Site Mapping Guide

International Organisation for Migration (IOM)

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Introduction

Last updated: 1st November 2022

Welcome to *SiteMapping.Guide*, an online guidance for the production of site maps in humanitarian response. Site maps are a key resource at all stages of a camp lifecycle; from the site planning of empty or partially settled land; the coordination and management of services on a site; the development and improvement of a sites' infrastructure; to the site closure/handover/decommissioning stage.

> ⚠ Warning
>
> This guidance is in draft-stage, much of the content is missing and its structure may be subject to change.

The aim of this guidance is fourfold:

1. Open up the process of developing site maps to more humanitarian actors and profiles as well as mainstream site mapping skills and reduce reliance on a limited pool of specialized profiles.
2. Increase the speed at which site maps are developed. The shorter the lead time for creating site maps, the more useful they are for planning activities and coordinating partners in site, especially in sudden onset contexts.
3. Scale the availability of site maps to increase their benefit to reponses in a wider number of sites as well as in a wider number of countries.
4. Encourage the creation of consistent site map products, in terms of visuals, quality and process that are affected population-centric and that adhere to data responsibility and safeguarding standards.

The Site Mapping Guide provides a full step-by-step workflow to develop site maps. It also outlines key considerations and data protection risks associated with the management of drone captured imagery, as well as the responsible dissemination of related information products produced in the process.

This guide presents two different approaches to developing site maps. The first approach uses existing satellite imagery and the second uses drones to capture aerial imagery of sites when and where satellite imagery is not available or not suitable.

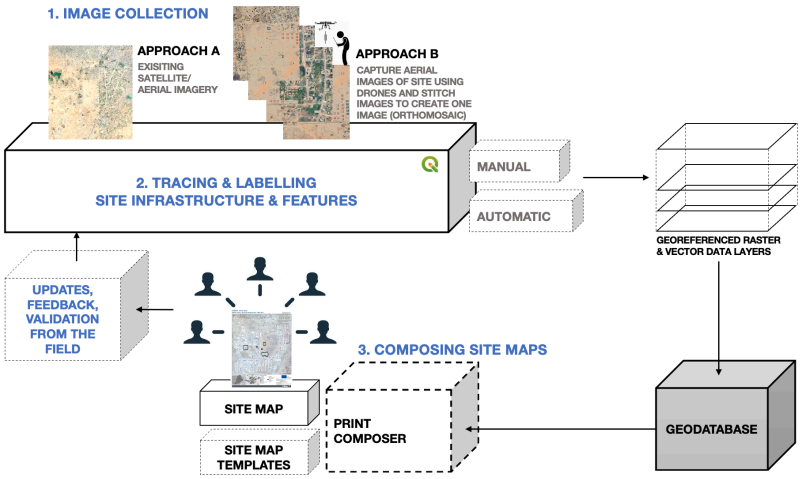

Figure 1: Diagram of the workflow presented in this Site Mapping Guide *Source: IOM*

What is a Site Map?

While no strict definition of a site map exists, this guidance considers site maps to be physical or electronic maps of IDP displacement sites that use imagery (aerial or satellite), along with the tracing and labelling of infrastructure (current or planned) as a tool for planning, coordination and risk analysis.

> **Note**
>
> Infographics or maps, which focus on needs or activity/output-level indicators are, for the purpose of this document, considered as Site Profiles rather than Site Maps and lie beyond the current scope of this guide.

Audience

This guide is for any Camp Coordination Camp Management, Shelter, or assessment actor, working in humanitarian contexts, requiring site maps to do site planning, camp coordination or risk analysis and working at either agency or inter-agency level. While some prior knowledge of GIS software is beneficial for those who plan to use this guide, it is not a prerequisite. We hope that the steps documented in the below chapters are sufficient in detail and clarity for first-time users and will accompany new and experienced site mappers through the process of making site maps, from creating and visualising spatial data to exporting and disseminating standardized site maps.

