F METHODOLOGY

1 *Overview and workflow*

77 This section provides an overview of FA's methodology relevant for the entirety of the report. Section-specific methods will be elaborated in each chapter methodology section.

78 All chapters are based on the following sources: images, videos, and other media online, including social media networks; surveys of relevant media publications; historical, academic, and civil society accounts and reports; as well as cartographic research of current and historical city plans.

79 To introduce the various methodologies we employ, it is necessary to start with an understanding of our workflow, which has five stages: collection, verification, interpretation, mapping, and analysis.

80 **Collection**: We collect information from a variety of media formats that include recorded videos, photographs, satellite and remote-sensing imagery, written and oral testimony, and text-based reports of incidents – from three types of sources:

(a) Using open-source research methodologies (see OSI below)

(b) Sent to us directly from individual sources (see Credibility below)

(c) Datasets shared with us by trusted organisations in our field (see Credibility below)

81 **Verification:** In relation to (a) and (b), materials are verified according to the verification framework outlined below. In relation to (c), we examine the third party's data-gathering methodology and sample the dataset to determine that the dataset meets our standards. If we deem it necessary, we investigate the file using verification software (see 'verification and interpretation').

82 **Interpretation:** Interpretation is the process of reading what the data pertaining to a particular incident tells us. For text-based materials, this means deriving the details of an incident, including its location, time, and context. Where necessary, our researchers corroborate the claims of an incident with visual evidence found in footage or satellite imagery, which may capture the incident or its aftermath (see 'verification and interpretation'). For visual materials, this involves close analysis of what is 'in the frame', and what is implied 'outside the frame' by the contents of the frame. This process varies depending on case context. It could include identifying the uniforms of soldiers or civil society personnel, identifying the presence of emergency services, or identifying any weapons or munitions (or munition fragments). Through examining these and other features, our researchers piece together what can be understood of what has unfolded within the incident captured by a piece of media. Commonly, the process of interpretation also involves cross-referencing between the subject data and other data apparently pertaining to the same incident. This process ends by providing a written description of the incident, which is stored within our incident database and subsequently the GCD.

83 **Mapping**: Once an incident is considered to have been verified, either as 'confirmed' or 'most likely', we enter that incident into our database, categorising and labelling it to include information such as sources, time of incident, location of incident. Each incident is given an identification number ('Incident ID') comprised of the abbreviated date of the incident and a unique code (YMMDD-12345). These IDs are cited and footnoted where the relevant incident is mentioned in the report, so that it can be directly corroborated with information pertaining to it in the database. All incidents that are referenced

in the body of the text are listed in the appendix of the chapter in which they appear, along with their primary source information. Additional source information can be found in the GCD. Incident data is also pulled into the GCD's cartographic interface, where it can be analysed in relation to other incidents in space and time. Incidents which are mapped in figures throughout the report are in the GCD along with their source materials.

84 **Analysis**: This research workflow, from data collection to verification and interpretation, to mapping within the GCD, is intended to facilitate 'pattern analysis'; a process of reading the constellations of data points with similar properties through which we make observations about the scale and character of a conduct or series of actions we are studying.

2 *Verification and Interpretation*

85 A majority of our investigative research, across case contexts, is founded in gathering, verifying, interpreting, mapping, and analysing digital media. The process of verification ensures, before a potentially valuable piece of evidentiary material is mapped and analysed, that it is authentic. While there are fundamental practices at the core of any verification process, the process varies across research contexts, depending on the form and combination in which material is received - that is, whether we are working with testimony, videos, images, audio recordings, or some combination of each or all of these.

86 The data on which this report is founded are primarily images or videos, either shared with us directly, or found online, through a process of open-source investigation (OSI). (A small amount of information came to us as testimony, either directly or via third-party organisations.) In almost every case, that image or video data presents an FA researcher with an explicit or implicit 'claim' associated. That claim could be a headline in news media, or the content of a post on X/Twitter or Telegram. Where a piece of evidentiary material comes to us with a claim associated, the process of verification begins most commonly from the question: does the image/video in question show what is claimed?

