constant strive for visual evidence.<sup>43</sup> In nearly all cases these agencies are not privileged to access the same high-resolution sources as the perpetrator and rely on various sources.<sup>44</sup>

The conflict areas IDF researchers investigate involve mostly territories that are not accessible or even prohibited. This hinders journalists, human-right organisations and IDF research agencies in conducting ground research.<sup>45</sup> Therefore, IDF agencies state that it became exceedingly obvious that geolocation-data and remote sensing are fundamental forensic tools to understand what is happening on the ground in conflict areas.<sup>46</sup>

## 2.3 Identifying the Community of Practice

Wenger describes that CoPs arise from social learning processes which display the general systemic characteristics of the continuous negotiation of identity and cultural meaning.<sup>47</sup> In this light a CoP can be stated as a relational network; where learning is materialized by *co-participation* in shared practices in the “lived-in” world.<sup>48</sup> This process of meaning making is therefore inseparable from direct social engagement (conversations, sharing knowledge and debates), situatedness and context.<sup>49</sup> <sup>50</sup> Besides this Wenger states that in the process of meaning making *reification* plays an important role, the production of physical and conceptual artefacts reflect a shared experience.<sup>51</sup> It is around reification that CoPs like IDF researchers organize their participation. Without the combination of engaged participation and reification the practice would be drifting and uncoordinated, which correlates with continuous progress of interplay, resulting in a social history of learning that Wenger frames as a *regime of competence*. It is here where members of the community can be distinguished from others. Complying with shared criteria and expectations is expressed in understanding the essence of the pursuit of the domain, “being able (and allowed) to engage productively” and properly utilizing the *repertoire of resources* assembled by the shared social history of learning and relational processes.<sup>52</sup> <sup>53</sup>

CoP follows three modes of identification: *engagement, imagination and alignment*; which I use to address relating theories that are explanatory for IDF.<sup>54</sup>

43 Pouwels, Saskia. 2019. “No attention without visual control: The prevalent tension of denial of evidence curates the public chronicle”. University of Utrecht

44 Pouwels, Saskia. 2019. “No attention without visual control: The prevalent tension of denial of evidence curates the public chronicle”. University of Utrecht

45 Weizman, Eyal. 2017. *Forensic Architecture: Violence at the threshold of detectability*. New York: Zone Books. Pages 30 – 33, 65, 133 – 148

46 Strick, Benjamin. “How to Use Google Earth’s Three-Dimensional View: Feat. Syria, Yemen, Sudan”. *Bellingcat* 05 March 2019. <https://www.bellingcat.com/resources/how-tos/2019/03/05/how-to-use-google-earths-three-dimensional-view-feat-syria-yemen-sudan/> (last accessed 11.03.2019)

47 Wenger, Etienne. 2010. “Communities of Practice and Social Learning Systems: The Career of a Concept”. *Social Learning Systems and Communities of Practice*, edited by Chris Blackmore. Springer, London. Page 180

48 Omidvar, Omid and Kislov, Roman. 2014. “The Evolution of the Communities of Practice Approach: Toward Knowledgeability in a Landscape of Practice— An Interview with Etienne Wenger-Trayner”. *Journal of Management Inquiry* 23(3) 266–275. Sage Publisher. Page 267

49 Fuller, A. 2007. “Critiquing theories of learning and communities of practice”. *Communities of practice: Critical perspectives*, edited by N. Jewson, J. Hughes, & L. Unwin. Oxon, UK: Routledge. Pages 17–29

50 Murillo, Enrique. 2011. “Communities of practice in the business and organization studies literature”. *Information Research* 16 (1).

51 Wenger, Etienne. 2010. “Communities of Practice and Social Learning Systems: The Career of a Concept”. *Social Learning Systems and Communities of Practice*, edited by Chris Blackmore. Springer, London. Page 180

52 Repertoire of resources can practically be framed as: experiences, tools, methods, stories. This lies the fundament for a shared practice.

53 Wenger, Etienne. 2010. “Communities of Practice and Social Learning Systems: The Career of a Concept”. *Social Learning Systems and Communities of Practice*, edited by Chris Blackmore. Springer, London. Page 180

54 Wenger, Etienne. 2010. “Communities of Practice and Social Learning Systems: The Career of a Concept”. *Social Learning Systems and Communities of Practice*, edited by Chris Blackmore. Springer, London Page 184

### 2.3.1 Engagement – collective intelligence, the epitome of IDF

This is the closest and most immediate relation of engaging with a practice; direct experience of the regime of competence. The overarching methodology of IDF breaks with the authority and conventions of a single expert to render valid specific facts, which leads to intense collaboration between multiple perspectives and disciplines, accumulating many minds to excel individual creativity and intelligence to solve crucial problems; this is known as *collective intelligence (CI)*.<sup>1,2</sup> This mentality is revealed in the extensive collaborative-relationships during the research-project ‘Rhetoric versus Reality’ (table 01, page 23). There are multiple academic perspectives and interpretations of CI, I use the cognitive lens of Levy in relation to Wenger’s perspective on CoPs.<sup>3,4</sup> Levy explains CI as a “form of universally distributed intelligence, constantly enhanced, coordinated in real time and resulting in effective mobilization of skills”, these collective powers are materialized in IDF methods.<sup>5</sup> A more detailed description on the relationship between IDF and CI can be found in the secondary appendix 2 on page 47.

Our changed way of communicating since the introduction of interconnectivity of digital data (web 2.0) has established our virtual memory and extends possibilities for collective human intelligence.<sup>6</sup> This digital-online environment is adopted by IDF and implemented to grow their intelligence in substantial groups of practitioners. The online sphere provides an ideal space and technology to activate CI and collaborate through *open source* data and tools.<sup>7</sup> The IDF researchers’ ethos revolves around open access to the essential elements (data, source code, software) with the motive of collaborative improvement, public free (re-)distribution and transparency, Brabham describes this as the *open source* philosophy.<sup>8,9</sup> It is in the pursuit of accountability and truth by IDF agencies that this philosophy finds a strong interconnection and becomes an inseparable part of their methodology.<sup>10</sup>

### 2.3.2 Imagination and alignment – creating consensus through boundary objects

The idea of interconnection also plays an important role in the dynamic process of participation and reification between global IDF research-teams, where a shared understanding is essential. Wenger states that using *imagination* to construct “images” that help us understand (how we belong in a broader context) are crucial for relating with and

1 Weizman argues that this entangled process of verification involves producing the ‘unlikely common’ between communities and institutions of diverse natures: scientific, political, juridical and cultural to develop a foundation on which collectively a public truth is built.

2 Weizman, Eyal. 2018. “Propositions #7/2: Counter Forensics”. Utrecht: BAK, basis voor actuele kunst. Lecture 18 October 2018. <https://www.youtube.com/watch?v=kACsOGT8ECM> (last accessed 11.01.2019)

3 Pór, George. 2008. “Cultivating collective intelligence: a core leadership competence in a complex world”. *Collective Intelligence: Creating a Prosperous World at Peace*, edited by Mark Tovey. Earth Intelligence Network, Virginia. Pages 238 – 240

4 Wenger, Etienne and Beverly Trayner. 2015. “Communities of practice a brief introduction”. <https://wenger-trayner.com/introduction-to-communities-of-practice/> (last accessed 11.03.2019)

5 Pór, George. 2008. “Cultivating collective intelligence: a core leadership competence in a complex world”. *Collective Intelligence: Creating a Prosperous World at Peace*, edited by Mark Tovey. Earth Intelligence Network, Virginia. Pages 238 – 240

6 Lévy, Pierre. 2008. “A metalanguage for computer augmented collective intelligence”. *Collective Intelligence: Creating a Prosperous World at Peace*, edited by Mark Tovey. Earth Intelligence Network, Virginia. Page 15

7 Surowiecki, James. 2004. “*The Wisdom of Crowds: Why the Many are Smarter than the Few and How Collective Wisdom Shapes Business, Economies, Societies, and Nations*”. New York: Doubleday. Page xiii

8 Brabham, Daren C. 2008. “Concepts, Theories and Cases of Crowdsourcing as a Model for Problem Solving: An Introduction and Cases”. *Convergence* 14 (1). Page 79

9 Parens, B. (n.d.). “The Open Source Definition”, Open Source Initiative. URL. (accessed 17 May 2019): <https://opensource.org/osd> (last accessed 05.06.2019)

10 To avoid an extensive discourse of positioning open source, I situate the term in the context of IDF and share a broader description of open source in relation to working methods of Airwars and Amnesty International that can be found in the secondary appendix 3 on page 48.

identifying the domain.<sup>55</sup> Wenger explains that language, maps, pictures and so on can be seen as “tools of imagination” to construct these “images”.<sup>56</sup> It is around these that CoP *align* their engaged practice, through coordination of perspective, interpretation, law and actions.<sup>57</sup>

In the research-case ‘Rhetoric versus Reality’ Google Earth’s geospatial-images were used to construct this shared understanding. Google Earth’s mediation of geospatial imagery by KML is internationally standardized and regulated and can therefore be framed as a *boundary object*. Fox explains that these objects are entities that improve the capacity of concepts, theories or practices to transmit meaning and interpenetration across cultural boundaries, strongly related to the adoption of innovative ideas, technological development and sharing of knowledge.<sup>58</sup> Boundary objects are critical for the demarcation of knowledge and how they affect the CoP. Carlile indicates that boundary objects establish a shared “syntax or language” wherein individuals embody their knowledge, it enables the CoP to consolidate separated perspectives to a particular matter.<sup>59</sup> Star and Griesmer state that boundary objects (like geospatial imagery) are the same for various CoPs, nevertheless the content can differ, meaning that interpretation is subjective, for example: agriculture, natural features, geopolitics or forensic evidence.<sup>60</sup>

Parks critically studies the *vertical field* (figure 02, page 24) and *vertical mediation* (figure 03, page 25) of geospatial imagery and evaluates how the use of geospatial technology changes the representation of global conflicts and international relations.<sup>61</sup> Google Earth is the centre of long existing debates about geopolitics, visibility and its relation (as a technological structure) to public communication and popular culture.<sup>62</sup> <sup>63</sup> It is in this discourse that IDF research takes place, that Weizman and Dziuban explained as “the politics of verticality” where the complex relation and tension between those in power and civilians takes place.<sup>64</sup> <sup>65</sup> I argue that this mediated imagery by Google Earth is the *boundary object* that Airwars and Amnesty International addressed to organize their participation around. It is in the context of Google Earth that this specific CoP built its *regime of competence* through the process of *participation and reification* – ongoing development of shared meaning and knowledge – resulting in properly utilizing their *repertoire of resources*. This materialized in coordinating and stimulating multiple practitioners (table 02, page 26) in their shared practice of geolocating civilian harm and damaged sites in Raqqa.

55 Wenger, Etienne. 2010. “Communities of Practice and Social Learning Systems: The Career of a Concept”. *Social Learning Systems and Communities of Practice*, edited by Chris Blackmore. Springer, London. Page 184

56 Idem.

57 Idem.

58 Fox Nick, J. 2011. “Boundary objects, social meaning and success of new technologies”. *Sociology* 45 (1) Sage publishers, London. Pages 71 – 73

59 Carlile P.R. 2002. “A pragmatic view of knowledge and boundaries: Boundary objects in new product development”. *Organization Science* 13(4). Pages 442–55.

60 Star S.L and Griesemer J.L. 1989. “Institutional ecology, translations and boundary objects”. *Amateurs and professionals in Berkeley’s Museum of Vertebrate Zoology 1907–1939. Social Studies of Science* 19: Page 387–420.

61 Parks, Lisa. 2018. “*Rethinking Media Coverage: Vertical Mediation and the war on Terror*”. Routledge London. Pages 102–105, 129–134

62 Parks, Lisa. 2009. “Digging into Google Earth: An analysis of ‘Crisis in Darfur’”. *Geoforum* 40 (4). Elsevier. Pages 535–545

63 Ó Tuathail, G. 2004. “Geopolitical structures and cultures: towards conceptual clarity in the critical study of geopolitics”. *Geopolitics: Global Problems, Regional Concerns*, edited by Lasha Tchamouridze. University of Manitoba Press, Winnipeg, Pages 75–102.

64 Parks, Lisa. 2018. “*Rethinking Media Coverage: Vertical Mediation and the war on Terror*”. Routledge London. Page 102

65 Dziuban, Zuzanna. 2017. “*Mapping the ‘Forensic Turn’: Engagements with Materialities of Mass Death in Holocaust Studies and Beyond*”, editors, Peter Black, Gustavo Corni, Irina Scherbakowa. New Academic Press, Vienna. Page 11

Weizman, Eyal. 2017. “*Forensic Architecture: Violence at the threshold of detectability*”. New York: Zone Books. Pages 30 – 33

### 3 | Retracing a forensic case-study and socio-technological affordance analysis of KML-files

The main goal of this research is to answer the question: how do socio-technological affordances of KML-files enable the CoP to apply Google Earth (as a tool) for IDF research? This will be accomplished by retracing the forensic case-study of Airwars and Amnesty International, ‘Rhetoric versus Reality’ by conducting a socio-technological affordance analysis on original KML-files.<sup>66 67</sup> By conducting this analysis, I want to show how the KML technology affords the process of meaning making in relation to IDF. By analysing the original data, I will explore how these reveal the social structures of their CoP.

My use of socio-technological affordance analysis draws from the notion that modern technologies are not isolated entities but intertwined in complex relations that can be explored from multiple perspectives.<sup>68 69</sup> My approach on this analysis focuses on relationships between infrastructures of (invisible) technologies and people’s interpretation and understanding of these. To clarify the term “affordances” within my research, I refer to Boyle and Cook who state that McGrenere and Ho “*distinguish utility of an object, the actions it affords for the user, from the usability of an object, which is related to the perceptual information that signals the affordances*”.<sup>70 71 72 73</sup> In this light, Hutchby’s vision that affordances are “functional and relational” characteristics that form and are formed by human interaction concurrently, corroborates this and will therefore be part of my socio-technological affordance analysis.<sup>74</sup> It will be conducted to explain the complex relationship between the technological functionalities of for example placemark KML-files (in this specific case-study, pinpointing damaged sites in Raqqa). They are easily shared with others or placed on a server in order for collaborators to elaborate and contribute upon the research. This facile sharing models relational affordances that structure and stimulate a CoP.<sup>75</sup> As Hutchby explains, affordances differ from user to user and context to context, that is why conducting this research through the lens of an IDF investigator will shape the conditions of the analysis.<sup>76</sup>

#### 3.1 Explaining the corpus and retracing forensic research

The second step entailed assembling the corpus by retracing the existing forensic research ‘Rhetoric versus Reality’. This was done by attending a lecture and participating in a workshop by Airwars about their research methodology and collaboration with Amnesty International. The intensive workshop walked through several exercises to gain knowledge

66 The retracing will be based upon the forensic research by Airwars over the course of US Coalition strikes in Raqqa (Syria) between June and October 2017. <https://airwars.org/news-and-investigations/raqqa-amnesty-airwars/>. (last accessed 12.04.2019)

67 Amnesty International & Airwars. Report. 2019. “Rhetoric versus Reality: How the ‘most precise air campaign in history’ left Raqqa the most destroyed city in modern times”. <https://raqqa.amnesty.org/> (last accessed 12.04.2019)

68 Hutchby, Ian. 2001. “Technologies, Text and Affordances”. *Sociology* 35(2). BSA Publications Limited, UK. Page 444

69 Zuboff, Shoshana. 2018. “*The age of surveillance capitalism: The Fight for a Human Future at the New Frontier of Power*”. Profile Books Ltd, London. Page

70 Conole, Gráinne, and Martin Dyke. 2004. “Understanding and Using Technological Affordances: A Response to Boyle and Cook”. *Research in Learning Technology* 12 (3).

71 Boyle, Tom, and John Cook. 2004. “Understanding and using technological affordances: a commentary on Conole and Dyke”. *Research in Learning Technology* 12(3). Pages 295-299.

72 Boyle, Tom, and John Cook. 2004. “Understanding and using technological affordances: a commentary on Conole and Dyke”. *Research in Learning Technology* 12(3). Page 296.

73 McGrenere, Joanna, and Wayne Ho. 2000 “Affordances: Clarifying and evolving a concept”. *Graphics interface* 2000. Page 180-181

74 Hutchby, Ian. 2001. “Technologies, Text and Affordances”. *Sociology* 35 (2). BSA Publications Limited, UK. Page 444

75 Hutchby, Ian. 2001. “Technologies, Text and Affordances”. *Sociology* 35(2). BSA Publications Limited, UK. Page 447

76 Hutchby, Ian. 2001. “Technologies, Text and Affordances”. *Sociology* 35 (2). BSA Publications Limited, UK. Page 447

and skills on how to: geolocate, conduct geospatial-image analysis, reconcile and verify the time and location of events documented (assembled via social media channels like YouTube, Twitter and Facebook) in text, image or video, using the original KML datasets, which were also made available for further research.<sup>77</sup> Together with inside information gathered during personal conversations with Airwars researchers Dyer and Rullmann it became possible to retrace their investigation on Raqqa in depth.<sup>78</sup> I will exclusively focus on the final KML dataset of two years of research and apply these in Google Earth Pro, which will be used due to its advanced technological features which are crucial for IDF research: the *history-tool* and the ability to import and export *spreadsheet-data* (which is not possible in the browser version).

### 3.2 Performing the methodologies

The analysis will examine the general features, focussing on structuring hierarchical information and naming folders. Specific objects utilised during the retracing involved: *placemarks* that pinpoint demolished sites and civilian harm, *polygons* marking areas, as well as *descriptions* used in those placemarks, the time (history tool) of (geo) transformation.<sup>79 80</sup> The challenge was identifying specific features that provide a complete spectrum of properties that explain how the KLM-files afford the social process of community practice and the relation to the functional aspects that enable collective aggregation of evidence, in relation to openness and transparency.

Limitations of this research are firstly expressed in the notion that this is an individual research project in which collaboration with third parties can be sought to evaluate created KML-files, this will not directly lead to establishing a CoP. Therefore, exploring dynamic participation on the same file to come to a deeper understanding of the technological affordances in relation to social structures is strenuous. Due to inside knowledge through personal conversations with direct researchers of Airwars and Amnesty International I gathered information on their social structures and working methods beside the Google Earth KML-files. With this knowledge it was possible to have an informed view while analysing the extensive KML-files, despite this it can convey an interpretative perspective on their social structures. Secondly, it was not feasible to enclose the full geo-location (re-tracing) of the forensic research in this thesis, this part of the research can be found in secondary appendix 1 page 39. Finally, it was not possible to determine how the results of the 'Strike Tracker' project were combined with the original UNOSAT (*vide infra*) in the analysed KML-files; for this research this did not pose any major obstacles, however it could pose those in eventual legal proceedings due to lack of transparency.

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77 This IDF method and process is shown in secondary appendix 1 on pages 39-47.

78 Sophie Dyer and Hanna Rullmann are researchers and worked with Amnesty to incorporate Airwars' own findings in the study.