When and how can site maps be used

Site maps can illustrate camp settings in both sudden-onset disasters as well as protracted emergencies. They can be used to support the following activities:

- Site planning during suddent onset emergencies.
- Site planning for site improvements.
- Assessmets for site improvements for disability and inclusion, GBV and fire hazard risk mitigation.
- Camp coordination at the site level amongst service providers and setting up of essential site infrastructure and camp services.
- CCCM coordination at the cluster level.
- GBV/ Protection Safety Audits conducted through direct observation, key informant interviews, focus group discussions.

Acknowledgments

This guide was developed by IOM, with considerable, inputs, support and feedback by many experts in fields such as site planning, GIS, CCCM and GBV. Financial support for this guide was generously provided by United States Bureau of Population, Refugees, and Migration (BPRM) through the Safe From the Start Initiative. A full list of names of those who contributed or support to this guide can be found in the acknowledgements annex.

Feedback

Many of the approaches and software/hardware tools are quickly evolving and improving. As such, we consider this guide to be a living document. If you have any suggestions on how we can improve this guide, please reach out to majones@iom.int and bmcdonald@iom.int.

Part I

Preparation

1 Identifying requirements

Producing site maps requires a significant investment of personnel, time, software and hardware. In addition to these, the political/security/conflict context of the area, as well community acceptance and regulatory framework are factors to consider in whether or not site maps can be developed in your context and if so, which approach is most feasible.

Before jumping into **how** to develop site maps, it is important to first assess whether site maps **can and should** be developed:

1. Are site maps needed in your context and what activities or decisions will they inform?
2. What stakeholders need to be involved, both in the development of the site maps (affected population, local and national authorities, staff, etc) and in their use (CCCM actors, local authorities, etc)? How will buy in from these stakeholders be ensured?
3. What will be required to develop site maps in your context? Regardless of the chosen approach, the development of site maps requires personnel, time, hardware, software, connectivity and funding. A shortcoming on any of these may affect the feasibility or timeline of the development of site maps.
4. What red-line contextual challenges, risks and sensitivities exist or may arise during the development of the site maps that may affect the overall feasibility or appropriateness their development?

1.1 Stakeholders

Whilst the development of site maps is somewhat approach and context-dependent, typically the following stakeholders will be involved:

- **Affected population in sites** These need to be consulted before collecting drone-captured imagery to make sure they are informed and consent to the activity in order to minimize risks associated with this approach and prevent any misunderstandings.
- **Humanitarian actors*.** These can help inform how many and which sites need to be mapped. Humanitarian actors, especially those on the ground, can also feed into the iteration process of the site maps, to validate information and keep the maps and underlying data up to date.
- **Authorities*.** The authorities are a crucial interlocutor for approvals as well as the use of the maps and handover of expertise and equipment in the case of capacity development for future scenarios.

- **Legal team** IOM Legal colleagues will provide any additional guidance on data collection, processing and sharing related to your specific context and are responsible for providing the final approval on the use of drones.

1.2 General Requirements

Developing site maps typically requires the following:

1.2.1 Personnel

Staff with relevant skills and expertise, as well as support staff such as drivers and procurement support will be needed. Depending on the number of sites and how quickly the site maps are needed, the site mapping team may need to be scaled up.

1.2.2 Time

Developing site maps can be a time-intensive process, requiring prior consultations with various stakeholders, lead-time for procurement of equipment, travel time for site visits, time for collecting and processing the imagery, composing the site maps and collaboratively iterating or updating their content. These are important factors to consider when looking at the time frame of their intended use. ### Hardware and Software Depending on the chosen approach, not all items in the below table will be required. Highlighted are items which are required regardless of the chosen approach:

Hardware	Software
Laptop	QGIS (or other GIS software)
Drone kit	WedODM
Android Tablet	Avenza maps

1.2.3 Connectivity

While connectivity requirements vary depending on the chosen approach, some degree of connectivity should be assumed as needed. In situations of sudden onset disasters, connectivity can be very challenging and quite often can lead to bottlenecks and delays.