87 The process of verification also varies to meet the extent of interpretation and analysis required by the research objective. Given that the GCD is a cartographic tool, and that our research was concerned in substantial part with how impacts of Israel's military offensive in Gaza had played out in terms of space and regional geography, the process of verification in this research was often primarily – but rarely only – concerned with the question: where did the events captured in this video/image data take place? For example, a large number of posts on X/Twitter, published on 10 September 2024 claimed to show the aftermath of an air strike on the al-Mawasi 'humanitarian zone' on the same date, in which 19 civilians were reported to have been killed.[52] In the case of most of these X/Twitter posts, the video or image itself, in combination with other image data pertaining to the same incident, drawn from other posts, contains information sufficient to determine the location of the airstrike as indeed within the al-Mawasi 'humanitarian zone'. Further, the image, in combination with satellite imagery from the days before and after, contains information sufficient to determine that the airstrike indeed occurred on the day claimed – at the coordinates determined by the process of geolocation, there is no crater visible on 9 September 2024, but a crater is visible in imagery captured on 10 September 2024. The image, and other associated image data, does not in itself contain enough information to determine that 19 civilians died in the strike, as was reported by Gaza's health ministry.[53] However, that

[52] Incident ID: 40910-91667
[53] Bethan McKernan, 'Khan Younis Safe Zone: Israel Launches Deadly Strike on al-Mawasi, Gaza Officials Say' *The Guardian* (10 September 2024) <https://www.theguardian.com/world/article/2024/sep/10/khan-younis-israel-strike-al-mawasi-tent-camp-gaza-deaths-humanitarian-safe-zone> accessed 27 September 2024.

information is not required in order for this data point to contribute to addressing part of our research scope pertaining to attacks on and destruction within 'destination zones' and 'humanitarian zones' (see Chapter 3: Displacement).

88 A second example: a video posted online on 29 February 2024 claims to show the aftermath of an attack on a group of civilians waiting to receive aid from a truck at the al-Nabulsi roundabout, near the Netzarim corridor. The video contains information sufficient to determine that the incident took place at the claimed location. The content of the original video is not immediately, fully, and straightforwardly clear, and thus a process of careful interpretation of the video's content begins. That process of interpretation may involve cross-referencing the content of this video with other videos and images of the same incident from different angles – a process which requires that those videos are themselves geo- and chronolocated and interpreted. (In this way, it is evident that verification and interpretation of multiple images and videos may occur simultaneously; image and video sources may be mutually supporting.) The original image and video may also be cross-referenced with reports from news organisations, independent journalists, and NGOs, until such time – as in this example – that to the best of our researchers' understanding, the incident can be fairly described as claimed: as an attack on civilians waiting for aid distribution.

89 As the examples above demonstrate, verification is a process which responds to, and is determined by, the available evidentiary material, and by the questions that are asked of that material, and the objective of the process: what about the material is a researcher seeking to verify? The process of verification is not (or not only) a set of yes/no questions; the processes of verification and interpretation often overlap. Further, in some cases, we have found that while the incident transpired almost as described in the associated claim, the claim in some respects varied from or exceeded what can be known by the contents of the image/video material, and any associated and credible reports.

90 In this case context, the result of the process of verification and interpretation is that an incident is classified as **confirmed**, **most likely**, or **unknown** (see below). That classification is the result of the processes described above, or of an incident having been reported by a credible source (see Credibility below). Three categories of classification are defined as follows:

(A) Confirmed

91 In our professional assessment, this incident occurred as described by the associated claim.

92 An incident is classified as 'confirmed' if:

(a) there is image/video material documenting the incident which has been geolocated and chronolocated, and the content of the material corresponds to the associated claim

OR

(b) there is image/video material documenting the incident which has not been geolocated and/or chronolocated, but at least one credible source has reported on the same incident

OR

(c) there is no image/video material capturing the incident, but it has been reported by a credible source

(B) Most likely

93 In our professional assessment, this incident is most likely to have occurred as described by the associated claim.

94 An incident is classified as 'most likely' if:

(a) there is image/video material documenting the incident which has not been geolocated and/or chronolocated

OR

(b) it has not been reported by a **credible source** (see definition below)

BUT

(c) there is visual evidence pertaining to the potential incident via satellite imagery

(C) Unknown

95 In our professional assessment, insufficient image/video material or insufficient credible sources exist to confirm with any confidence a given claim.