79 The term object comes from the KLM object orientated hierarchy, see figure 01, page 22

80 Airwars kept a public archive and timeline on their website. <https://airwars.org/conflict/coalition-in-iraq-and-syria/> (last accessed 02.06.2019)

## 4 | How socio-technological affordances of KML-files enabled the CoP to use Google Earth for digital forensic research

### 4.1 The domain

#### 4.1.1 Explaining the shared ideology

The US operation to evict IS from Raqqa, succeeded in October 2017 through thousands of airstrikes,<sup>81 82 83</sup> in urban areas where IS held civilians as shields.<sup>84 85 86</sup> The US Coalition claimed that their strikes were precise and took all measures preventing civilian casualties.<sup>87</sup> Rovera of Amnesty International Ground Investigation documented completely demolished building-blocks, stating that “claims about minimising civilian casualties are unsupportable”.<sup>88</sup> It is in this unsupportable narrative of precision warfare that Airwars and Amnesty share an ideology, although deriving from different motivations – Airwars pursuing public transparency and shifting public opinion,<sup>89</sup> Amnesty searching for juridical justice and accountability<sup>90</sup> – both parties strive to assemble a body of evidence against violation of human rights affected by political violence by the US Coalition’s systemic civilian harm.<sup>91 92</sup>

#### 4.1.2 In relation to the turn of forensics

The partnership between Airwars and Amnesty International (table 01, page 23) unites strengths of diverse research fields; this is crucial because IDF methods and geo-practice alone is currently not enough to serve as evidence in courts and tribunals.<sup>93</sup> In their pursuit to perceive more knowledge, the CoP relied upon (open source) information on social media platforms; the spectrum stretched from hyperlocal reports of civilians (in local languages) to content produced

81 The operation named ‘Operation Inherent Resolve’ established by the United States Army Central Command “to formalize ongoing military actions the rising threat posed by ISIS in Iraq and Syria”. Combined Joint Task Force Operation Inherent Resolve APO AE 09306. <https://www.inherentresolve.mil/About-CJTF-OIR/> (last accessed 03.06.2019)

82 Callimachi, Rukmini. “Fight to Retake Last ISIS Territory Begins”. *The New York Times*, 11 September 2018. <https://www.nytimes.com/2018/09/11/world/middleeast/isis-syria.html> (last accessed 03.06.2019)

83 “Raqqa: a journey into the destroyed heart of the Islamic State capital”. *The Guardian*, 10 October 2017. <https://www.theguardian.com/world/2017/oct/10/raqqa-a-journey-into-the-destroyed-heart-of-the-islamic-state-capital> (last accessed 03.06.2019)

84 Weizman, Eyal. 2017. *Forensic Architecture: Violence at the threshold of detectability*. New York: Zone Books. Pages 30 – 33

85 Amnesty International and Airwars. “War in Raqqa: Rhetoric versus Reality”. Amnesty International, 25 April 2019. <https://raqqa.amnesty.org/> (last accessed 03.06.2019)

86 “Syria: Unprecedented investigation reveals US-led Coalition killed more than 1,600 civilians in Raqqa ‘death trap’”. Amnesty International, 25 April 2019. <https://www.amnesty.org/en/latest/news/2019/04/syria-unprecedented-investigation-reveals-us-led-coalition-killed-more-than-1600-civilians-in-raqqa-death-trap/> (last accessed 03.06.2019)

87 Idem.

88 Rovera, Donatella & Walsby, Benjamin. “‘Precision’ airstrikes kill civilians. In Raqqa we saw the devastation for ourselves: Amnesty’s research reveals the huge civilian toll of bombings by the US-led coalition forces in the Syrian city”. *The Guardian*, 05 June 2018. <https://www.theguardian.com/commentisfree/2018/jun/05/british-us-airstrikes-raqqa-civilians-killed> (last accessed 12.04.2019)

89 Airwars. “Methodology”. <https://airwars.org/about/methodology/> (last accessed 03.06.2019)

90 Amnesty International. “What we do”. <https://www.amnesty.org/en/what-we-do/> (last accessed 03.06.2019)

91 Coalition members: United States, Britain and France.

92 U.S. Air Forces Central Command. 2017. <https://www.afcent.af.mil/Portals/82/Airpower%20Summary%20-%20March%202017.pdf?ver=2017-04-13-023039-397> (last accessed 17.05.2019)

93 Many Independent Forensic agencies (like Bellingcat in Den Haag) are working on creating accepted forensic standards and protocols. Analysts applying these geo-techniques have little documentation from the past to deduce from. The first “notable exception is declassified satellite imagery and aerial reconnaissance photography related to the 1995 Srebrenica massacre. This imagery was later released after it was used as evidence exhibits in the International Criminal Tribunal for the former Yugoslavia. This remote sensing discipline is currently developing itself and is faced with operational challenges and setting “new” requirements. Raymond, Nathaniel A., Brittany L. Card, and Isaac L. Baker. “A new forensics: Developing standard remote sensing methodologies to detect and document mass atrocities.” *Genocide Studies and Prevention: An International Journal* 8 (3).

by the (US-led Coalition) militaries and governments (figure 04, page 27).<sup>94</sup> This content was extensively used (figure 05, page 28) – and archived – in the investigation and the analysis and authentication of these sources laid the foundation for geolocating the civilian harm in Raqqa that was potentially caused by the international Coalition strikes and mapping it digitally on Google Earth.<sup>95 96</sup>

## 4.2 The Community of Practice

The research took two years of intense collaboration, resulting in a growing interactive network of various disciplines; a CoP. Their participation was organized around the reification of meaningful (computed) artefacts, set up within open source tools that stimulated a flow of research.<sup>97</sup> Their production of a shared jargon, shared (data) documents and geolocating methods are clearly visible in the way the CoP applied KML-files. These open source files not only compile evidence; but also create a space for dynamic negotiation with the purpose to improve and complete the existing research.<sup>98 99</sup>

### 4.2.1 Participation and reification

The shared jargon emerged in response to the language used by the US Coalition in monthly Civilian Casualty Reports, referring to civilian deaths as credible or non-credible (figure 06, page 29). This sharp dichotomy of true or false is not sufficient in many of the cases involving civilian casualty according to Airwars and Amnesty International.<sup>100</sup> Their verification method Grading applies five stages: *Confirmed to Fair*, *Weak*, *Contested*, *Discounted* (figure 07, page 29).<sup>101</sup> This approach towards confirming civilian casualties and choice of language distinguishes them from the US Coalition Civilian Casualty team – the Combined Joint Task Force - Operation Inherent Resolve (CJTF-OIR) team.<sup>102</sup> In the original KML-files only *Confirmed to Fair* casualties are included and *placemarked*.<sup>103</sup> These are organized in two separated folders that distinguish between; remote monitoring – *remote only* and ground investigation – *verified*. The placemarkers in the *verified* folder carry different *name-tags* mostly expressing neighbourhood districts (figure 08, page 30), appearing less detached than the codes uses in the remote only folder (figure 9, page 31). These placemarkers do not show the possible overlap of remote monitoring and the verification on the ground. It is most likely

94 Dyer, Sophie and Rullmann, Hanna. Lecture "Counting the Uncounted" by Airwars at Het Nieuwe Instituut. 02 May 2019. <https://thursdaynight.hetnieuweinstituut.nl/en/activities/lecture-counting-uncounted>

95 Idem.

96 To grasp the completeness of this archive visit Airwars publicly accessible archive – this is an example of one specific case: <https://airwars.org/civilian-casualties/cs1526-september-25-2017/> (last accessed 12.04.2019)

97 Besides Google Earth, Google Drive, Google Sheets and Google Docs where heavily used to resemble found evidence.

98 Brabham, Daren C. 2008. "Concepts, Theories and Cases of Crowdsourcing as a Model for Problem Solving: An Introduction and Cases". *Convergence* 14 (1). Page 79

99 Parens, B. (n.d.). "The Open Source Definition", Open Source Initiative, URL. (accessed 17 May 2019): <https://opensource.org/osd> (last accessed 05.06.2019)

100 In relation to the vague international war laws considering civilian deaths: This law expresses that the military can never aim at civilians, although it is not against the law to "collaterally" cause the death of civilians. The law contains a vague notion about "out of proportion to the concrete and direct military aim". The US Coalition claims that they take all the measurements to spare civilian casualties; as required by this law. What does (this vague) law mean when put in to practice during military operations? Questions as: Who decides what is proportional – since the law does not specify numbers of deaths, nor the scale of attacks. The military's goals are leading; therefore, they calculate and decide what is civilian death.

Eviatar, Daphne. "US Military Admits It Killed Dozens More Civilians Than Previously Acknowledged. Now What?". *Just Security*, 22 August 2018.

<https://www.justsecurity.org/60413/military-admits-killed-dozens-civilians-previously-acknowledged-what/> (last accessed 01.06.2019)

Moyn, Samuel. "A War Without Civilian Deaths? What arguments for a more humane approach to war conceal?". *New Republic*, 23 October 2018. <https://newrepublic.com/article/151560/damage-control-book-review-nick-mcdonnell-bodies-person> (last accessed 01.06.2019)

101 Airwars. "US-led Coalition in Iraq & Syria". <https://airwars.org/conflict/coalition-in-iraq-and-syria/> (last accessed 01.06.2019)

102 Operation Inherent Resolve. "About-CJTF-OIR". <https://www.inherentresolve.mil/About-CJTF-OIR/> (last accessed 17.05.2019)

103 The Weak, Contested, Discounted casualties can be found on the public archive of Airwars. <https://airwars.org/conflict/coalition-in-iraq-and-syria/> (last accessed 01.06.2019)

that the investigation on the ground in 2019 pursued the previous collected and reconciled data to visit the sites and localize witnesses (table 03, page 32). It is impossible (as an outsider of the CoP) to distil from this final KML-version where, by whom and by how many members the negotiation took place and if placemarkers shifted between the two folders or even disappeared.

The organization of folders and *placemarks/name-tags* help members of the CoP searching through enormous amounts of data. KML technology effectively navigates the users to the exact coordinates; flying over the mediated demolished view of Raqqa, effortlessly crossing 1962 km<sup>2</sup>.

The created *polygons* frame different neighbourhoods and are a substantive addition to the original Google Earth map; especially for efficiently geo-locating sites (figure 10, page 33). The technological affordances allow drawing polygon objects that facilitate shared knowledge on the boundaries of these neighbourhoods. As a non-member of the (IDF) CoP it is difficult to distinguish the districts within the neighbourhoods that are used as name-tags by the ground investigation. It might be here that a shared deep understanding about the areas could be negotiated and additionally marked in the KML-files to forge a stronger social-relation between the research teams (remote monitoring and ground investigation). By increasing and sharing this knowledge the meaning making process would gain an extra layer of “social history of learning”. Therefore, in Wenger’s theory using the polygon feature to mark the districts would expand the *repertoire of resources* within this CoP research.<sup>104</sup>

#### 4.2.2 Engagement of collective intelligence

The fact that KML-files are dynamic and effortlessly shareable (with participants that have access to devices connected to internet and an installed version of Google Earth Pro) takes away physical geographic boundaries and enables non-location bound collaboration with many people, which has been fully utilized by Airwars and Amnesty International. The intense collaboration between multiple disciplines and diverse forms of engagement were globally employed and shaped *collective intelligence (CI)* (tables: 01, page 23 / 02, page 26 / 03, page 32).

Assessment and authentication of enormous amounts of content asked for collaborations with Amnesty’s Digital Verification Corps (DVC) and Decoders<sup>105</sup> (tables: 01, page 23 / 02, page 26 / 03, page 32); the crowdsourcing campaign ‘Strike Tracker’ project helped analyse UNITA UNOSAT’s data, which revealed more than 10.000 destroyed buildings, visualized by red-dot-placemark-icons in the KML-file (figure 11, page 34).<sup>106 107</sup> A broader description on the crowdsourcing “Strike Tracker” project can be found in secondary appendix 6 on page 50 and secondary appendix 7 on page 51. It is in the ‘Damaged sites’ (KML) folder that complex relations and knowledge came together and had to be comprehended by the participants that directly worked with these files (figure 11, page 34).<sup>108</sup> The codes like: SensDt, SensID2, ConfID2, Damst2 only make sense in relation to the geospatial imagery of Raqqa, mediated through Google Earth. The intensified frequency of geospatial image production during the strikes were used as a boundary object by

104 Wenger, Etienne. 2010. “Communities of Practice and Social Learning Systems: The Career of a Concept”. *Social Learning Systems and Communities of Practice*, edited by Chris Blackmore.. Springer, London Page 180

105 A broader description on the DVC can be found in secondary appendix 4 on page 48 and Decoders secondary appendix 5 on page 50

106 UNITAR Operational Satellite Applications Program – UNOSAT. <https://unitar.org/unosat/> (figure 15)

107 This crowdsourcing ‘Strike Tracker’ research was of major importance in verifying the original dataset of UNITAR. Time and place were verified and visualized strike patterns, these data-points were implemented in the first data reconciliation. This resource was used during the ground research in 2019. It was hard to pinpoint where the Strike Trackers input found a place in the KML-file, but I am guaranteed by Hanna Rullmann of Airwars that the ‘damaged sites’ KML-folder is based upon the original UNITAR data. Source personal email conversation with Hanna Rullmann researcher at Airwars. A more elaborative description can be found at appendix 0 page 00.

108 UNITAR Operational Satellite Applications Program – UNOSAT. <https://unitar.org/unosat/>

the CoP (figure 12, page 35). Because the IDF CoP developed a shared understanding and methodology to analyze geospatial images; they all interpret them as potential evidence. Their shared *repertoire of resources* makes that comprehending the codes in *placemark-balloons*, layered on the “earth’s surface”, which visually can be changed over time, reinforces their perception of the vertical field politics.

Developing (social) structures to coordinate and align complex relationships and multiple disciplines is fundamental for a CoP to also function as a CI. The technological structure that is facilitated by the default settings of Google Earth – objects are hierarchically ordered, pre-set graphic-styles and standardized geospatial imagery – forms the basis. Possibilities to customize KML are endless; despite that the analysed files adopted the object-hierarchy and graphic-styles – only “customizing” the icons by changing their colours. This expresses that the standardized features of KML/Google Earth met the IDF-CoP standards and facilitated their research sufficiently and were appropriated as an accessible tool.

#### 4.2.3 Creating consensus

Woods states that open source investigation is changing our understanding of civilian harm. Listening to communities in conflict zones and revealing their truth is what open source is about.<sup>109</sup> This vision is clearly expressed in the *descriptions* made in each civilian casualty *placemark-balloon* of the KML-files. In relation to Parks’ vision that satellite images mediate a multitude of objects – of which most become latent or dormant in the visual perception of geospatial images<sup>110</sup> – objects transformed to abstract data are perceptible – like the demolished sites – but are unintelligible without a place in a narrative or discourse.<sup>111</sup> The notion that each placemaker contains a descriptive story of the incident, often including numbers of civilian casualties and names of the victims, changes that understanding (figure 13, page 36). The sometimes clustered placemarkers and coded name-tags come to life – as personal and confronting stories – over the alienating backdrop of an apocalyptic demolished visual-mediation of Raqqa in 2017, which dynamically can be transformed to a “restored” city in 2011 (back and forward) by using the history tool of Google Earth (figure 14, page 37). The technological affordance and the way these *placemark-balloons* are applied by the CoP reveal the social-constructs of *all* involved parties and people.

This puts forth questions on how the *vertical field* (figure 02, page 24) is mediated through Google Earth (vertical mediation – figure 03, page 25).<sup>112</sup> Parks states that Google Earth can be understood as an instrumentalized tool that assembles geospatial imagery and asserts the US vertical hegemony. The monitored territory of Raqqa – by US Federal and commercial satellites – is transformed in digital intellectual property mediated by Google Earth.<sup>113</sup> It is in this mediation that the CoP creates a shared consensus and claims this intellectual property and use the US hegemony –

109 Woods, Chris founder of Airwars spoke during a discussion with open source researchers and human right organizations around technologies that strengthens reporting of civilian harm in conflicts worldwide. The event was organized by Frontline Club. ‘New Reporting Frontiers: OSI, Airstrikes and Civilian Harm’. Streamed live on 24 April 2019. <https://www.youtube.com/watch?v=P2kaLnkNcn4>. (last accessed 17.05.2019)

110 Parks, Lisa. 2018. *Rethinking Media Coverage: Vertical Mediation and the war on Terror*. Routledge London. Page 119

111 Idem.

112 In 2005 Google Earth was released as a free application, changing the geospatial industry, that until then was dominated by the US federal agencies National Reconnaissance Office (NRO) and the National Geospatial-intelligence Agency (NGA) alongside the major commercial-remote sensing satellite operators, who collect most of their revenue through US government contracts, GeoEye and DigitalGlobe. Google bought the digital mapping company Keyhole in 2004 and their 3D interactive mapping interface became the foundation for what we now know as Google Earth. Satellite imagery is encoded in KML (formerly Keyhole Markup Language) that displays geographic annotation and visualization integrated in Google Earth’s geolocation software that is governing and mediating the output through: (graphic) design, computational imagery (rendering-process) and computer networks explained by Lisa Parker as the vertical field (figure 01).

113 Parks, Lisa. 2018. *Rethinking Media Coverage: Vertical Mediation and the war on Terror*. Routledge London. Page 117

explicated by the intensified geospatial image production<sup>114</sup> – against US Coalition to claim justice and accountability.

Throughout the research ‘Rhetoric versus reality’ the CoP shaped and aligned the KML-files to their purpose (using geospatial imagery for geolocating civilian harm and damaged sites); working with its properties to consolidate separated perspectives and construct a specific context.<sup>115</sup> KML-technological affordances facilitate “spaces” for *co-participation* and *reification* through building structures and layers of placemarkers, polygons over the foundational mediation of geospatial imagery of Raqqa. It is within these “spaces” that productive engagement and utilizing the *repertoire of resources* divines the CoP’s *regime of competence*. A fluid CI research is made possible due to the accessible settings of Google Earth, that also allowed forms of negotiation in written and visual “conversations”; in for example the shared editing of the descriptions in the *placemarkers-balloons*. What stands out in all these technological affordances is that social structures are created, but conversely the process of negotiation is not perceptible or re-traceable – when content has been changed or deleted – which raises question on how an accountable “history of learning” can be established though the use of KML.<sup>116</sup>

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114 Sophie Dyer of Airwars expresses that this notion of power is extremely visible in the intensified frequency of geospatial-image production of Raqqa during the US-Coalition strikes in 2017. Plus, the notion that during Airwars’ research, the “private” satellite imagery provider Digital Globe pulled out (their payed) access to high-resolution geospatial-images of Raqqa which made them dependent on Google Earth. Dyer explained that the account with Digital Globe no longer provided their agency with high-resolution imagery of Raqqa and that these images became available for an unaffordable price that no NGO or digital forensic agency could afford. Sourced in personal conversation at the workshop “Counting the Uncounted” by Airwars at Het Nieuwe Instituut. 04 May 2019. <https://thursdaynight.hetnieuweinstituut.nl/en/activities/lecture-counting-uncounted> (last accessed 17.05.2019)

115 Wenger, Etienne. 2010. “Communities of Practice and Social Learning Systems: The Career of a Concept”. *Social Learning Systems and Communities of Practice*, edited by Chris Blackmore. Springer, London Page 184 – 186

116 Wenger, Etienne. 2010. “Communities of Practice and Social Learning Systems: The Career of a Concept”. *Social Learning Systems and Communities of Practice*, edited by Chris Blackmore. Springer, London Page 181

## 5 | Conclusion

In this paper I have argued that KML-files play a role in shaping an open source space for collectively aggregating forensic evidence. In the studied research-case ‘Rhetoric versus Reality’ KML-files employ a major role in the meaning making process and development of a shared consensus between members of the IDF CoP. Google Earth functioned as a space to collect potential evidence; assembled on top of- and by geospatial imagery through the practice of IDF methods. I have shown that the open source character of KML-files afforded: the repository of structured layers of evidence, that the technological functionalities allowed co-participation and negotiation to improve the reification of evidence, that the body of evidence was easily (re-)distributed between the members of the CoP.<sup>117 118 119</sup>

I have shown that Google Earth’s geospatial imagery functioned as a boundary object, where diverse subjective perspectives were channelled into a CI. The mediation of geospatial imagery was fundamental for the IDF CoP to work towards their shared aim; digitally mapping the US Coalition strikes and verifying civilian casualties. This visual process changed the understanding and scale of civilian harm in Raqqa, caused by those in power. It revealed the tension of “invisible” political influential technology, expressed by the increased geospatial-image production of Raqqa. The intertwined relation between the technological functions and the social constructs is disclosed in the form of descriptive placemark-balloons overlaying the mediated imagery. Airwars and Amnesty appropriated the infrastructures of KML to use that political technology against its original intended use; so, claiming the intellectual property and making it publicly tangible, to express their counter narrative of 1,600 civilian deaths opposed to the US Coalition “precision war” admitting 159 deaths.<sup>120</sup>

The KML technical affordances did facilitate intense collaboration and the development of a well-functioning CoP. KML-files helped constructing social structures and space for negotiation, it was in these spaces that a “social history of learning” was established.<sup>121</sup> The establishment of this process is fundamental for a CoP to build a repertoire of resources wherein members of the CoP can claim their competence and accountability.<sup>122</sup> Reflecting on the notion that accountability and transparency have priority within IDF research I can state that KML technologies did not provide this sufficiently in the ‘Rhetoric versus Reality’ case. Meaning that – as shown in the analysis –applying KML-files has a counter side; which is that the important negotiation is not documented or archived. The made changes are no longer visible, additionally it is not insightful who and how many members where negotiating and how the shared understanding came into existence. This realisation makes that the process of their research cannot be precisely reproduced by just following these final KML-files.