1.2.4 Cost

There are a series of costs involved in the development of site maps that need to be taken into account. Annex 4 provides a table that can provide indicative figures for the purpose of costing a site mapping exercise.

1.2.5 Context

The security, political and regulatory environment play a large role in determining the approach to site mapping in a country but also whether or not the process is feasible at all. Identification of these challenges and risks is best done as early as possible to avoid wasting resources or to allow sufficient time to mitigate them.

2 Deciding on an approach

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Uses and challenges of drone use *Source: ICRC*

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![Uses and challenges of drone use <br> *Source: ICRC*](images/droneuseschallenges.png){#f

There are two approaches to making sites maps presented in this guide. The main differeren
1. Using high-resolution satellite imagery.
2. Using drones to capture aerial images of the site.

Each of these approaches have pros and cons and it is important to evaluate each approach

### Conflict and Data Sensitivity concerns
There are key considerations to take into account when collecting, processing and sharing

- the potential to harm data subjects and others;

- the potential to discriminate;

- the potential to harm IOM staff and individuals representing authorized third parties.

In addition to the data risks and concerns outlined in the [IOM Data Protection Manual](ht

Due to protection risks, humanitarian use of drones in conflict settings is strongly disco

Once your flight area is identified, a risk-benefit assessment should be conducted prior t

### Data security/responsibility
The use of drones to capture aerial image for site mapping does not require the collection

### Regulatory environment
In many contexts, permissions to fly Drones is required. In some cases, a remote pilot lic
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- Add [Global Drone Regulations Database](https://droneregulations.info/)

### Information needs

It is important to be clear on what images you want to collect and for which specific purp

### Organizational requirements and final checklist

Once you have completed a risk-benefit assessment, identified your flight area, sought per

The following checklist aims to ensure that all ethical and data protection considerations

Trainings:
Ensure that the IOM drone operator(s) have received sufficient training to be able to fly


| Consideration            |
| ------------------------ |
| **Risk-Benefit Assessment** <br><br> Have you conducted a risk-benefit assessment to det
| **Data Collected** <br><br> Are you clear about the specific purpose of the image collec
| **Flight Area** <br><br> Have you clearly identified your flight area?|
| **Technology** <br><br> Is the technology that will be used of high standards? (UAV equi
| **Data Transfer, Sharing and Access controls** <br><br> Do you plan to transfer any of t
| **Trainings** <br><br>
| **Logos/ Branding** <br><br> The mission, in coordination with state authorities and HQ,
| **Approvals/ Permissions** <br><br> Firstly, familiarise yourself with national legislat


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[^footnote1]: [Chapter 7](https://www.icrc.org/en/data-protection-humanitarian-action-hand

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3 Getting Imagery

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4 Introduction to satellite imagery

4.1 Types of satellite imagery

There are different types of satellite imagery. The types of imagery generated from a satellite depends on the kind of image-capturing method (remote sensing technology) it uses: active or passive sensors. Active sensors emit radiation towards the Earth's surface and collect the reflected radiation. Lidar and Synthetic Aperture Radar (SAR) are both example of active sensors, SAR emitting electromagnetic pulses and Lidar emitting light pulses towards the Earth surface and measuring the reflection. Passive (or Optical) sensors detect radiation naturally reflected from the Earth's surface and is dependent on the day-night cycle.

4.2 Cloud cover

Passive satellites are not able to capture through clouds and therefore can be limited when observing certain areas with dense cloud coverage.

4.3 Understanding spatial resolution

Resolution of an image is categorized as follows: - High resolution: 30cm-5m/pixel - Medium resolution: 10-30m/pixel - Low resolution: over 60m/pixel

10m resolution means that each pixel represents a 10m x 10m area on the ground.The smaller the spatial resolution, the higher the level of detail.