96 A potential incident is classified as 'unknown' if:

(a) there is no image/video material documenting the incident

AND

(b) there are no reports by a **credible source**

AND

(c) the potential incident or its aftermath is not visible in satellite imagery

(D) Credibility

97 A process of 'source analysis' is used to establish whether an online source should be considered credible, drawing on best practice guidelines for the field, including the Berkeley Protocol on Digital Open-Source Investigations (the 'Berkeley Protocol'), and in line with established practices of other agencies in our field (including Bellingcat, Mnemonic, the Global Legal Action Network, and Airwars, among others).[54]

98 Our process of source analysis carefully considers the online footprint of a source, including information such as its posting history, biographical or other contextual information about that source, including whether the source has previously posted or shared reliable material, and whether the source has an observable history of good practice (including accurate and ethical reporting, for example). The

[54] 'Berkeley Protocol: on Digital Open Source Investigations,' (United Nations Human Rights Office of the High Commissioner, 2022) <https://www.ohchr.org/sites/default/files/2024-01/OHCHR_BerkeleyProtocol.pdf> accessed 27 September 2024.

credibility of a source may as such be established over time. It may also be relevant to our process of source analysis if a source is already well-known and trusted by other organisations in our network and field.

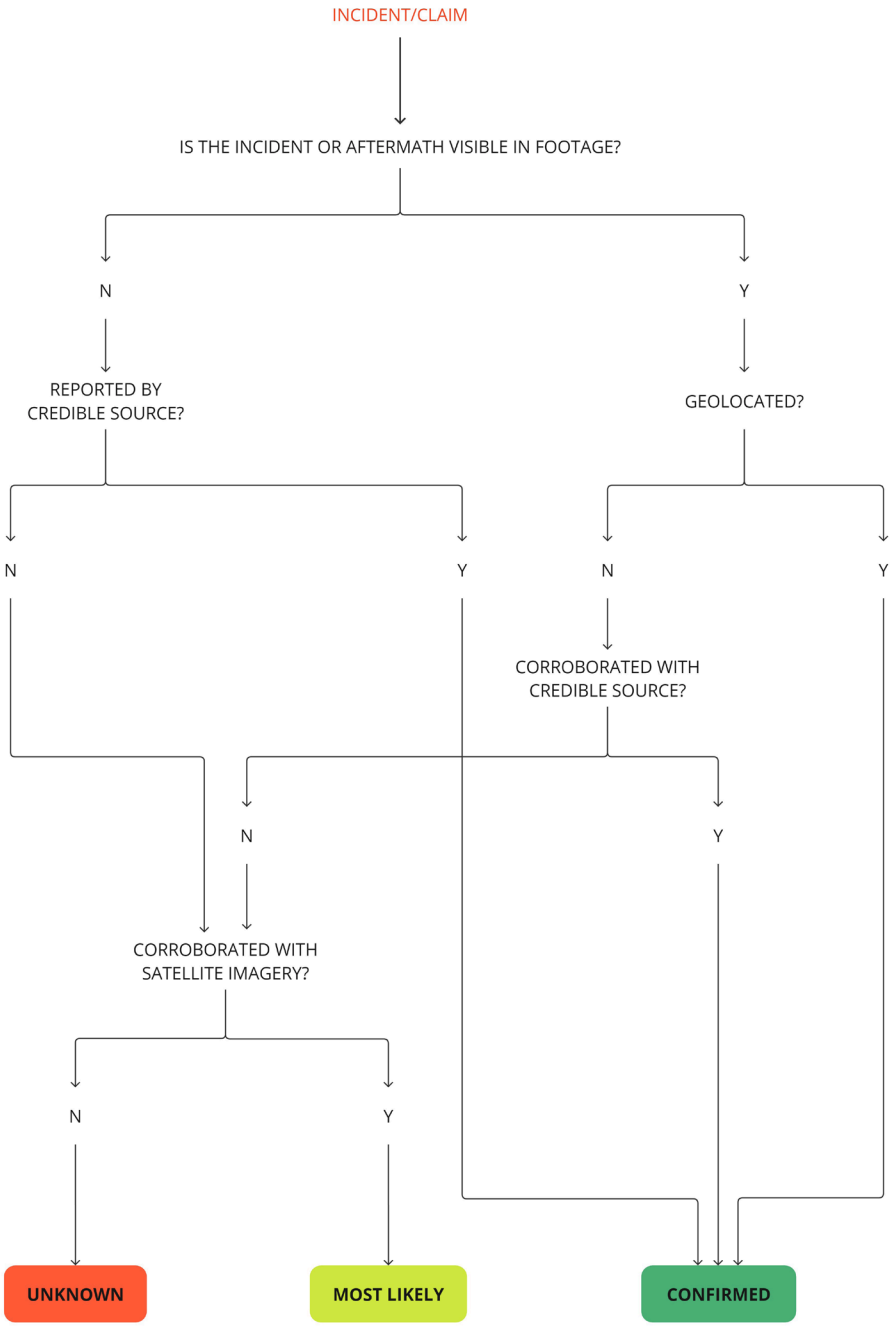

Figure 1.2. FA's verification framework flow chart.

(E) Mapping and analysis

99 Once data is considered confirmed or most likely, after the process of verification and interpretation described above, they are entered into the GCD to form the basis of the assessments arrived at throughout this report.

100 The GCD is designed to facilitate research based on the analysis of spatial and cartographic patterns over time. The GCD can be accessed at the following URL: gaza.forensic-architecture.org/database.