117 Brabham, Daren C. 2008. “Concepts, Theories and Cases of Crowdsourcing as a Model for Problem Solving: An Introduction and Cases”. *Convergence* 14 (1) Page 79

118 Parens, B. (n.d.). “The Open Source Definition”, Open Source Initiative, URL (accessed 17 May 2019): <https://opensource.org/osd> (last accessed 05.06.2019)

119 Idem

120 Amnesty International & Airwars. Report. 2019. “Rhetoric versus Reality: How the ‘most precise air campaign in history’ left Raqqa the most destroyed city in modern times”. <https://raqqa.amnesty.org/> (last accessed 12.04.2019)

121 Wenger, Etienne. 2010. “Communities of Practice and Social Learning Systems: The Career of a Concept”. *Social Learning Systems and Communities of Practice*, edited by Chris Blackmore. Springer, London Page 181

122 Wenger, Etienne. 2010. “Communities of Practice and Social Learning Systems: The Career of a Concept”. *Social Learning Systems and Communities of Practice*, edited by Chris Blackmore. Springer, London Page 181

I could argue that the socio-technological affordances of KML-files enabled the CoP to use Google Earth as a tool for IDF research; but the documentation of the process of negotiating the evidence and pursuit of truth is un-transparent due to Google Earth's affordances and pre-sets. Google Earth does not allow the CoP to create a real-time space wherein the discussion between members can be monitored and archived. Acknowledging this in the context of the unstable meaning making process and the fact that the created KML-files changed over the course of time makes the analyzed final-version a snapshot in time. This raises questions on the possibility of continuous negotiation that Wenger states shapes a CoP.<sup>123</sup> In this light the open source philosophy can therefore be put into question as well, although it is easily (re-)distributed and collaboratively improved and adjusted; getting to the origin (source) of the process is not facilitated by Google Earth's technological affordances. I propose to extend research in the domain of the IDF CoP and explore how socio-technological protocol-models could be developed within the boundaries of Google Earth, to be able to keep utilizing the accessible and easy to use tools of Google Earth. This enables to participate with CI and individuals do not need to have extensive skills in for example programming. These relations between social structures and technology could be researched in more depth by conducting a real-time forensic research, applying Google Earth KML-files and exploring what forms of negotiation can be built in by developing socio-technological protocols, rules and maybe even hierarchical structures that monitor the process; in light of datasets and documented process for the use in courts and tribunals.

The interaction between IDF CoP and KML-technology could also be investigated in relation to Google Earth Engine, a cloud-based platform for geospatial processing and data analysis.<sup>124</sup> This platform has a massive public archive of (historical) remote-data and works with computing power, API's and a scripting environment that can be appropriated to develop code and creating algorithms to the CoP requirements.<sup>125</sup> It could be here that the original research-data of Airwars and Amnesty International could extend and implement the existing (mostly environmental) Google's Earth Engine datasets and broaden its own IDF community.<sup>126</sup> Maybe answering Moore's call to dispel the reputation of Google's Earth Engine being a niche tool can be a first step.<sup>127</sup>

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123 Wenger, Etienne. 2010. "Communities of Practice and Social Learning Systems: The Career of a Concept". *Social Learning Systems and Communities of Practice*, edited by Chris Blackmore. Springer, London Page 184 – 186

124 Developers. "Google Earth Engine API" <https://developers.google.com/earth-engine/> (last accessed 07.06.2019)  
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125 Idem.

126 Idem.

127 Idem. / Rebecca Moore is the director of Google Earth: Earth Engine & Earth Outreach

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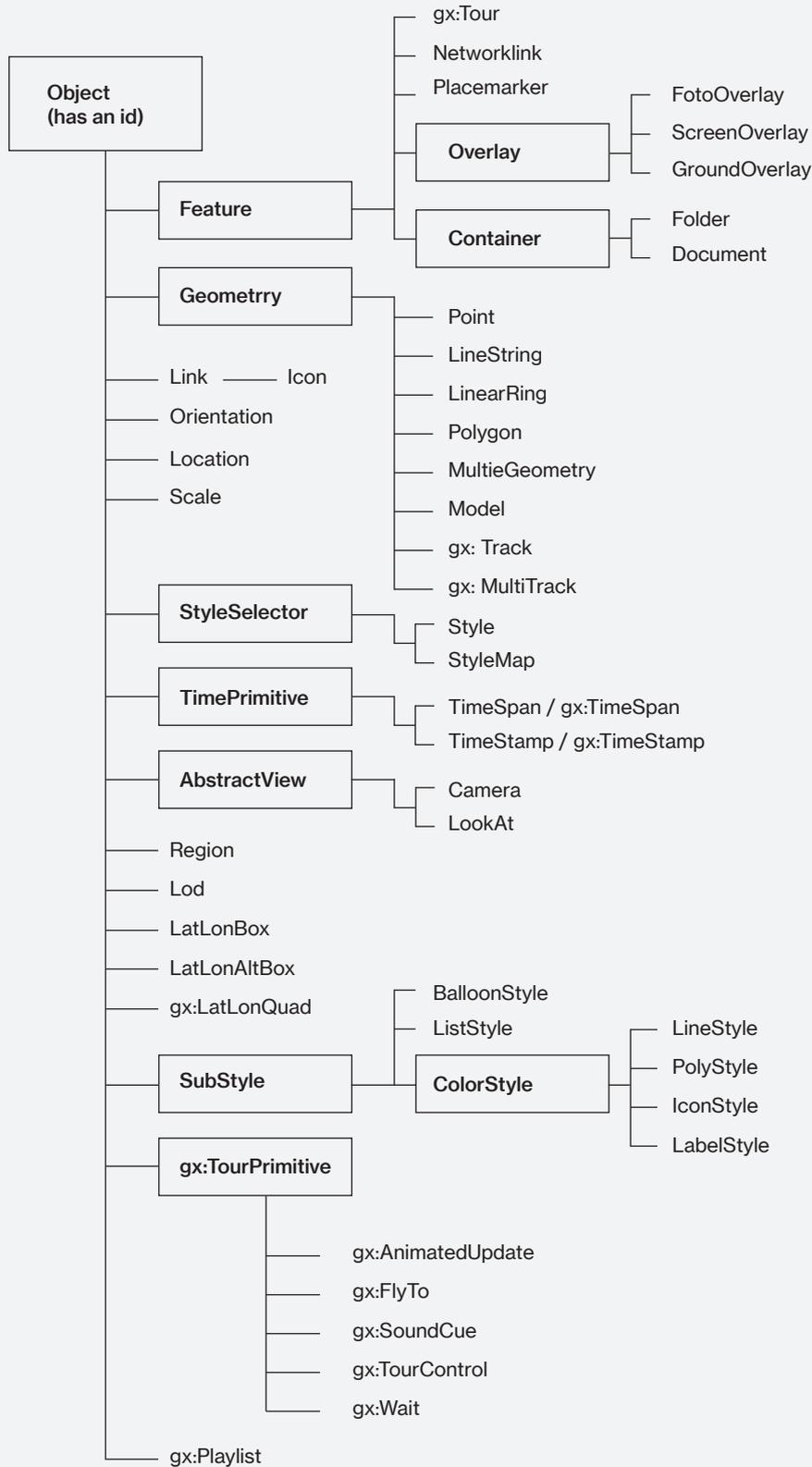
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# Appendix



## Object-oriented hierarchy to comprehend KML



<p><b>2017 – 25 April 2019</b></p>	<p><b>Airwars</b></p> <p>Independently tracked 429 locally alleged civilian harm events during the battle for Raqqa. This comprehensive dataset also formed a key part of the study 'Rhetoric versus Reality'.</p> <p><b>Shihab Halep</b> – Building a database</p> <p><b>Hanna Rullmann &amp; Sophie Dyer</b> – Close research collaboration with Amnesty International incorporating Airwars data.</p>
<p><b>2017 – Early 2019</b></p>	<p><b>Amnesty International Digital Verification Corps (DVC)</b></p> <p>DVC based at four universities around the world analysed and authenticated video footage captured during the battle to geolocate the events.</p> <p><b>Sam Dubberley</b> – Special advisor of Evidence Lab at Amnesty International, lead Digital Verification Corps programme.</p>
<p><b>February 2018 + Early 2019</b></p>	<p><b>Ground Investigation Team Raqqa (GITR) Amnesty International</b></p> <p>In 2018 researchers visited 42 sites of air strikes and interviewed 112 civilian residents of Raqqa.</p> <p>In 2019 carried out site investigations at more than 200 strike locations and interviewed more than 400 witnesses and survivors.</p> <p><b>Donatella Rovera</b> – Senior Crisis Response Adviser at Amnesty International.</p>
<p><b>November 2018 – Early 2019</b></p>	<p><b>Amnesty International / Decoders</b></p> <p>Amnesty International's <b>Strike Trackers</b> project collaborating with UNITAR Operational Satellite Applications Program - <b>UNOSAT</b>, combining and verifying geolocation - later applied this data in Google Earth (kml-files).</p> <p><b>Milina Marin</b> – Project Lead at Decoders Amnesty International</p>
<p><b>Publish Report 25 April 2019</b></p>	<p><b>Airwars + Amnesty International</b></p>

## The vertical field

The vertical field is the space between the orbit and earth's surface, those in powers make "hegemonic use of the *vertical field* intelligible and exposes efforts to remediate the landscapes and lifeworld's of untold and unnamed Others".

The mediation of geospatial imagery is strongly tied with the material re-organizing of all life on earth. Besides that, this form of *vertical mediation* plays part in: strikes, targeting, boarder regimes, destruction of territories, eliminating people with the aim that "new" governments can re-build other forms of social order and environments.

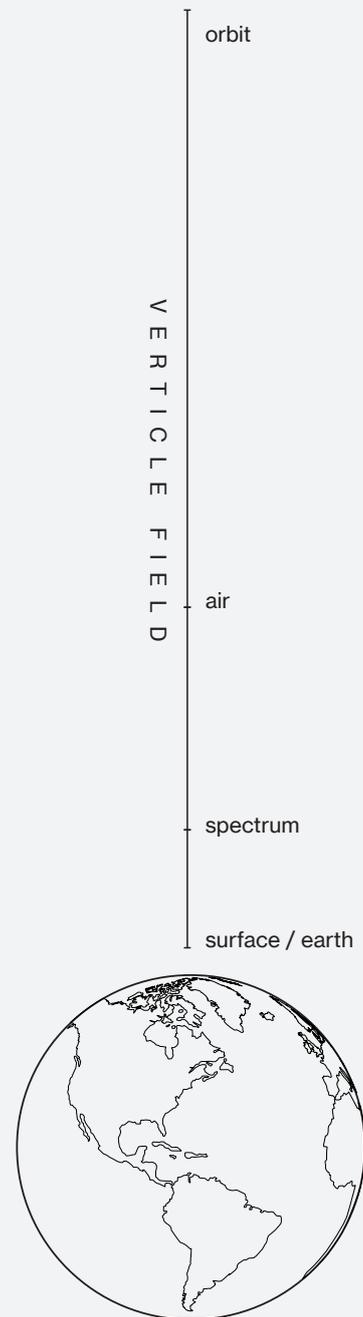
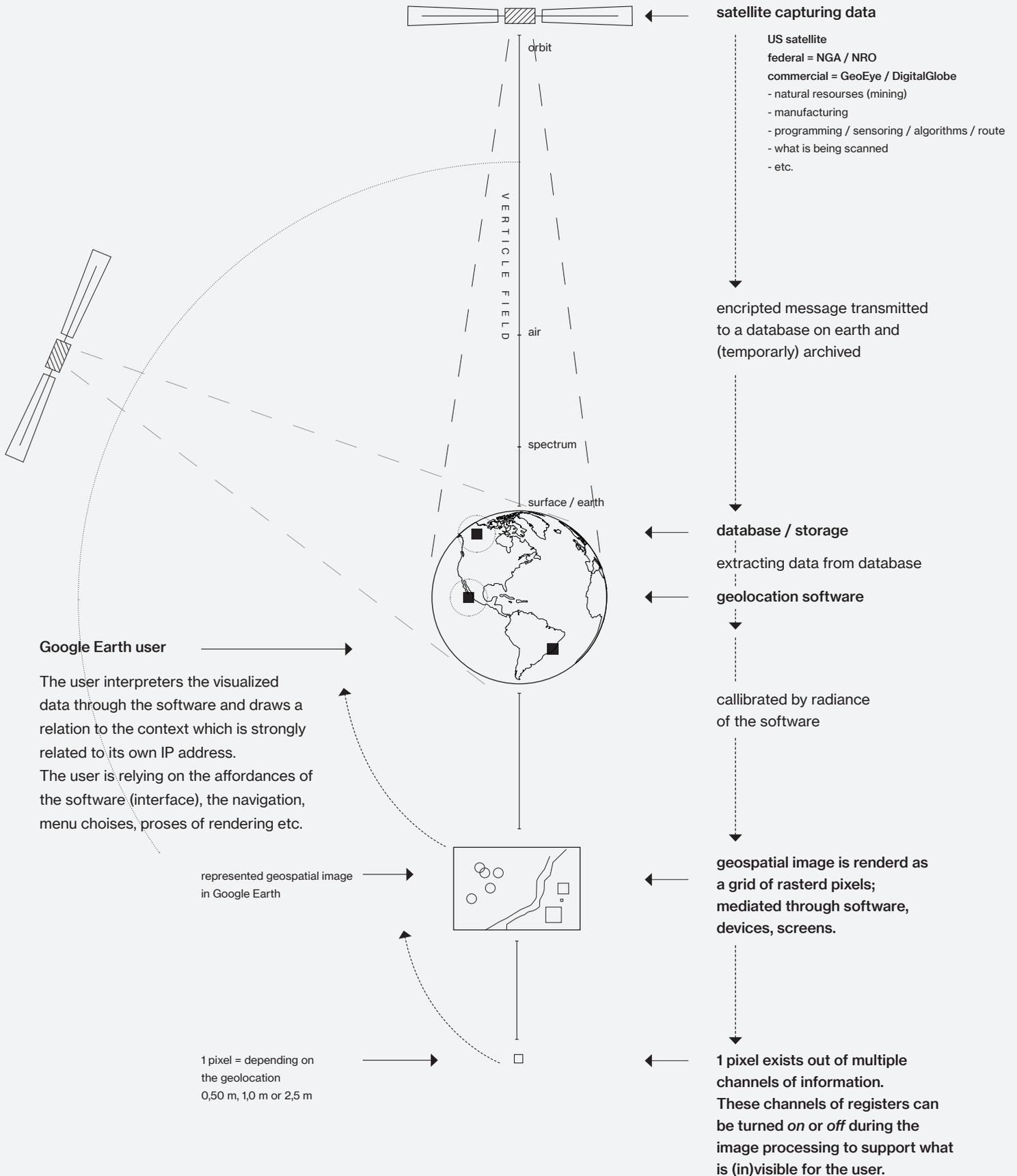