Depending on the users needs, different image resolutions are used.

Low to Medium resolution images are good for understanding the bigger picture, whether that is looking at historical trends or deriving insights from spectral analysis. For example, ESA's Sentinel and NASA/USGS Landsat data provide historical data at this resolution.

High resolution images are ideal for small scale analysis or monitoring since often a smaller area if covered. The level of detail at such spatial resolution allows from small and individual objects to be identified which makes it ideal for humanitarian aid applications, detailed mapping, urban planning, as well as infrastructure, forestry and agriculture monitoring. However, high-resolution imagery is expensive and as a result less of it is openly accessible.For the purposes of creating site maps, high resolution imagery is preferable.

5 Existing imagery

Some free data sources for low to medium resolution imagery include USGS/NASA's Landsat and ESA's Sentinel series.

High resolution Satellite imagery can be requested from IOM DTM.

Alternatively, OpenAerialMap provides access to openly licensed aerial imagery. Imagery can be downloaded as a .tiff image file for free. However, in some cases, imagery for your area of interest may not be available. In this case, you may need to capture your own imagery.

6 UAV

6.1 Obtaining a drone kit

6.2 Pre-flight

Go through the Humanitarian UAV Network | Operational Check List.

6.2.1 Flight plan, nadir vs oblique images

6.2.2 Ground control points

6.2.3 Community engagement

6.2.4 Path and image overlap

A minimum of 16-31 images are needed to create an orthophoto from drone captured imagery with WebODM. Images should averlap by 70-72%.

- Minimum number of images captured: 16-32
- Minimum image overlap: 70-72%
- Minimum image overlap for 3D: 83%

6.2.5 Altitude Ground sampling distance

6.3 Flight

... ## Post-Flight ... ## Post-Flight processing

Drone captured images then need to be stitched together into one image or *orthomosaic*. Here we recommend using WedODM and take you through software installation, creating a new project, uploading the images, creating a task, and downloading the orthomosaic.

6.3.1 Orthomosaics with WebODM

To install WedODM manually, follow the steps outlined here.

Create a new project, upload drone captured images to create a task and download the orthomosaic. After the task ahs been successfully processed, select orthophoto.tif in the list of available

Part II

Developing Maps

7 Tracing and labelling

Once the site mapper has the aerial imagery, a series of options exist to process that imagery according to your needs. One of these needs may include generating labelled shelter and/ or building outlines. The site mapper may chose to either manually or automatically trace and label these features. In order to determine which option to use, let's look at the advantages and disadvantages of both.

Manual	Automatic
Advantages Tracing and labeling manually requires only basic GIS skills. Can be done offline in contexts with limited connectivity. Allows for medium to high accuracy tracing of shelters and buildings with irregular or non-rectangular geometry.	**Advantages** High number of shelters and buildings can be traced and labelled in a small amount of time, relative to manual tracing.
Disadvantages Time intensive, relative to automatic tracing.	**Disadvantages** Some tools may require basic to advanced understanding of machine learning principle. This is required with most open-source tools. Most low-code tools are not open source or free and may incur additional costs Depending on how much training data is available, the type and accuracy of the tool used,(amongst other factors), there may be errors or inaccuracies in the outlines and labels generated.

Note: If there is high cloud or tree coverage, some features may not be visible in the aerial imagery and thus will not be detected by the site mapper or the machine learning model. Therefore, it is crucial to validate the generated outlines and labels with inputs from colleaugues in the field.

7.1 Manual tracing

Manual tracing can be done in GIS or AutoDesk software. Quantum GIS can be downloaded for free here. Once the software download is complete, import and georeference the aerial imagery in QGIS. Create a new shapefile layer and toggle edit to trace the features required. Untoggle edit to save your edits.