101 As described above, each recorded **incident** is collected, verified, geolocated, timed, and tagged. This allows for a high multiplicity of incidents to be cross-referenced and studied in relation to each other. Our researchers use the GCD to move across different levels of analysis and identify relations between **incidents**, **patterns**, and **repetitions** of acts of violence across the entire territory of Gaza and throughout the duration of the conflict. The GCD is conceived as both a tool of research and as a tool of **presentation**, allowing the extraction and presentation of multiple evidentiary threads.

102 The GCD is a cartographic documentation of actions conducted by the Israel Defence Forces (henceforth 'the Israeli military' or 'the military') in Gaza since October 2023, including aerial bombardment, shootings, artillery strikes, bulldozing, and demolition, organised as discrete 'incidents', but arranged in such a way that patterns and relationships between incidents may be discerned. Within the interface of the GCD, users can delineate a geographic region, a time period, or both, and retrieve information about all incidents we collected within that delineated domain. In this way, the GCD provides researchers with the raw data with which to analyse relations and potential patterns between incidents. All incidents are recorded in local time (Gaza), and place names are translated into English.

103 The GCD can display a variety of media formats which can be retrieved through direct links from the data points on the map. These include videos, photographs, recorded testimonies, aerial and satellite images, and sound files. The geographic base layers of the GCD include georeferenced satellite images and verified (see 'verification and interpretation') information from Humanitarian OpenStreetMap (HOSM). All data in this report is verified and confirmed as of 11 October 2024. The GCD will be continuously updated as part of our ongoing research.