figure 03

## Vertical mediation



Sources of Incident Reports (IR) and engagement

GATHERING & ARCHIVING REPORTED INCIDENTS

GATHERING & ARCHIVING REPORTED INCIDENTS

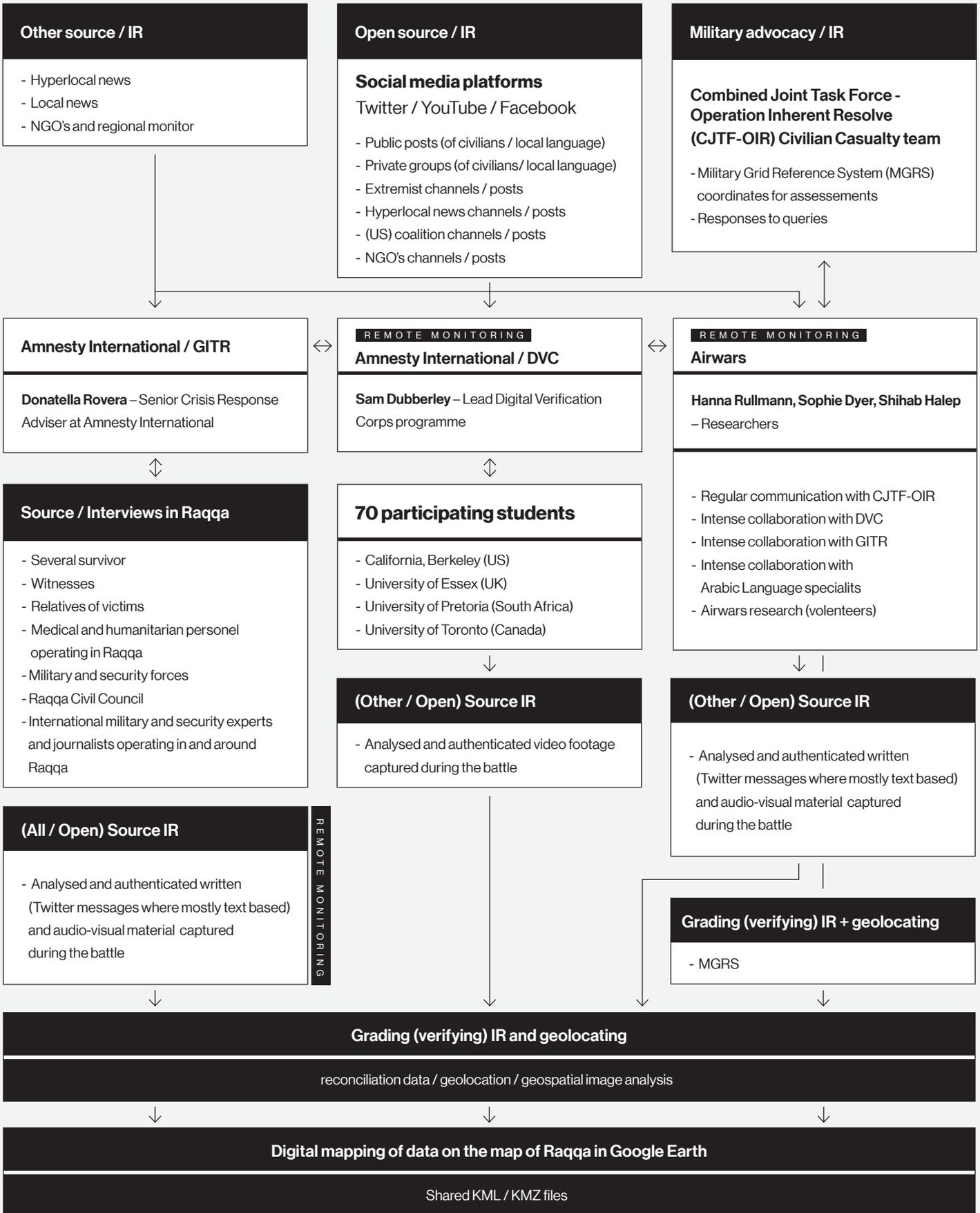


figure 04

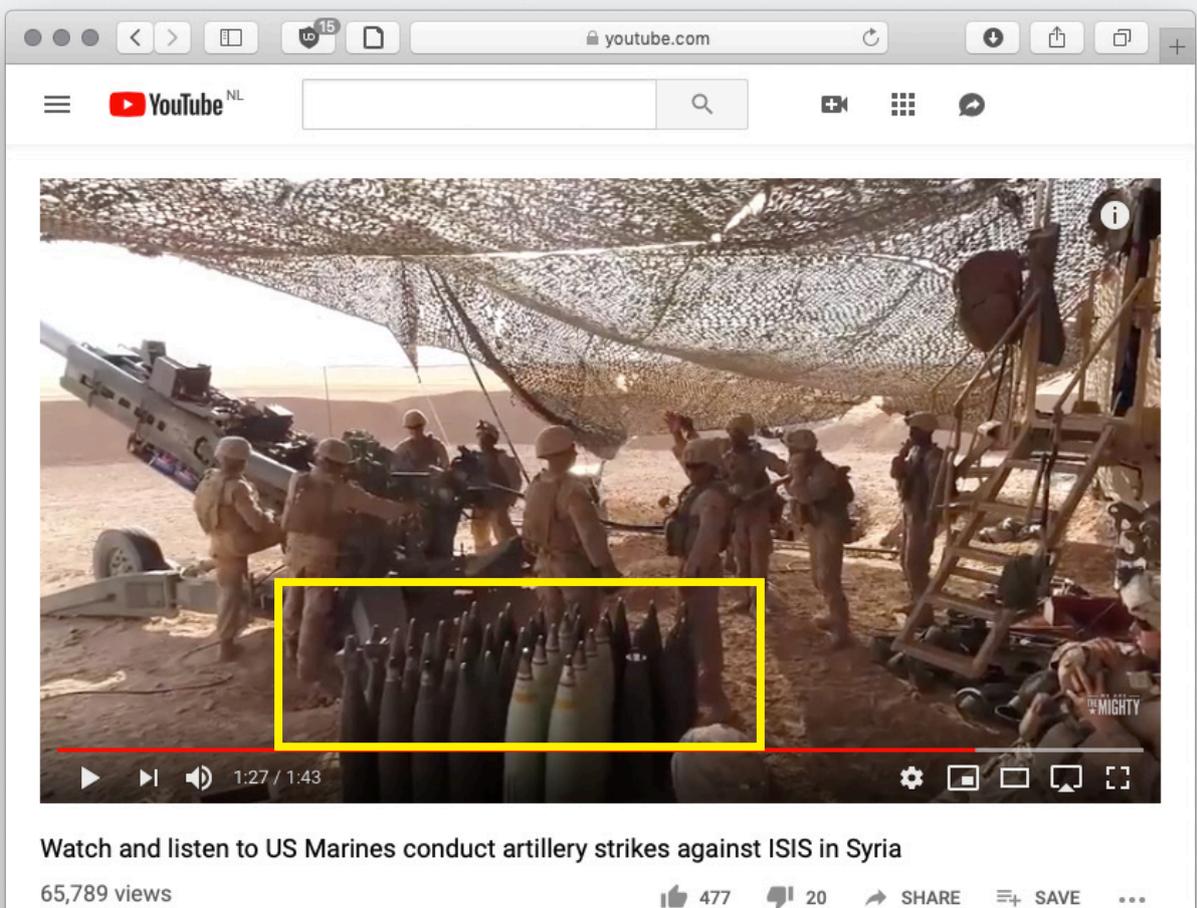
### Social media content used as source material



### Local report

These reportings of incidents are analysed and authenticated and used for geolocating the site and time of the strike and possible civilian harm. 'Raqqqa is Being Slaughtered Silently' is a citizen journalist group.

Source: workshop material



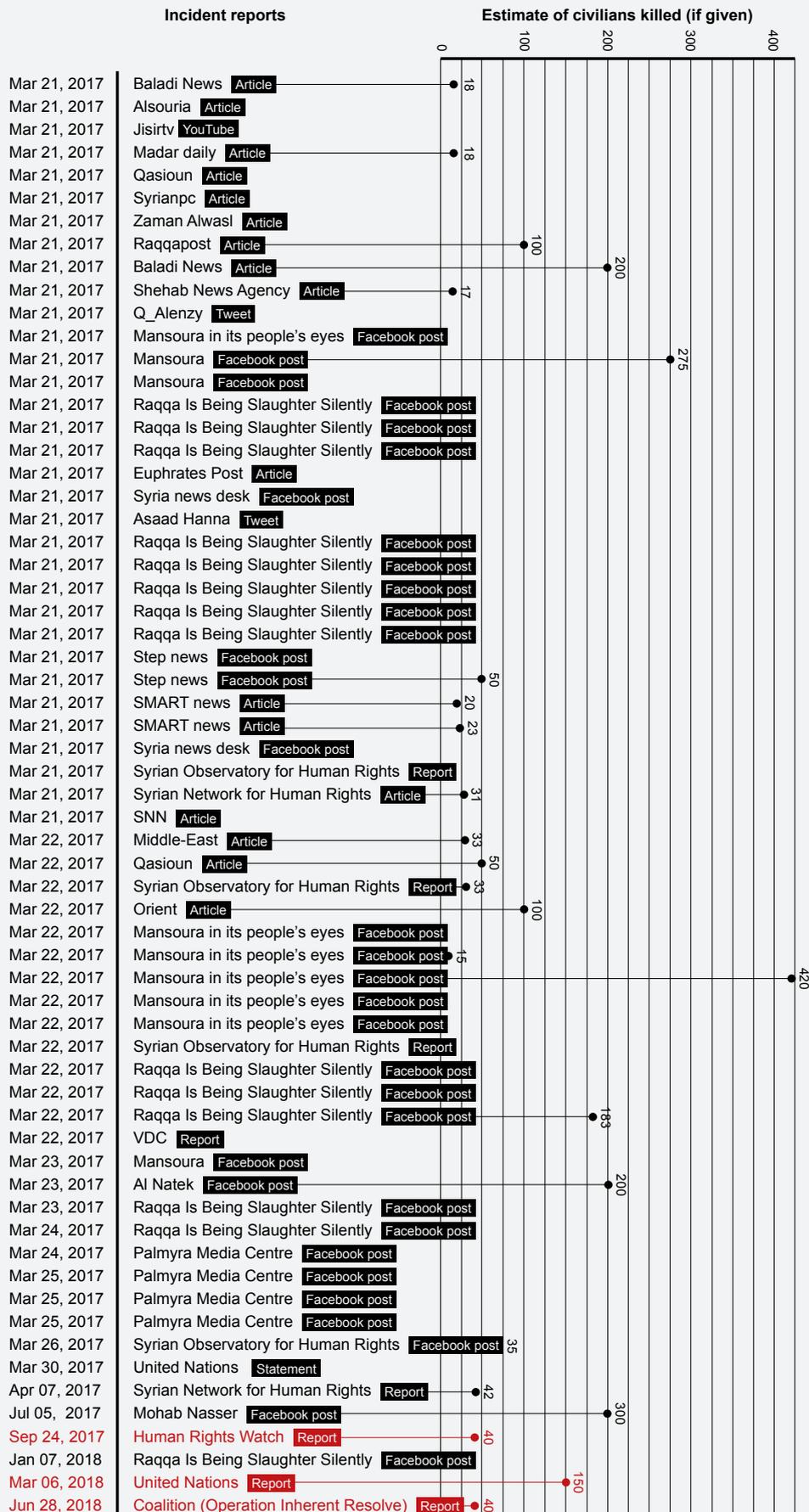
### US Coalition contend

The munition visible in this shot were identified by military experts and confirmed as wide-area artillery with a 100m radius instead of 50m which the Coalition claimed to use for their precision warfare. The areal-shots used in the video made clear this concerns the artillery-base build on 30 /31 May 2017 near Raqqa. This video was disseminated over multiple military social media channels and military websites, the captions made clear these strikes are part of Joint Task Force-Operation Inherent Resolve.

Source: We Are The Mighty. July 2 2017. YouTube. <https://www.youtube.com/watch?v=v62KisTuOL0> (last accessed 01.06.2019)

figure 05

Data sheet of all the reporting of one air strike in Raqqa



Source: Airwars

### Credible / non-credible versus verifying in five stages

06

**Combined Joint Task Force - Operation Inherent Resolve Monthly Civilian Casualty Report**  
| May 31, 2019

**SOUTHWEST ASIA--** Since the beginning of operations in 2014, the Coalition and partner forces have liberated nearly 110,000 square kilometers (42,471 square miles) from Daesh, eliminating their self-proclaimed territorial caliphate and freeing 7.7 million people from Daesh oppression. The Coalition will continue to work with partner forces to deny Daesh any physical space and influence in the region as well as deny Daesh the resources they need to resurge.

The Coalition continues to employ thorough and deliberate targeting and strike processes to minimize the impact of operations on civilian populations and infrastructure. This process includes thorough review and vetting of each target package prior to a strike and another report after that strike. Regular strike reports make Coalition activities publicly accessible, and monthly publication of civilian casualty reports makes civilian casualty assessments similarly accessible to the public.

As demonstrated, the Coalition is willing to consider new civilian casualty allegations as well as new or compelling evidence on past allegations to establish accountability based on the best available evidence.

The Coalition conducted 34,502 strikes between August 2014 and the end of April 2019. During this period, based on information available, CJTF-OIR assesses at least 1,302\* civilians have been unintentionally killed by Coalition strikes since the beginning of Operation Inherent Resolve. This report includes three credible reports that had not been previously reported in monthly CIVCAS releases.

In the month of April, CJTF-OIR carried over 122 open reports from previous months and received seven new reports. CJTF-OIR completed 18 civilian-casualty allegation assessment reports. Out of the 18 completed casualty allegation reports, three reports were determined to be credible and resulted in five unintentional civilian deaths. The remaining 15 reports were assessed to be non-credible. One hundred and eleven reports are still open, including three that had been previously closed but were reopened due to the availability of new information.

**Credible Reports--**In the three incidents assessed in April and the three previously unreported incidents, the investigations assessed that the Coalition took all feasible precautions, and the decision to strike complied with the law of armed conflict. Coalition forces work diligently to be precise during the planning and execution of strikes to reduce the risk of harm to civilians.

- Apr. 9, 2016, near Mosul, Iraq, via Airwars report. Coalition aircraft conducted an airstrike on a Daesh communication center in Mosul, Iraq. Regrettably, five civilians were unintentionally killed and nine others unintentionally wounded due to their proximity to the strike. (Not previously reported)
- Jan. 17, 2017, near Idlib, Syria, via self-report. Coalition aircraft conducted a strike against a Daesh vehicle. Regrettably, three civilians were unintentionally wounded due to their proximity to the strike. (Not previously reported)
- Mar. 27, 2017, near Idlib, Syria, via self-report. Coalition aircraft conducted a strike against a Daesh vehicle. Regrettably, three civilians were unintentionally killed and one civilian was injured due to their proximity to the strike. (Not previously reported)
- Dec. 24, 2017, near Kharayij, Syria, via self-report. Coalition aircraft conducted strikes on a Daesh weapons storage facility and Daesh terrorists. Regrettably, three civilians were unintentionally killed due to the proximity of the strikes.
- Aug. 1, 2018, near Ash Shajlah, Syria, via self-report. Coalition aircraft conducted a strike against a Daesh staging area. Regrettably, two civilians were unintentionally killed due to the proximity of the strike.
- Mar. 10, 2019, near Qayyarah-West Airfield, Iraq, via media-report. Regrettably, one civilian was unintentionally injured by Coalition small arms fire.

**Non Credible Reports--** After a thorough review of the facts and circumstances of each civilian casualty report, CJTF-OIR assessed the following 15 reports as non-credible. At this time there is insufficient information to assess that, more likely than not, a Coalition strike resulted in civilian casualties.

- Aug. 20, 2017, near al-Bado neighborhood, Raqqah, Syria, via Airwars report. After a review of all available strike records it was determined that, more likely than not, civilian casualties did not occur as a result of a Coalition strike.
- Aug. 20, 2017, near al-Sakhani neighborhood, Raqqah, Syria, via Airwars report. After a review of all available strike records it was determined that, more likely than not, civilian casualties did not occur as a result of a Coalition strike.
- Sept. 18, 2017, near al-Kahraba neighborhood, Raqqah, Syria, via Airwars report. After a review of all available strike records it was determined that, more likely than not, civilian casualties did not occur as a result of a Coalition strike.

### US Coalition credible / non-credible verifying civilian deaths

Source: Combined Joint Task Force - Operation Inherent Resolve Monthly Civilian Casualty Report. May 31, 2019. Inherentresolve.mil <https://www.inherentresolve.mil/Media-Library/News-Releases/Article/1862027/combined-joint-task-force-operation-inherent-resolve-monthly-civilian-casualty/> (last accessed 01.06.2019)

07

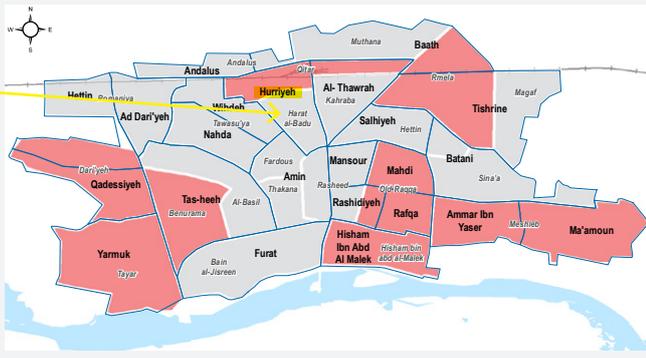
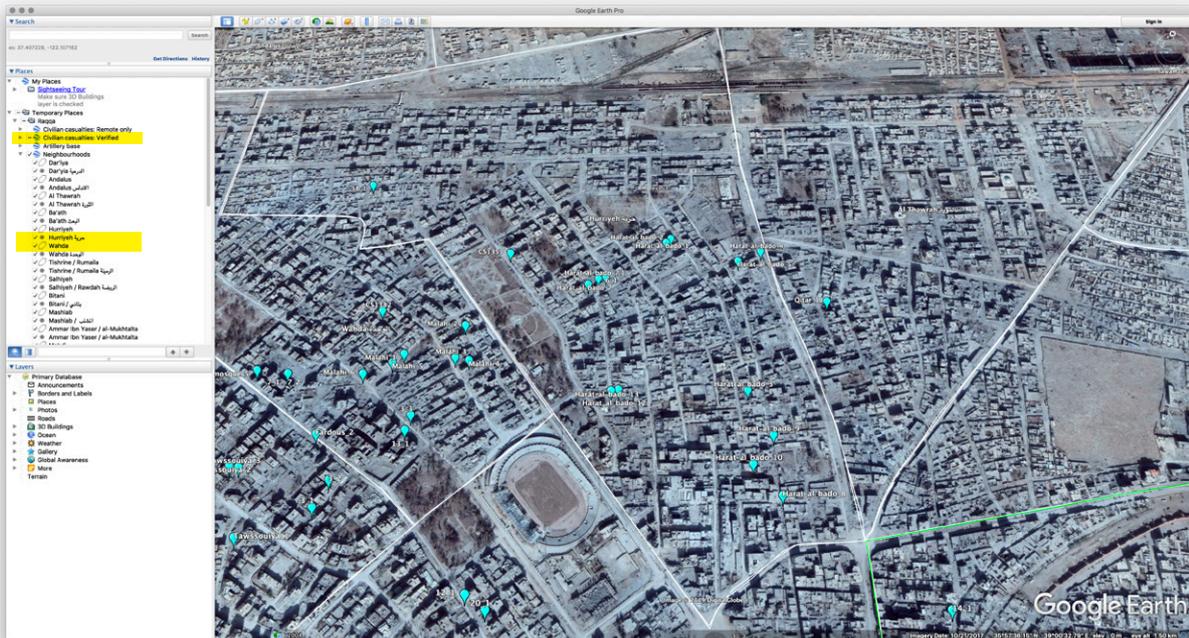
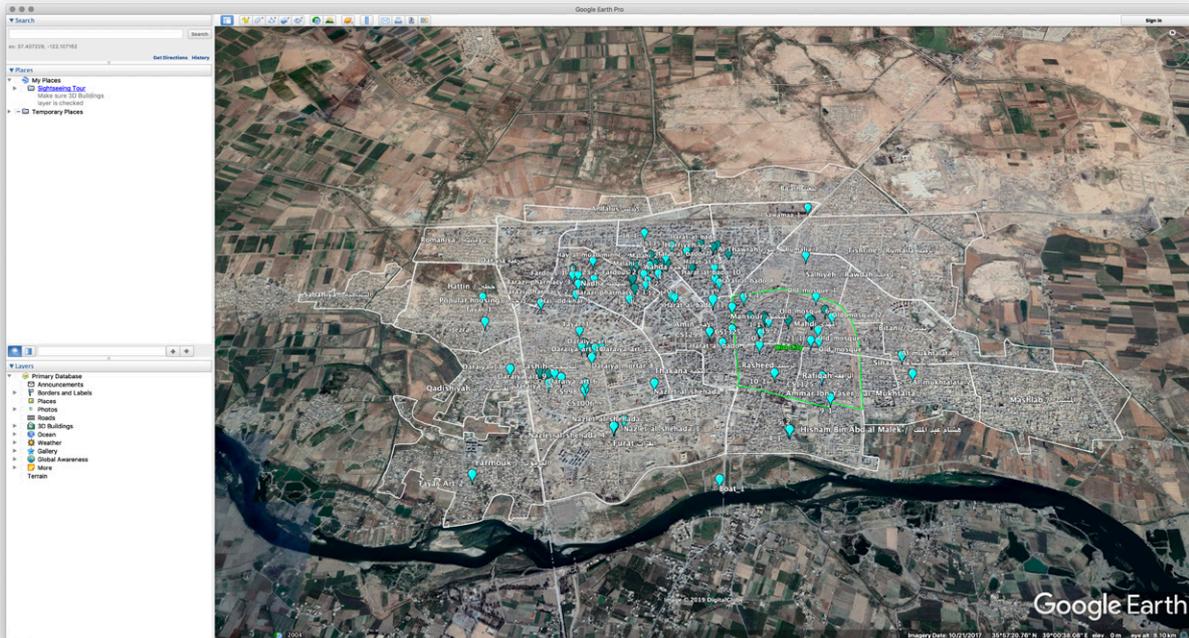
<b>Alleged deaths</b> 19,012-29,278	<b>Confirmed or Fair</b> ① 7,973-12,805	<b>Weak</b> ① 2,377-2,798	<b>Contested</b> ① 7,900-12,505	<b>Discounted</b> ① 710-1,100
Locally reported civilian deaths from US-led Coalition actions in Iraq and Syria.  2,855 separate alleged incidents	Civilian deaths for which the reporting was assessed by Airwars as Fair, or have been Confirmed by the US-led Coalition.  1,426 separate alleged incidents	Civilian deaths for which the reporting was assessed by Airwars as Weak.  434 separate alleged incidents	Civilian deaths for which the reporting is assessed by Airwars as Contested.  748 separate alleged incidents	Civilian deaths were Discounted by Airwars after assessment.  234 separate alleged incidents