7.2 Automatic tracing

Here are some open source tools which can assist you in creating a workflow for automatic shelter detection: - Create a training data set from aerial imagery with Groundwork.azavea. Upload orthophoto to Groundwork, label features and export training data in .json format. - Extract shelter outlines from aerial imagery using Mapflow's built in deep learning and semantic segmentation models. Mapflow can be used as a plugin in QGIS and can be downloaded from here. Further guidance on how to install the Mapflow QGIS plugin is available here. - Analyse and conduct image segmentation on aerial or satellite imagery using the UP42 platform.

8 Composing site maps

… ## Key elements of a site map

The following list of element should be included in the final output:

- Title and Subtitle
  - Country
  - State
  - Site Name
  - Thematic Title
  - Date
- Site map audience/ permission/ sharing restrictions
- Production date of site map
- Site map version
- Inset maps:
  - At Country/ Regional level
  - Ar Regional/ Area level
- Source notes:
  - Data sources
  - Satellite Imagery source
  - Coordinate system
  - Site GPS coordinate points
  - IOM CCCM Logo (or other)
  - Contact
  - Disclose limitations regarding accuracy of site map
- Map:
  - Base Map (satellite/ aerial imagery)
  - Scale bar
  - Orientation indicators
  - Legend
  - Camp Infrastructure:
    - Shelters
    - Shelter blocks
    - Zones
    - WASH facilities
    - Water points

        * Education facilities
        * Health Facilities
        * Distribution points (Food/ NFI)
        * Markets(s)
        * Information desks
        * CFM desks
        * Other camp facilities
        * Movement network (Roads, pathways)
        * Community areas/ centre
        * Religious buildings/ spaces
        * Site Entrance(s)
        * Site boundary
        * Security facilities or guard points
        * Fences/ Camp Boundaries

- Environment
    - Host community
    - Green belt
    - Trees/ Vegetation
    - Agricultural land

- Other optional labelling and infrastructure:
    - Functioning/ non-functioning
    - Male/ female latrines
    - Unusable area
    - Summary information/ figures
        * Site population (households and individuals)
        * Site area
        * Total no. of shelters
        * Shelter type and size
        * Quantity of sanitation blocks/ latrines/ showers
        * Type of water supply
        * Total no. of water points

8.0.1 Examples

8.1 GIS

8.1.1 Creating a Geodatabase

… ### Creating/ Importing Templates …

9 Collaboration

Throughout the development cycle of site maps, involving the stakeholders identified earlier in this guide is key to producing high quality, user-centered site maps. However

The main outputs of this workflow is the physical and PDF site map. However, in the process of making these - it is important to recognise the following products are also created:

- Aerial/ Satellite imagery of sites in which CCCM, shelter or other humanitarian activities are being carried out.
- Geodatabase containing Vector layers of shelters and other camp infrastructure
- Site map Templates
- GeoPDFs

These are valuable information products which can be used by colleagues and other humanitarian actors to conduct thematic analysis as well as serve as an evidence base for advocacy, planning and decision making. More importantly, these products are tools to collaborate with stakeholders and actors on the ground to:

1. Verify and validate the information,
2. Feedback and suggest modifications
3. Update the data when changes occur on the ground.

Therefore, the manner in which this data is stores, presented and shared is crucial to both allow for and promote the use of these products.

9.1 Generating geoPDFs

… ## Reading and annotating geoPDFs GeoPDFs can be imported into Avenza maps. The app uses the built in GPS in a tablet or smartphone to locate users when out of range of a network or internet connection. Users can mark points of interest, attach photos with exact location, and add annotations to existing features.

9.2 Gathering feedback and map iteration.

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Part III

Annexes

Acknowledgements

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Glossary

A glossary of common terms used throughout this guide.

UAV Unmanned Aerial Vehicle, commonly known as a drone. Radio controlled fixed-wing or rotorcraft.

IOM International Organization for Migration.

Secondary Data

References