104 **Note about the mapping of the Israeli ground invasion and ground forces presence:**

105 Our ground invasion data draws on cartographic reports published by the Institute for the Study of War (ISW) and the Critical Threats Project (CTP) at the American Enterprise Institute, which maps the geographic progression and extent of Israel's ground invasion day-by-day, based on third-party sources from 27 October 2023 onwards. We integrated two categories of data that CTP-ISW has mapped: 'Reported Israeli Clearing Operations' and 'Claimed Furthest Israeli Advances' in our research. We processed and mapped this data such that, for each report released, we could see and assess the furthest extent of the ground invasion to that date (in figure legends throughout: 'ground invasion') as well as the change in the extent of the ground invasion since the preceding report (in figure legends throughout: 'ground invasion recent').[55]

[55] 'Interactive Map: Israel's Operation in Gaza' (*ArcGIS StoryMaps*, 10 October 2024) <https://storymaps.arcgis.com/stories/2e746151991643e39e64780f0674f7dd> accessed 11 October 2024.

106 On 10 May 2024, CTP-ISW recessed their Israeli clearing operations layer in Gaza to cover only the areas in which the Israeli military was actively conducting clearing operations. This change in methodology is reflected in all data entries from 10 May onwards.[56]

107 All incidents analysed and mapped can be found in the GCD online. Sources for factual averments within this report which are not part of our incident database (GCD) follow the following criteria: text reports about events follow the verification framework's credibility criteria; the use of open-source footage follows the verification framework's standards for authenticity and geolocation; all statistics come from reputable and established organizations and experts.

108 All illustrations and maps by FA unless otherwise noted.

[56] 'Institute for the Study of War' (*Institute for the Study of War*) <https://www.understandingwar.org/backgrounder/iran-update-may-10-2024 > accessed 28 September 2024.

3 *FA Methodologies*

3.1 Open-Source Investigation (OSI):

109 OSI refers to a search for publicly available data on the open internet. OSI may constitute searches on social media, including use of hashtags, search operators, Boolean strings, and 'reverse image search', to find relevant documents, such as photographic or video images and audio files.

3.2 Geolocation

110 Geolocation is the technique by which researchers can determine the precise place at which an incident occurs. A definition is provided in the Berkeley Protocol on Digital Open Source Investigations:

111 'Geolocation is the identification or estimation of the location of an object, an activity or the location from which an item was generated. For example, it may be possible to determine the location from which a video or photograph downloaded from the Internet was taken using geolocation techniques. Such techniques could include, for example, identifying unique geographic features in a photograph with their actual location on a map.'[57]

3.3 Chronolocation

112 Chronolocation is the technique by which researchers identify, approximately or precisely, what date or time an image or video was captured by reference to the contents of an image frame, or digital information contained within the file. The approximate time at which an image or video was captured can be determined by reference to the file's metadata, by shadows visible within the frame, or by synchronisation with other media.

3.4 Environmental Analysis

113 **Satellite 'remote sensing' data** allows us to study and plot changes in site conditions and botanical transformation over time and monitor multi-year changes in vegetation patterns. Landsat 8 and MODIS satellite imagery and remote sensing data are the best state-of-the-art resources available to record, analyse, and map transformations across conflict regions and within the agricultural outskirts of cities.

114 **Environmental sensing** includes NDVI (Normalised Difference Vegetation Index) from Landsat 8 and MODIS, multispectral and infrared cameras, photosynthesis analysis. We calibrate information from NDVI and other remote sensing representations with ground-level images. See Chapter 4 – Destruction of Agriculture and Water Resources for a more detailed explanation of NDVI.

3.5 Cartographic Regression

115 Cartographic regression refers to the process of overlaying historical surveys, maps, and aerial photographs onto contemporary aerial imagery to track the transformation of the land and specific elements of the territory over time. Within the GCD, historical surveys, maps, and aerial photographs

[57] 'Berkeley Protocol: on Digital Open Source Investigations, ' (United Nations Human Rights Office of the High Commissioner, 2022), 190. <https://www.ohchr.org/sites/default/files/2024-01/OHCHR_BerkeleyProtocol.pdf> accessed 27 September 2024.

can be overlaid on contemporary satellite imagery to view changes over time for a given region, for example, to study a neighbourhood undergoing prolonged aerial attacks, or the degradation of vegetation in a field.