### Grading system, verifying civilian deaths by Airwars

Source: Airwars. "Us-led Coalition in Iraq & Syria". <https://airwars.org/conflict/coalition-in-iraq-and-syria/> (last accessed 01.06.2019)

figure 08

Place-marks and name-tags | Civilian casualties: verified



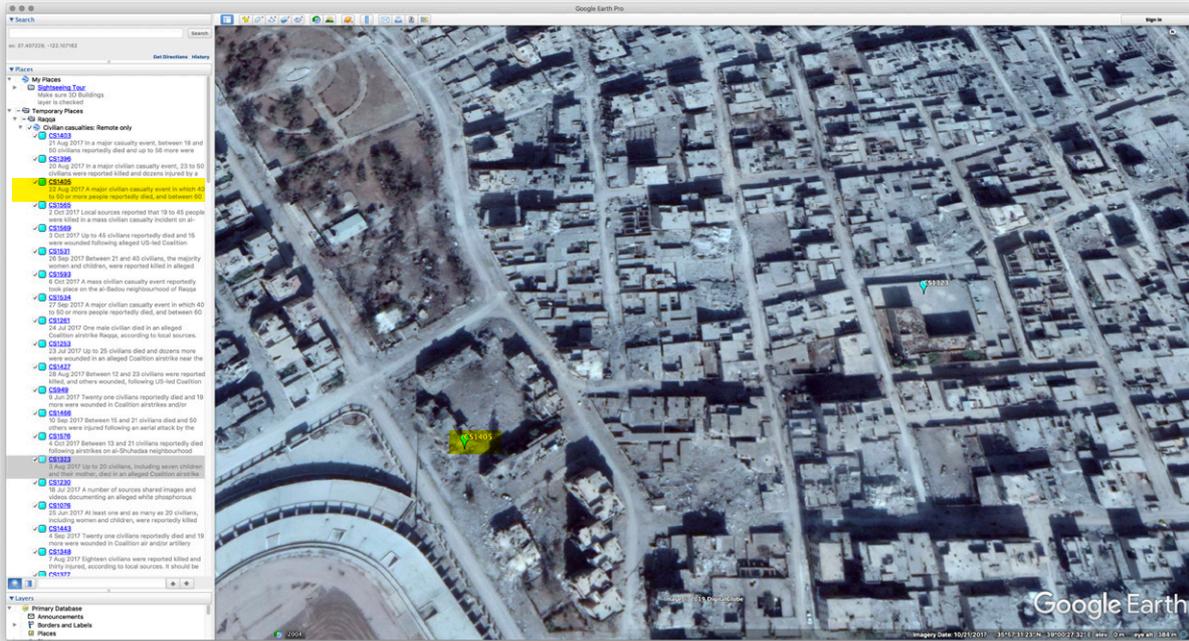
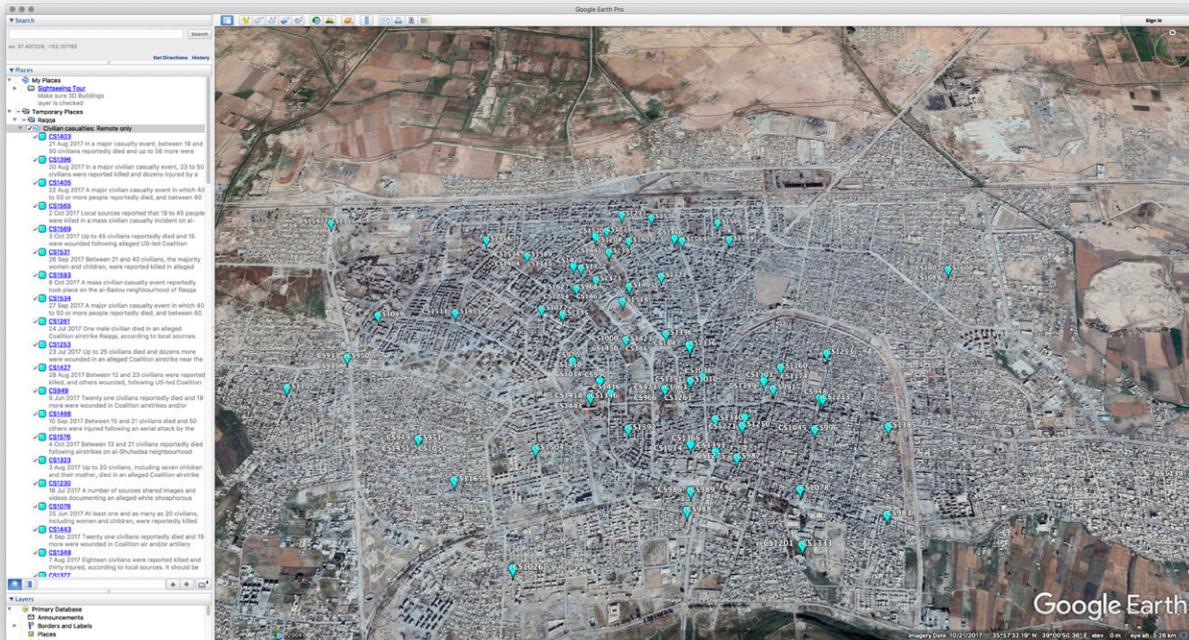
01 **Harat\_al\_bado\_1**  
 These tage-names express the district within a neighbourhood, they are numberd starting at 1 and counting up.

02 **Polygons**  
 Were created to distinguish neighbourhoods, which sketches out a clear overview and subdivision of the town. In the KML-file the Old City is highlighted in bright green.

Source map: 'Situation Overview: Area-Based Assessment of Ar-Raqqa City'. June 2018. Reliefweb.int [https://reliefweb.int/sites/reliefweb.int/files/resources/reach\\_syr\\_situation\\_overview\\_raqqa\\_city\\_aba\\_june\\_2018.pdf](https://reliefweb.int/sites/reliefweb.int/files/resources/reach_syr_situation_overview_raqqa_city_aba_june_2018.pdf) (last accessed 01.06.2019)

figure 09

## Place-marks and name-tags | Civilian casualties: remote-only

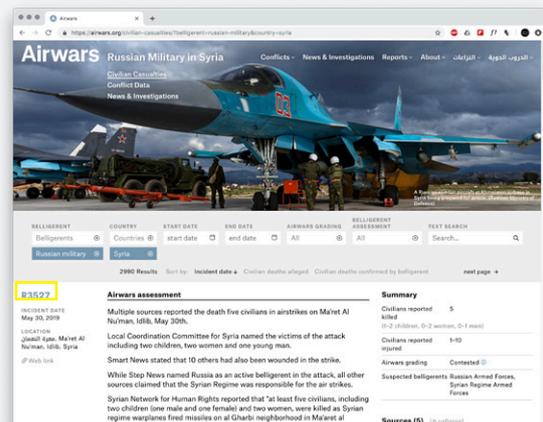


### CS1405 Coalition Syria (CS)

All codes created by Airwars start with one or two letters, of which the first is the army (in this case the Coalition). The Coalition operates in both Syria and Iraq, therefore incidents in Iraq begin with CI.

But it could also be Russia or Turkey, incidents linked to Russia only have an 'R'. These are not included in the analysed data-set.

The analysed KML-files only contains data of June till October 2017 when heavy US-Coalition strikes took place and Confirmed or Fair civilian casualties are place-marked, which causes an unregularly numbering in the codes.



Source: personal email conversation with Hanna Rullmann

Example Russian code

Sources of Incident Reports (IR) and engagement

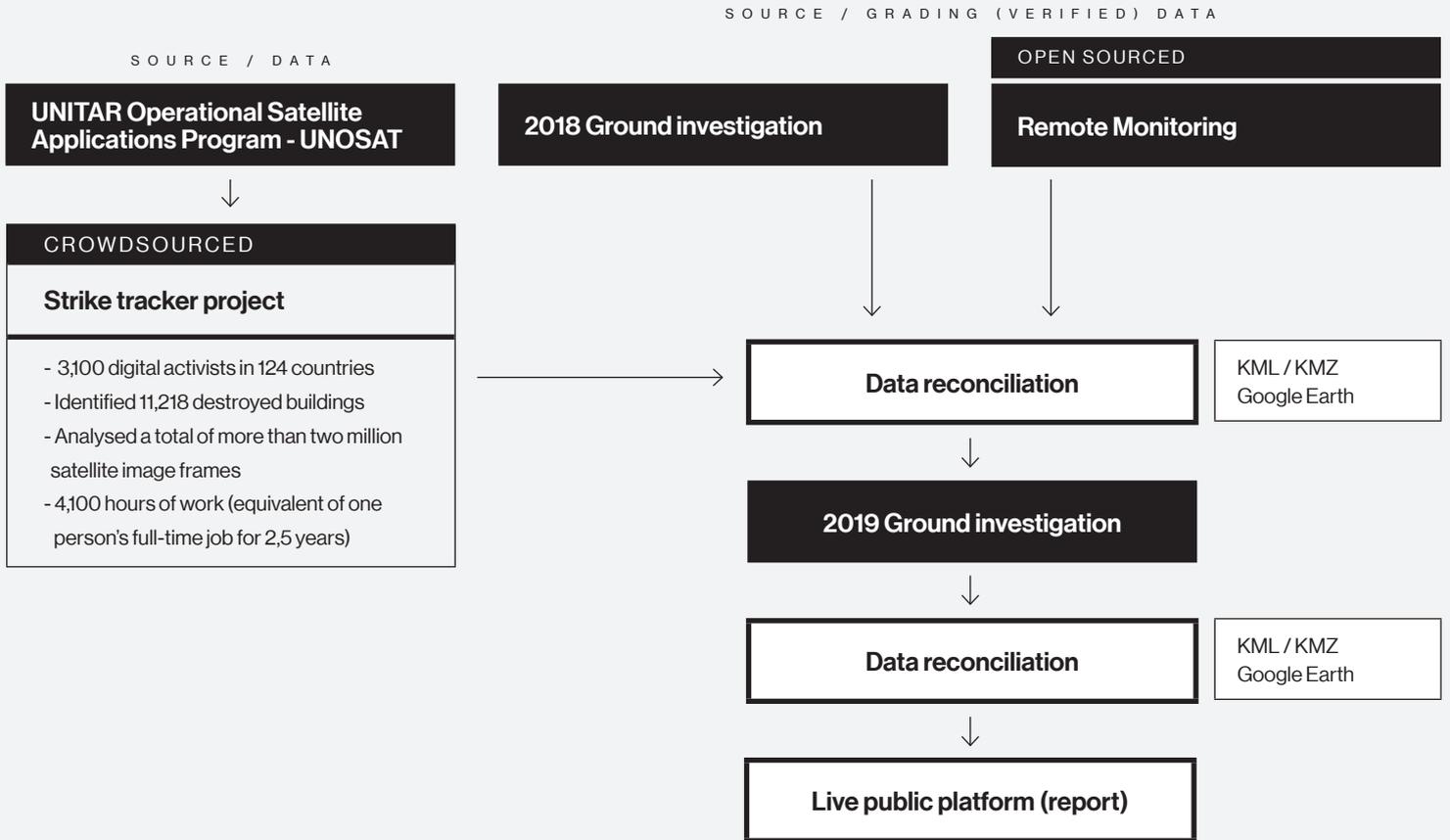
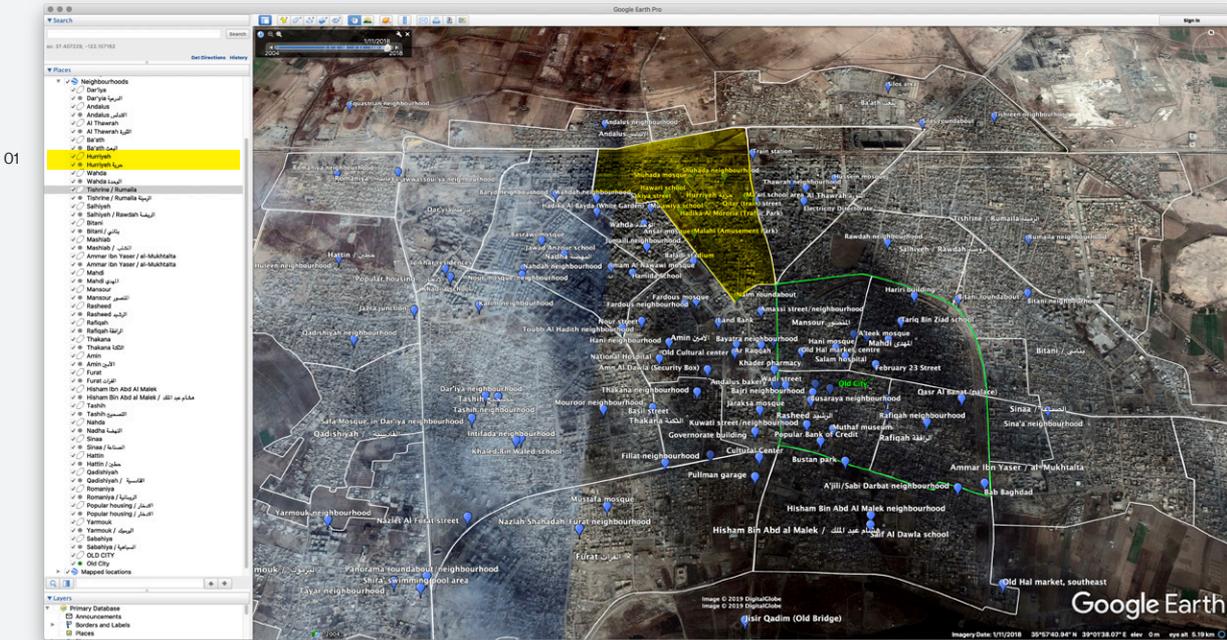
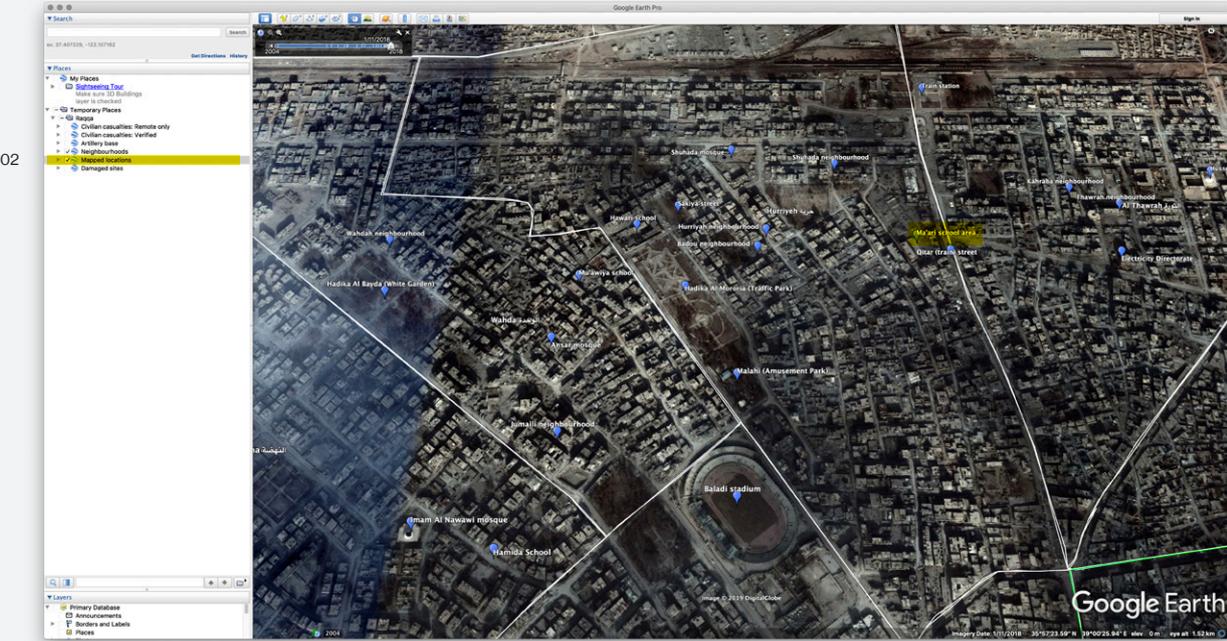


figure 10

**Polygon** | and mapped locations – landmarks



01



02

**01 Hurriye – Neighbourhood**

**Harat al bado – District**

The district is not marked on the map, which excludes people who do not have inside knowledge of the region. This object also provides the possibility to add extra information, which has not been applied in this KML-file

**02 Mapped locations - landmarks**

These placemarkers are important objects used during geo-locating sites. These landmarks were often named in (open source) repostings of strike incidents and are helpful “tools” within the CoP to create a shared understanding of the construct of the city, especially in relation to the polygons of the neighbourhoods.

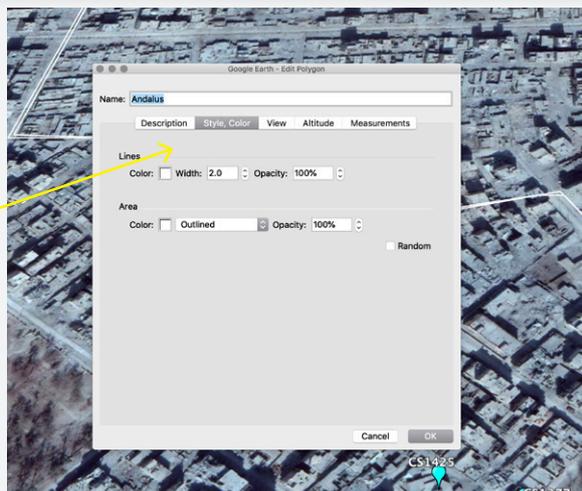
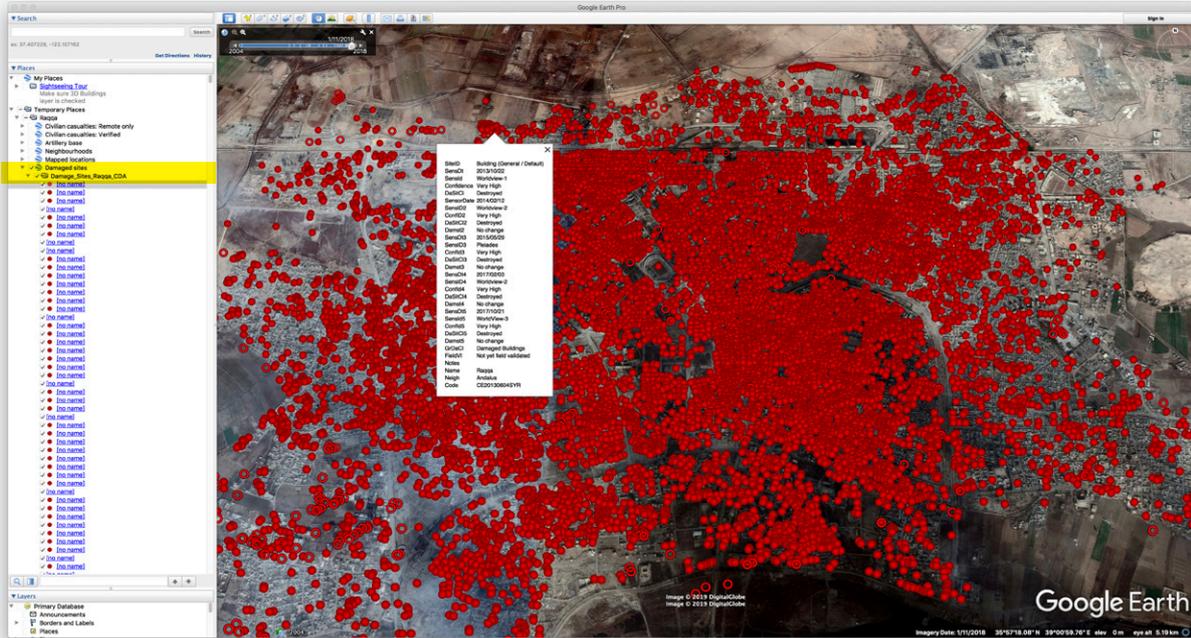
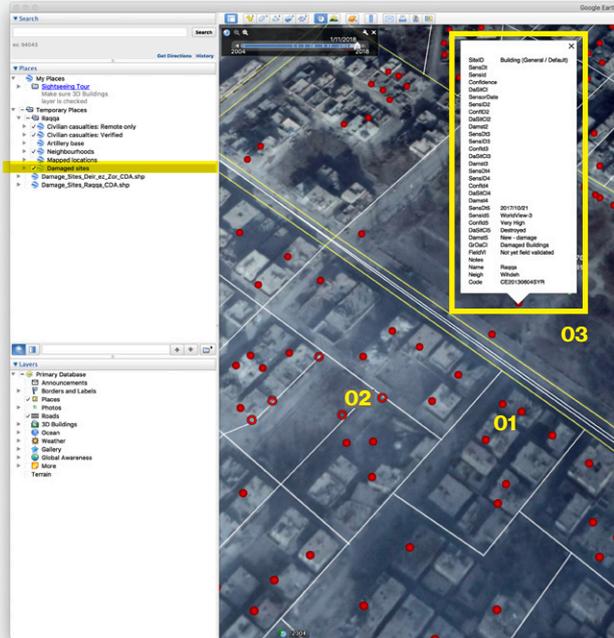


figure 11

**Damaged sites |** Damage density in the city of Raqqa, Syrian Arab Republic



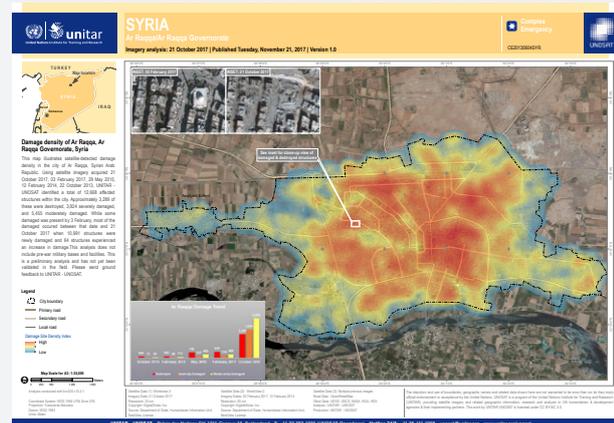
- 01 **Damaged sites icons red closed circles**  
mark impact on buildings
- 02 **Damaged sites icons red open circles**  
mark craters in open terrain  
(fields / roads / etc.)
- 03 **Codes**  
SensDt = date the damage was assessed  
SensID = the type of satellite view (world view)  
ConflD = related to the degree of damage  
DamSt = also related to the degree of (changed)  
damage (over time) in relation to already  
existing damage, for example:  
Damst4 = new - damage  
Damst 5 = no change



**UNITAR - UNOSAT identified a total of 12,668 affected structures within the city.**

**Approximately:**  
3.289 of these were destroyed  
3.924 severely damaged  
5.455 moderately damaged

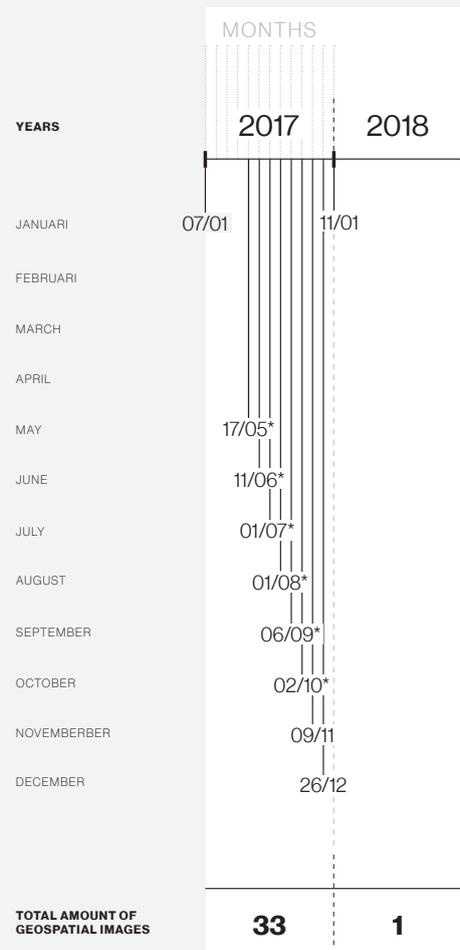
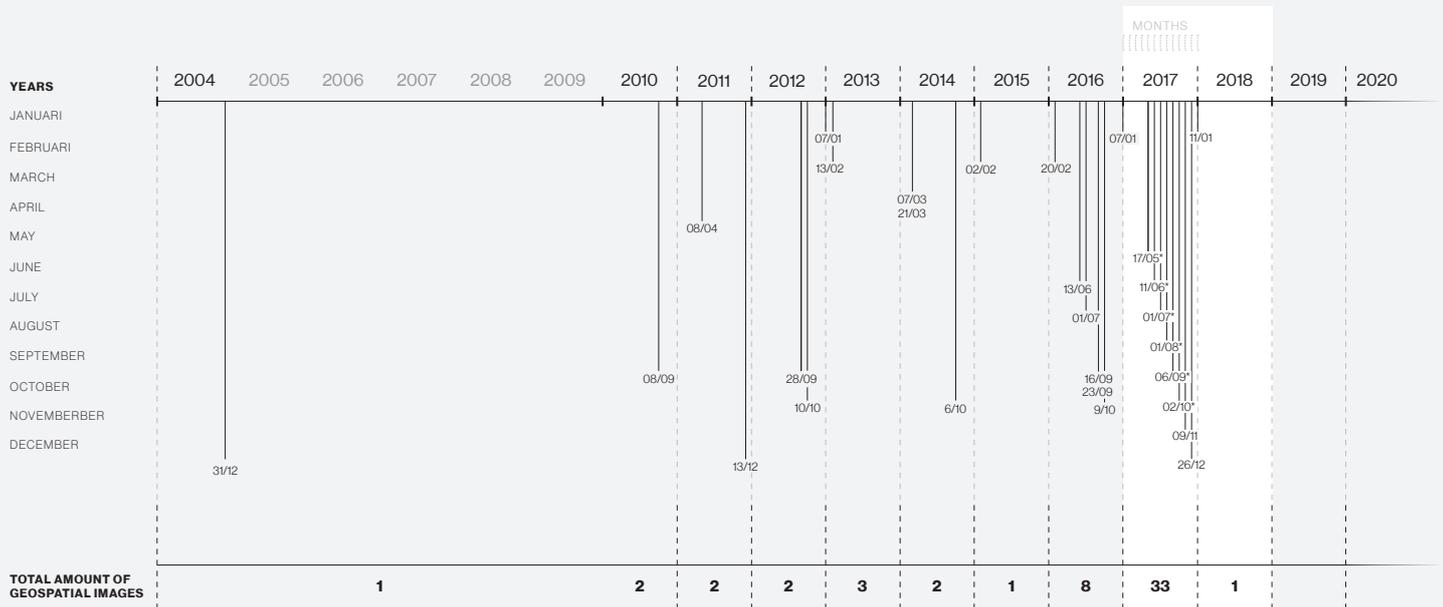
**Satellite imagery acquired at:**  
21 October 2017 / 03 February 2017  
29 May 2015 / 12 February 2014  
22 October 2013



Source: Airwars and personal email conversation with Hanna Rullmann

figure 12

### The intensified frequency of geospatial image production, released on Google Earth



**\*Released geospatial images on Google Earth 2017**

17 / 05	11 / 06	01 / 07	01 / 08	06 / 09	02 / 10
18 / 05	12 / 06	05 / 07	07 / 08	19 / 09	05 / 10
24 / 05	17 / 06	07 / 07	13 / 08	24 / 09	09 / 10
30 / 05	24 / 06	19 / 07	19 / 08	30 / 09	19 / 10
31 / 05	29 / 06	25 / 07	25 / 08		21 / 10
		26 / 07			24 / 10

Source: Google Earth Pro (last accessed 02.06.2019)

figure 13

The intensified frequency of geospatial image production, released on Google Earth



01 **Civilian casualties: remote only placemaker-icons in a cluster.**

01.1 <placemark> pin<point> a location referring to the Earth's surface. It contains a 01.2 <name> which is the label of the pinpoint, displayed on a map in this case code like CS1345

01.3 The lines (<LineString> element) that visually connect different "locations" in this case the place markers represent civilian casualties and their stories in relation to the location.

02 **Descriptions sharing the true stories**

A <description> appears when clicking on the icon. It also contains geographical information  
02.1 <coordinates>.

03 **History tool**

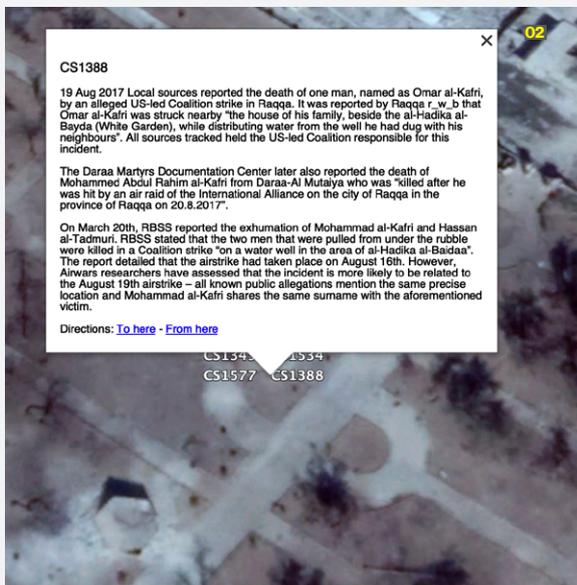


figure 14  
History tool



01 **History tool**  
Displays visual changes over time of the surface, it is possible to shift through historical perspectives by dragging the slider.

02 **Placemark cluster**

# Secondary Appendix



Google Earth

## 1 Re-tracing a forensic research ‘Rhetoric versus Reality’, Geo-locating site of an air strike

The turmoil in Syria was part of the extensive Arab Spring movement that gave hope to pro-democracy activists. The peaceful protesters turned into a civil war in 2011. That morphed into a war with global dimensions when Russia and Iran entered the conflict in 2015, supporting president Bashar al-Assad.<sup>1</sup> The first military intervention by the US was a direct response to the use of chemical weapons by Assad’s regime in April 2017.<sup>2 3</sup> The US shifted their focus to the threats of ISIS.<sup>4</sup> Between June and October 2017 the US annihilating operation to evict ISIS from Raqqa, the self-declared capital of the Caliphate, succeeded through thousands of airstrikes.<sup>5 6 7</sup> This complex war with thirteen Coalition nations besieging Syria alone – in the fight against IS – gained urgent public attention and claimed independent and trustworthy evaluation of political violence.<sup>8</sup> Airwars’ mission for public transparency started in 2014.<sup>9</sup> They are striving at tracking and assessing claims of non-combatant civilian casualties.<sup>10</sup> Besides this their aim is to build a publicly accessible archive where these (verified) claims and military reports can be viewed evaluated in the light of the public record.<sup>11</sup>

Airwars’ research has been a fundamental data source for many publications by for example: The Intercept, Washington Post and The New York Times.<sup>12</sup> With the release of their final research report of ‘Rhetoric versus Reality’ (a multidisciplinary collaboration with Amnesty International) they share their own narrative. A counter narrative stating that the rhetoric of a “precision war” led by the US Coalition is far from being the reality. The lecture given at The New Institute in Rotterdam elaborated on this extensive research – that unfortunately did not get the international recognition and attention as it should have – and informed my personal research extensively.

1 Yacoubian, Mona. “Syria Timeline: Since the Uprising Against Assad”. *United States Institute of Peace*, 12 February 2019. <https://www.usip.org/publications/2019/02/syria-timeline-uprising-against-assad> (last accessed 03.06.2019)

2 Kimball, Darly and Davenport, Kelsey. “Timeline of Syrian Chemical Weapons Activity: 2012-2019”. *Arms Control Association*, March 2019. <https://www.armscontrol.org/factsheets/Timeline-of-Syrian-Chemical-Weapons-Activity> (last accessed 03.06.2019)

3 Barnard, Anne and Gordon, Michael.R. “Worst Chemical Attack in Years in Syria; U.S. Blames Assad”. *The New York Times*, 4 April 2017. <https://www.nytimes.com/2017/04/04/world/middleeast/syria-gas-attack.html> (last accessed 03.06.2019)

4 Amnesty International and Airwars. “War in Raqqa: Rhetoric versus Reality”. Amnesty International. 25 April 2019. <https://raqqa.amnesty.org/> (last accessed 03.06.2019)

5 The operation is named ‘Operation Inherent Resolve’ established by the United States Army Central Command, “to formalize ongoing military actions the rising threat posed by ISIS in Iraq and Syria”. Combined Joint Task Force Operation Inherent Resolve APO AE 09306. <https://www.inherentresolve.mil/About-CJTF-OIR/> (last accessed 03.06.2019)

6 Callimachi, Rukmini. “Fight to Retake Last ISIS Territory Begins”. *The New York Times*, 11 September 2018. <https://www.nytimes.com/2018/09/11/world/middleeast/isis-syria.html> (last accessed 03.06.2019)

7 “Raqqa: a journey into the destroyed heart of the Islamic State capital”. *The Guardian*, 10 October 2017. <https://www.theguardian.com/world/2017/oct/10/raqqa-a-journey-into-the-destroyed-heart-of-the-islamic-state-capital> (last accessed 03.06.2019)

8 Airwars. “News and Investigation”. <https://airwars.org/news-and-investigations/raqqa-amnesty-airwars/>. (last accessed 12.04.2019)

9 Idem.

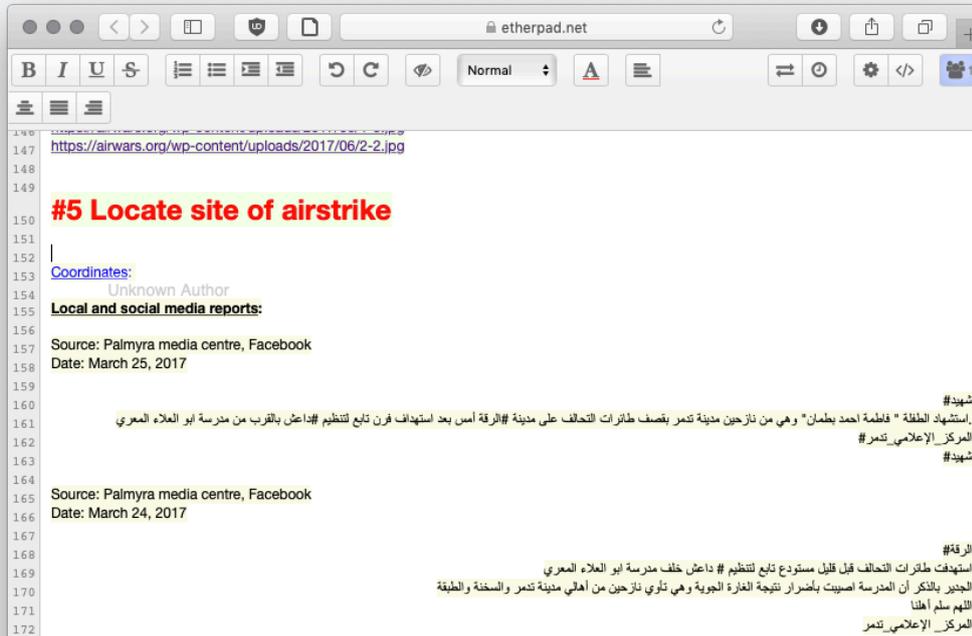
10 Idem.

11 Idem.

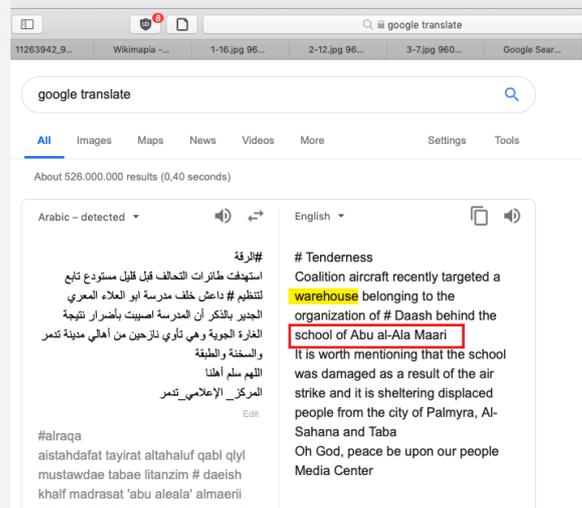
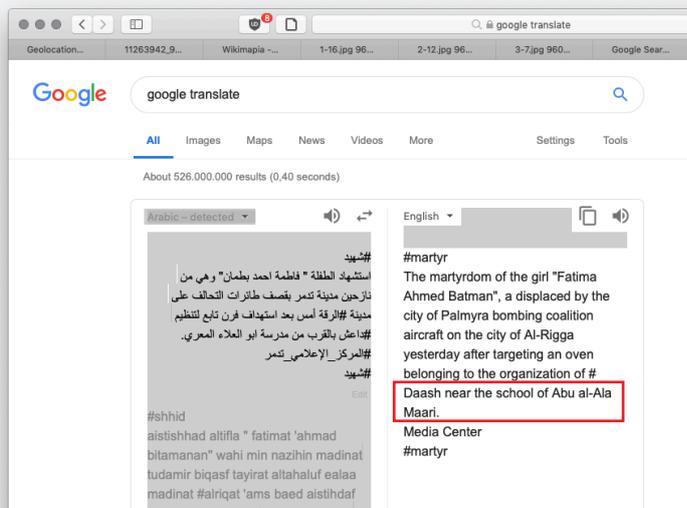
12 Information given during the lecture

During the lecture and the workshop, the focus lied on how social media is being instrumentalized in collecting reports of air strikes and civilian harm. We walked through several IDF methods and put these theories into practice. There are several ways to verify the authenticity of a source, in this workshop we used material collected and curated by the workshop leaders Sophy Dyer and Hanna Rullmann and therefore the sources have been all ready assessed. I will visually explain what steps need to be made during geolocating a strike report on social media. Based on an example of social media content the workshop members collectively in small groups applied the methods to conduct the research. The experience of working through the methods helped comprehending the methodology, besides this collaborating with multiple individuals with vast disciplinary backgrounds gave me a hint on how a CoP can be established within this domain.

## Re-tracing a forensic research ‘Rhetoric versus Reality’ | Geo-locating site of an air strike



Extracted social media content, used as workshop material (see figure 04)



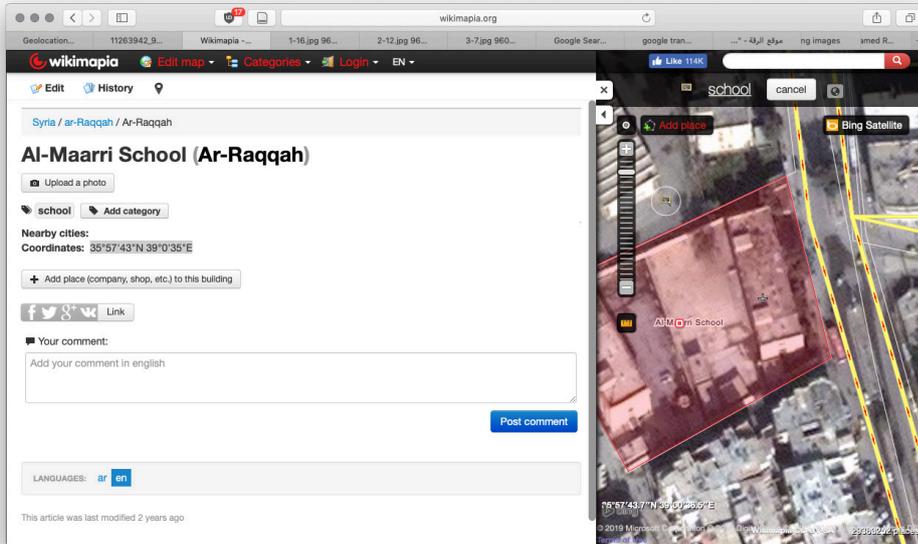
### Social media - Facebook reports

First start in how to translate - without an Arabic language specialist. Distil the Arabic names of landmarks or specific features named in the messages.

Location Arabic: يرعمل اءال عا وبا ءس ردم ءورلا  
يرعمل اءال عا وبا ءس ردم  
يرعمل اءال عا وبا

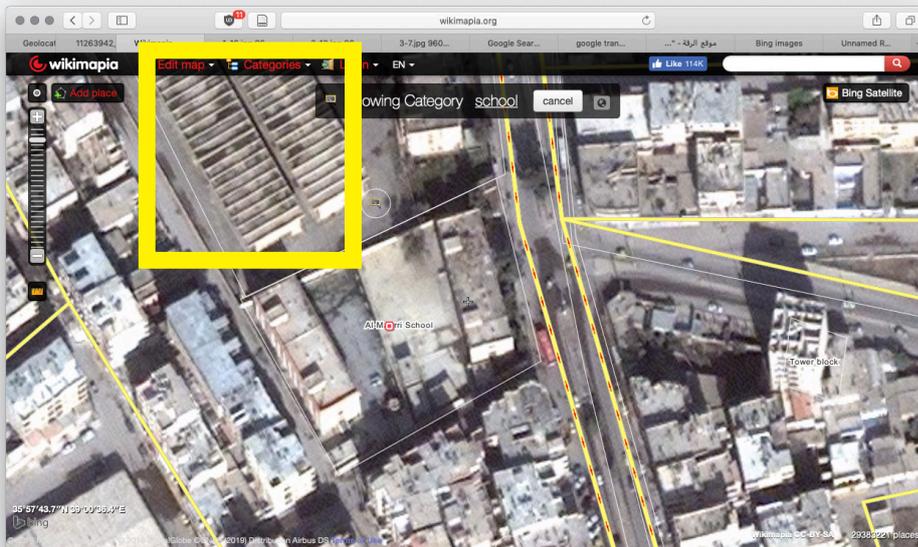
Location English: Warehouse  
Al Maari School  
Water tower

## Re-tracing a forensic research ‘Rhetoric versus Reality’ | Geo-locating site of an air strike



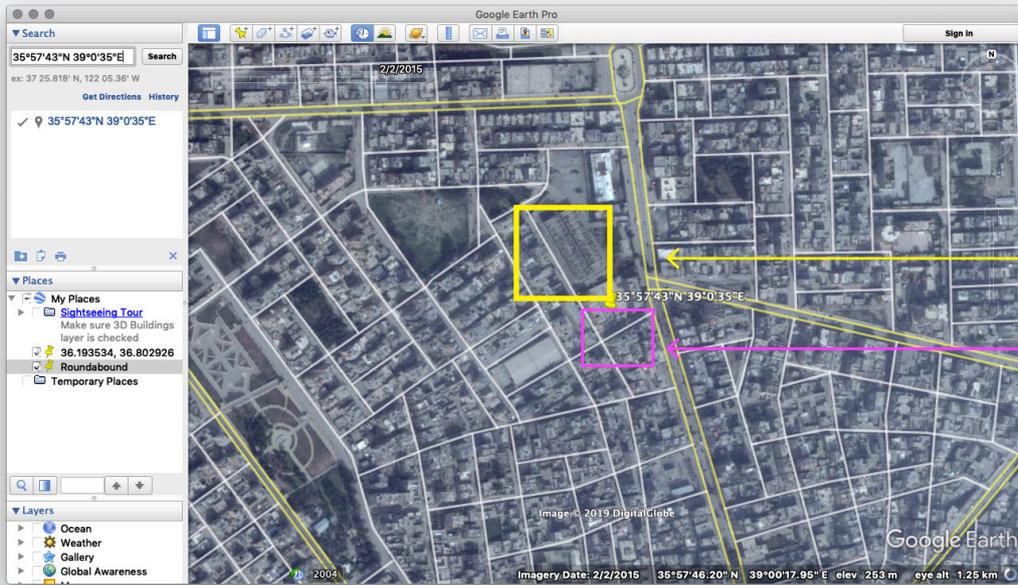
**Use of Wikimapia**  
an open-content collaborative (crowdsourced) mapping project.

The project implements an interactive “clickable” web map with a geographically-referenced wiki system, with **marked and described geographical objects** in the world.



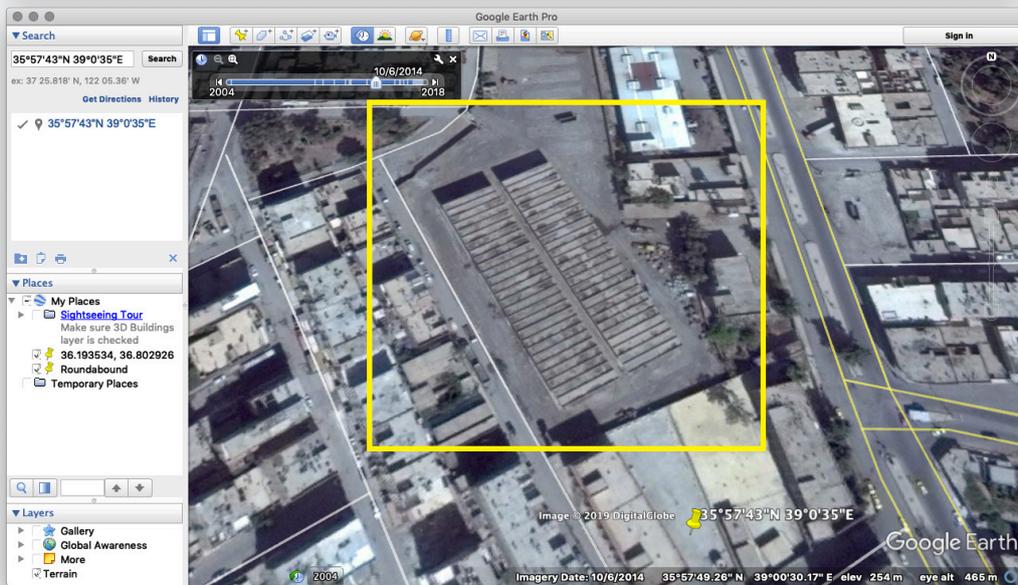
**Geospatial Image analysis**  
The visual appearance of the object seems to resemble a warehouse, due to the scale on roof features.

### Re-tracing a forensic research 'Rhetoric versus Reality' | Geo-locating site of an air strike



Location of the warehouse

Location of the school



#### Geospatial Image analysis

The visual appearance of the object seems to be a warehouse, due to the scale en roof features.



before strike



after strike

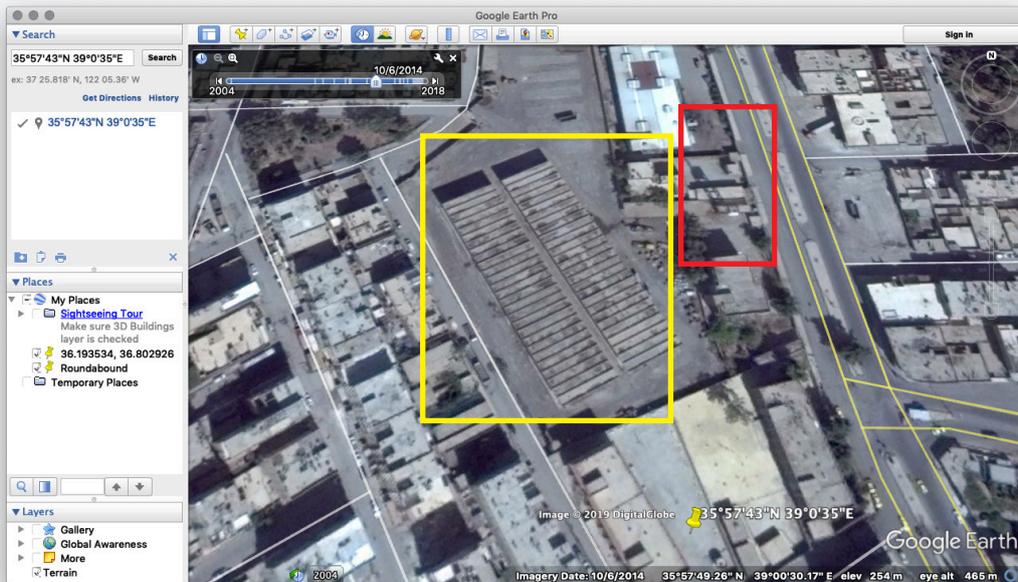
Re-tracing a forensic research 'Rhetoric versus Reality' | Geo-locating site of an air strike



**Image analysis**

On social media pictures of the surrounding of the strike appeared and showed features of the roof of the warehouse and a distinctive water tower.

- warehouse
- water tower

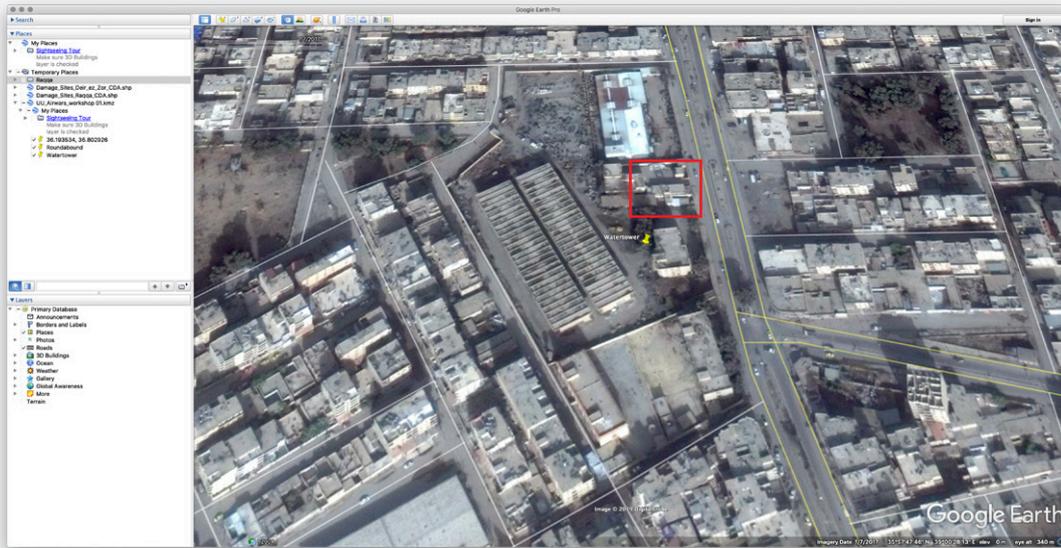


**Water tower**

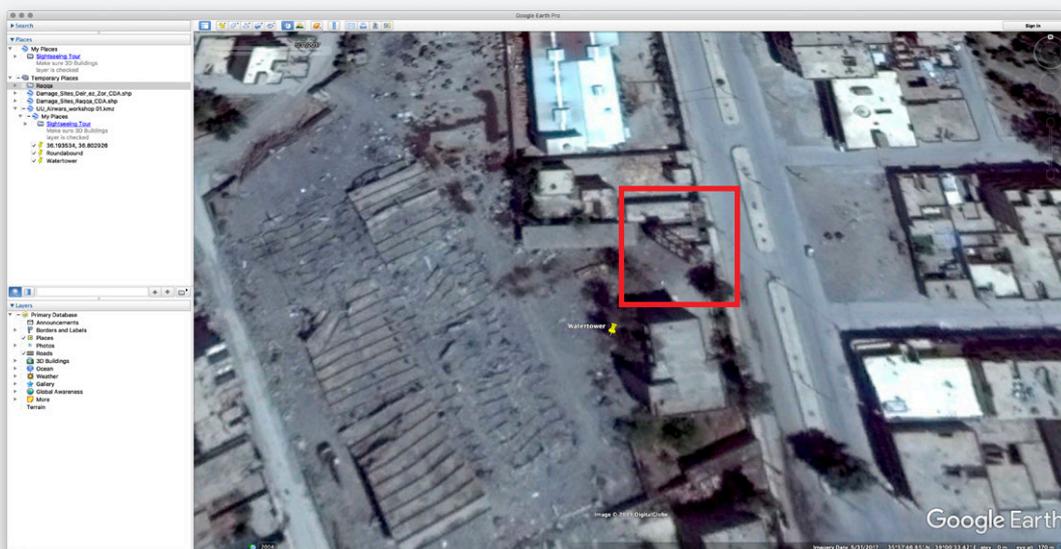
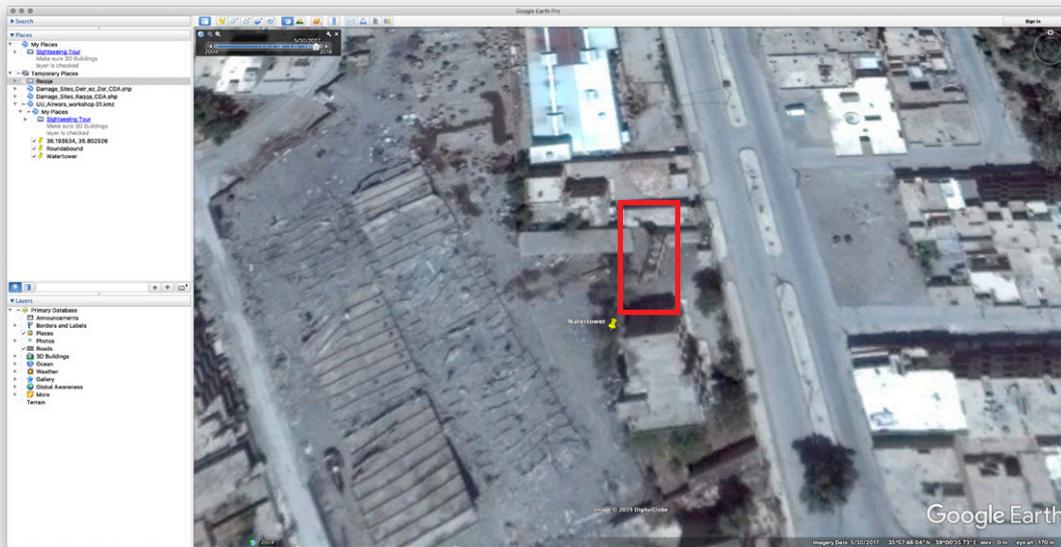
is clearly visible on the satellite image - analysing the shadow, four pillars.



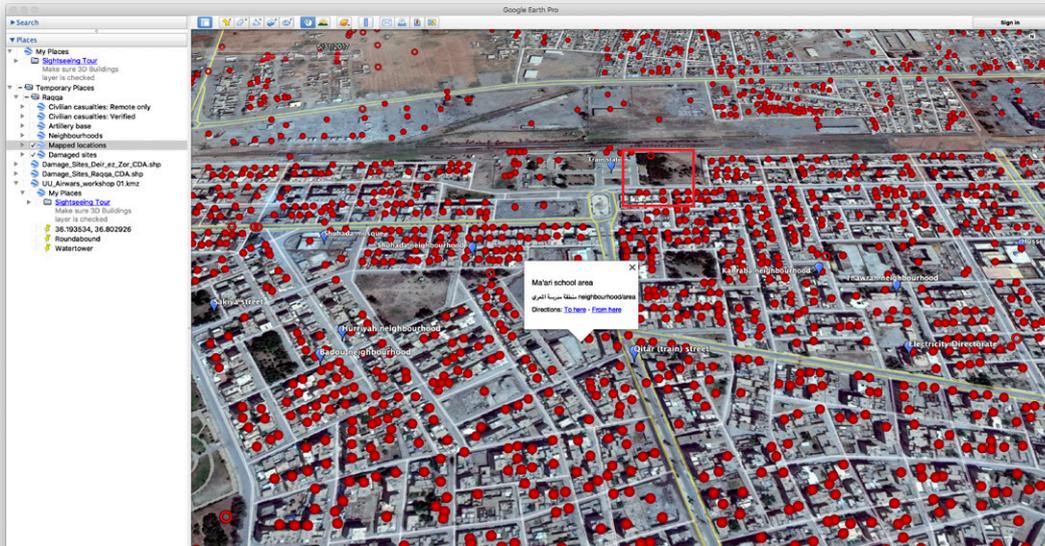
## Re-tracing a forensic research 'Rhetoric versus Reality' | Geo-locating site of an air strike



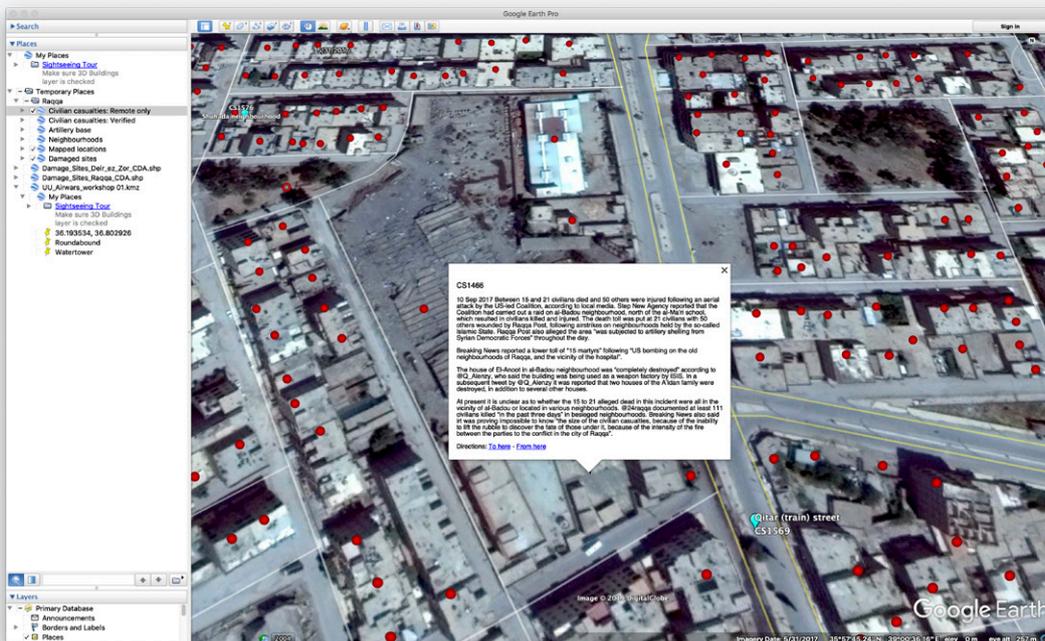
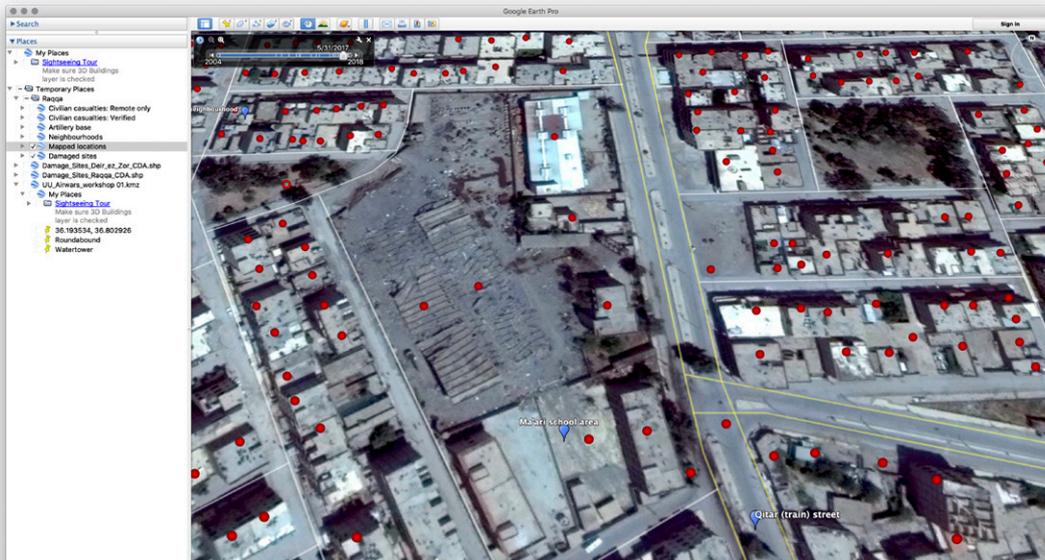
**Water tower**  
During the four months of the battle to observe the different perspectives to verify the location and possible new damage.



### Re-tracing a forensic research 'Rhetoric versus Reality' | Geo-locating site of an air strike



**After the workshop**  
When analysing the KML-files I looked up the school (landmark) and found the confirmed civilian casualties.



## 2 Independent digital forensic research in relation to Collective Intelligence

The understanding of the *turn of forensic* to online investigation and increased employment of Collective Intelligence (CI), lies in the notion that digital technologies have drastically changed our societies. These technologies reshaped the architecture of our societies; meaning that power relations transformed and the entry to (dynamic) information became globally more accessible.<sup>1</sup> The introduction of interconnectivity via digital data (Web 2.0) boosted the capacity to share and preserve a vast landscape of rich (media) content.<sup>2</sup> The realisation that most people have access to affordable recording and archiving devices – such as smartphones that provide possibilities to instantly share user-created-content on social media platforms; brings us to the point that long-lasting social dependency of traditional media monopolies faded away.<sup>3</sup> “Social media platforms and digital technologies support audiences in becoming impactful actors and empower ‘historically silenced’ citizens to have a voice, documenting misconducts and potentially changing the silence into public debate”.<sup>4</sup> This new form of collective awareness takes place in the online sphere and changes the graphical representation of war reporting. The Syrian war has been excessively reported by a vast range of parties like local civilians; the Islamic State (IS) and the international Coalition is exposed and brought into existence on (social) media platforms.<sup>5</sup> These vast amounts of data are available and can potentially become sources of evidence on platforms that are increasingly shaped into enormous ‘open’ access archives. It is in this new media landscape – where over 46,000 year of footage is uploaded on YouTube only – that IDF- and Human right researchers explore opportunities to integrate this data into their work.<sup>6 7</sup> The volume of this data and the time-consuming task of assessing and verifying these streams of content asks for different research methods. IDF methodology strongly believes in and accumulates many minds to excel individual creativity and intelligence to solve crucial problems.<sup>8</sup>

It is in this context that Levy’s definition of CI – “Collective intelligence is the capacity for a group of individuals to envision a future and reach it in a complex context” – comes to a practical understanding.<sup>9</sup> He refers “intelligence” to cognitive powers: “perception, action planning and coordination, memory, imagination and hypothesis generation, inquisitiveness and learning abilities”, therefore the definition of CI by Levy appoints the cognitive powers of the group,<sup>10</sup> I would like to add social skills, emotional intelligence which are important components for a successful IDF CoP

1 Tufekci, Zeynep. 2017. *Twitter and Tear Gas: The Power and Fragility of Networked Protest*. New Haven & London: Yale University Press. Pages.xxii – xxxi, 5-7, 16 -18, 84, 225-229.

2 Manovich, Lev. 2009. “The practice of everyday (media) life”. *Critical Inquiry* 35(2). Pages 319-331

3 Tufekci, Zeynep. 2017. *Twitter and Tear Gas: The Power and Fragility of Networked Protest*. New Haven & London: Yale University Press. Pages.xxii – xxxi, 5-7, 16 -18, 84, 225-229.

4 Pouwels, Saskia. 2019. “No attention without visual control: The prevalent tension of denial of evidence curates the public chronicle”. University of Utrecht

5 Idem.

6 Verhaert, Paola. “Amnesty International’s Digital Verification Corps: New networks and methods for human rights research”. *The Engine Room*, 19 June 2017. <https://www.theengineroom.org/digital-verification-corps/> (last accessed 05.06.2019)

7 Slater, Dirk. ‘NCR Online Discussion: Crowdsourcing Human Rights Research’. 24 April 2018. YouTube. [https://www.youtube.com/watch?time\\_continue=195&v=Qg33Ae71g-sA](https://www.youtube.com/watch?time_continue=195&v=Qg33Ae71g-sA) (03:03 – 04:29, 09:08 – 09:47) (last accessed 05.06.2019)

8 Lévy, Pierre. 2008. “A metalanguage for computer augmented collective intelligence”. *Collective Intelligence: Creating a Prosperous World at Peace*, edited by Mark Tovey. Earth Intelligence Network, Virginia. Page 15

9 Noubel, Jean-Francois. 2008. “Collective intelligence: From pyramidal to global”. *Collective Intelligence: Creating a Prosperous World at Peace*, edited by Mark Tovey. Earth Intelligence Network, Virginia. Page 225

10 Pór, George. 2008. “Cultivating collective intelligence: a core leadership competence in a complex world”. *Collective Intelligence: Creating a Prosperous World at Peace*, edited by Mark Tovey. Earth Intelligence Network, Virginia. pages 238 – 240

working in the shared domain of collecting evidence against those in power and human rights. The often-complicated open source investigations of IDF are digitally coordinated (frequently) in real time – which was the case at ‘Rhetoric versus Reality’ – and involve many participants. Their success lies in the amplification of intelligence, were the group becomes more intelligent than its individual members.<sup>11</sup>

### 3 Open source in relation to Independent digital forensic research

The realisation that an increasing dematerialization and computation is at hand and gazillions of information currently is digitally produced, meaning that most information and data are stored in- and never leave the digital domain.<sup>12</sup> The expanding complexity of the digital and online domain impacts our society which comes forward in the way data can be interpreted from many perspectives. The “new” reality of digital forensic methodologies frame data as potential evidence; collected on “open source” platforms, archived, assessed and authenticated, analysed and interpreted, verified (of publicly available geospatial-imagery, text-tweets, datasets, audio-video and photographic material). The IDF researchers strive for transparent and accountable results (to admit in courts and tribunals) and therefore not only rely on open source platforms to collect evidence (a vast range of rich publicly available material/ media) but also open source tools. The use of the term open source can be questioned nowadays. Brabham states that the term derives from software development and refers to the Open Source Initiative’s (OSI) that define open source “philosophy” as allowing the crucial elements of an object (such as source code for software) to anybody with the “purpose of collaborative improvement to the existing [object]”.<sup>13 14</sup> Further fundamental characteristics are continuous transparency and the free (re-)distribution by open development.<sup>15</sup> This definition seems far from the open source “way” that directly taps in to popular culture, the “new” values are vague and therefore open for interpretation.<sup>16</sup> The Open source “way” is more loosely applied and characterized by: publicly accessible, shareable, modifiable and can be a collaborative participation.<sup>17</sup> The IDF investigation uses open source in both definitions, the loose “way” in collecting their evidence on “open source” social media platforms and follow the OSI philosophy when it comes down to their process of compiling a body of reliable evidence, produced and provided by (their own build or existing) tools.<sup>18</sup>

### 4 Amnesty’s Digital Verification Corps (DVC)

The understanding that assessing and authenticating the enormous amounts of data within the field of Human Rights motivated activists to change their working methods. The two-year-old DVC is established and managed by

11 Lévy, Pierre. 1997, [1995]. *Collective Intelligence: Mankind’s Emerging World in Cyberspace Plenum* New York, Ch. 3 Pages 13–14

12 Delgado, Manuel and Aparicio, Manuel and Costa, Carlos. 2012. “Using Open Source for forensic Purpose”. ACM International Conference Proceeding Series, Lisboa. Page 32 -34

13 Brabham, Daren C. 2008. “Concepts, Theories and Cases of Crowdsourcing as a Model for Problem Solving: An Introduction and Cases”. *Convergence* 14 (1) Page 79

14 Parens, B. (n.d.). “The Open Source Definition”, Open Source Initiative, URL (accessed 17 May 2019): <https://opensource.org/osd> (last accessed 05.06.2019)

15 Idem.

16 “Open source: resources”. <https://opensource.com/resources/what-open-source> (last accessed 05.06.2019)

17 “Open source: resources”. <https://opensource.com/resources/what-open-source> (last accessed 05.06.2019)

18 Delgado, Manuel and Aparicio, Manuel and Costa, Carlos. 2012. “Using Open Source for forensic Purpose”. ACM International Conference Proceeding Series, Lisboa. Page 32 -34

Sam Dubberly, Special advisor of Evidence Lab at Amnesty International.<sup>19</sup> A network of four global Universities: the University of California, Berkeley (US), the University of Essex (UK), the University of Pretoria (South Africa), and the University of Toronto (Canada). Seventy volunteering (human rights law) students are educated to conduct open source forensic research, applying digital methods of verifying social media content. For the research ‘Rhetoric versus Reality’ they assessed and analysed mostly videos, to verify their authenticity, time and location. The potentially vicarious traumatising videos have been pre-selected by Dubberly before sharing these with the students. The results of their work have been added in the KML-files by the Airwars team and Dubberly himself.

## 5 Amnesty's Decoders

A global platform that facilitates human right volunteers in participating extensive digital research projects; by just applying their technical devices – like smart phones, (laptop) computers and tablets.<sup>20</sup> These crowdsourced data projects are named Decoders, established in 2016 and have already accomplished “mobilizing more than 50,000 digital activists from 150 countries”.<sup>21</sup> The large streams of data that are processed reach above 1.5 million tasks.<sup>22</sup>

Milina Marin (Project Lead at Decoders Amnesty International), explains that it has to be very accessible – the projects are set up in a way that anybody (with access to internet) can participate.<sup>23</sup> <sup>24</sup> Participants do not necessarily have to possess specific knowledge or skills – like for example geospatial imagery analysis expertise.<sup>25</sup> The tools that are built are developed in such a way that they train the practitioners new skills through digestible materials, working towards a shared understanding and aim for meaningful engagement.<sup>26</sup> Marin states that the general feedback of contributors is that they have gained a lot of knowledge and understanding of the addressed cause.<sup>27</sup> This method of creating a shared “social history of learning” builds an engaged CoP.<sup>28</sup> Marina states that these projects not only successfully analyse the overwhelming data, producing sense and understanding through CI; they also afford Amnesty to engage people in more meaningful ways than signing petitions on Facebook or financial donations.<sup>29</sup>

19 Verhaert, Paola. “Amnesty International’s Digital Verification Corps: New networks and methods for human rights research”. *The Engine Room*, 19 June 2017. <https://www.theengineerroom.org/digital-verification-corps/> (last accessed 05.06.2019)

20 Amnesty Decoders. <https://decoders.amnesty.org/> (last accessed 05.06.2019)

21 Idem.

22 Idem.

23 Slater, Dirk. “NCR Online Discussion: Crowdsourcing Human Rights Research”. *FabRiders*. 24 April 2018. YouTube. [https://www.youtube.com/watch?time\\_continue=195&v=Qg33Ae71gsA](https://www.youtube.com/watch?time_continue=195&v=Qg33Ae71gsA) (03:03 – 04:29, 09:08 – 09:47) (last accessed 05.06.2019)

24 “Crowdsourcing Human Rights Research with Amnesty’s Decoder Project, Online Discussion Notes”. *FabRiders*, 9 May 2018. <https://www.fabriders.net/hcrnotesamnestymilena/> (last accessed 05.06.2019)

25 Idem

26 Idem

27 Idem

28 Wenger, Etienne. 2010. “Communities of Practice and Social Learning Systems: The Career of a Concept”. *Social Learning Systems and Communities of Practice*, edited by Chris Blackmore. Springer, London Page 180, 184- 186

29 Slater, Dirk. “NCR Online Discussion: Crowdsourcing Human Rights Research”. *FabRiders*. 24 April 2018. YouTube. [https://www.youtube.com/watch?time\\_continue=195&v=Qg33Ae71gsA](https://www.youtube.com/watch?time_continue=195&v=Qg33Ae71gsA) (03:03 – 04:29, 09:08 – 09:47) (last accessed 05.06.2019)

## 6 Amnesty's Strike Tracker

UNITA UNOSAT's data – of satellite imagery acquired at: 21 October 2017, 03 February 2017, 29 May 2015, 12 February 2014, 22 October 2013 – showed that more than 10,000 buildings in Raqqa were destroyed or damaged.<sup>30</sup> “This scale of civilian devastation is simply too large for us to analyze alone” Marin explained.<sup>31</sup> This crowdsourced research brought a global community of human right activists together for one single issue, the demolition of Raqqa by US Coalition strikes. The aim of the project was to establish the timeframe of destruction and locate exactly where the strikes had demolished buildings, roads and squares, this to digitally map the apocalyptic destruction of Raqqa.<sup>32</sup> This project, developed by Amnesty's Decoders, invited everyone with a smart phone or other device connected to the internet to contribute.<sup>33</sup> Their task existed of “tracking buildings on a timeline, looking for change and pinpointing the dates before and after the building's destruction” (figure 01).<sup>34</sup> The task started with clear instructions, a public forum created a negotiation space where activist could communicate and share their thoughts.<sup>35</sup> This project was an important part of the investigation of civilian deaths, potentially caused by the US Coalition strikes between June and October 2017.<sup>36</sup> Project results are shown in (figure 02).<sup>37</sup>



figure 01 Example Strike Tracker tool

30 United Nations Institute for Training and Research (UNITAR Operational Satellite Applications Program, UNOSAT). “Damaged density of Ar Raqqa, Ar Raqqa Governorate, Syria”. UNITAR. 28 November 2017. <https://unitar.org/unosat/map/2742> (last accessed 05.06.2019)

31 Slater, Dirk. “NCR Online Discussion: Crowdsourcing Human Rights Research”. FabRiders. 24 April 2018. YouTube. [https://www.youtube.com/watch?time\\_continue=195&v=Qg33Ae71gsA](https://www.youtube.com/watch?time_continue=195&v=Qg33Ae71gsA) (03:03 – 04:29, 09:08 – 09:47) (last accessed 05.06.2019)

32 Amnesty International. “Syria: Thousands of digital activists to track how US-led air strikes destroyed Raqqa”. Amnesty. 21 November 2018. <https://www.amnesty.org/en/latest/news/2018/11/syria-thousands-of-digital-activists-to-track-how-us-led-air-strikes-destroyed-raqqa/> (last accessed 05.06.2019)

33 Amnesty Decoders. “Strike Tracker: Decode how US-led bombing destroyed Raqqa, Syria (project completed)”. Decoders Amnesty. <https://decoders.amnesty.org/projects/strike-tracker> (last accessed 05.06.2019)

34 Idem.

35 Idem.

36 Idem.

37 Idem.

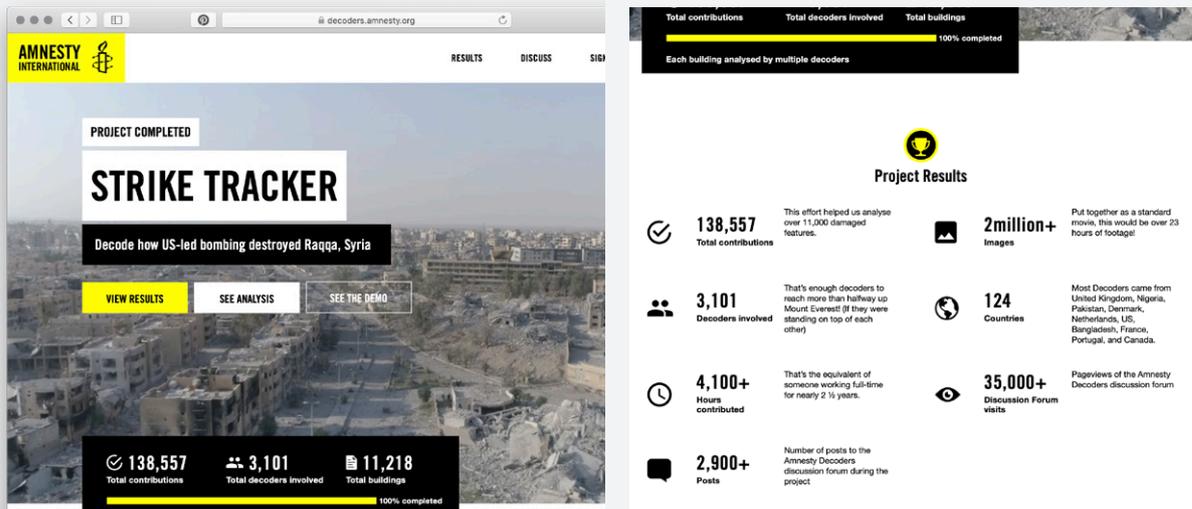


figure 02 Outcomes crowdsourcing project

## 7 Crowdsourcing and collective Intelligence

The Strike Tracker project is a crowdsourced research which Brabham states is an utilization of CI, which overlaps Marin’s explanation and vision. The project is a developed model that merges transparent and democratizing elements of the open source philosophy into an online facilitated tool and platform that solved the problem of analyzing two million geospatial-images of Raqqa. Brabham explains the uniqueness by explaining the integration of bottom-up (open) problem solving and learning process; and achieving the top-down organizational goals of Amnesty.<sup>38</sup> This new forensic methodology applied in Human right research and activism strengthens the results, speeds up the process and breaks physical geological boundaries.

38 Brabham, Daren C. 2008. "Concepts, Theories and Cases of Crowdsourcing as a Model for Problem Solving: An Introduction and Cases". *Convergence* 14 (1) Page 86



- ▼ Search
  - ex: 94043
  - ▼ Places
    - My Places
      - Sightseeing Tour
        - Make sure 3D Buildings layer is checked
    - Temporary Places
      - Raqqa
        - Civilian casualties: Remote only
        - Civilian casualties: Verified
        - Artillery base
        - Neighbourhoods
        - Mapped locations
        - Damaged sites
          - Damage\_Sites\_Deir\_ez\_Zor\_CDA.shp
          - Damage\_Sites\_Raqqa\_CDA.shp
- ▼ Layers
  - Primary Database
    - Announcements
    - Borders and Labels
    - Places
    - Photos
    - Roads
    - 3D Buildings
    - Ocean
    - Weather
    - Gallery
    - Global Awareness
    - More
    - Terrain