Global Shelter Cluster
ShelterCluster.org
Coordinating Humanitarian Shelter

GLOBAL SHELTER CLUSTER REMOTE SENSING GUIDANCE

DRAFT 1

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ACRONYMS

SAR	Synthetic aperture radar
VHR	Very high resolution
UNOSAT	United Nations Institute for Training and Research Operational Satellite Applications Program
DEM	Digital elevation model
AI	Artificial intelligence
GDACS	Global disaster alert and coordination system
DRR	Disaster risk reduction
GEE	Google Earth Engine
UNSPIDER	United Nations Platform for Space-based Information for Disaster Management and Emergency Response
NASA	National Aeronautics and Space Administration
ARSET	Applied remote sensing training program

OBJECTIVE OF THIS DOCUMENT

The *Shelter Cluster Remote Sensing Guidance* has been produced to supplement the Global Shelter Cluster Information Management & Assessment toolkit developed in December 2020 in collaboration with REACH. By providing an overview of imagery and analysis options available, the guidance document should enable country-level clusters to determine where remote sensing may add value in their respective contexts.

It is intended for use as a reference document to help country-level clusters leverage remote sensing in ways most appropriate to their context of operations.

TARGET AUDIENCE

The guidelines are targeted towards field practitioners either directly involved in shelter cluster coordination activities or partners and members participating in the shelter cluster mechanism with the shared objective of ensuring an effective and coordinated response, particularly following natural disasters and during protracted crises witness to conflict and displacement. These include shelter cluster leads, IM and Assessment and GIS focal points, as well as all shelter cluster members at country and global level.

1. IMAGERY SELECTION CRITERIA

There are numerous satellite data sources available. The key selection criteria are resolution, both spatial and temporal, and application.

Primarily, the focus is on optical imagery, which includes the visible spectrum plus near infrared. There are multi- and hyper- spectral sensors available that are useful for more advanced analysis. And there are many other specialized sensors and instruments, including synthetic aperture radar (SAR) which has the advantage of operating at wavelengths not impeded by cloud cover or a lack of illumination and can acquire data day or night in all weather conditions.

Spatial resolution is generally split between three categories:

- Very High Resolution, or VHR, imagery includes imagery with a resolution of 31cm to 1 meter, also referred to as sub-meter resolution;
- High Resolution includes all imagery with a resolution between 1 and 15 meters;
- Moderate Resolution includes all imagery with a resolution lower than 15 meters.

Temporal resolution can be defined as the amount of time needed to revisit and acquire data for the exact same location. For example, WorldView-3, perhaps the best available VHR data source (at 30cm resolution) has an average revisit time of less than 1 day, so both a high spatial resolution and a high temporal resolution.

The chart below provides a general overview of which resolution is relevant for key applications.

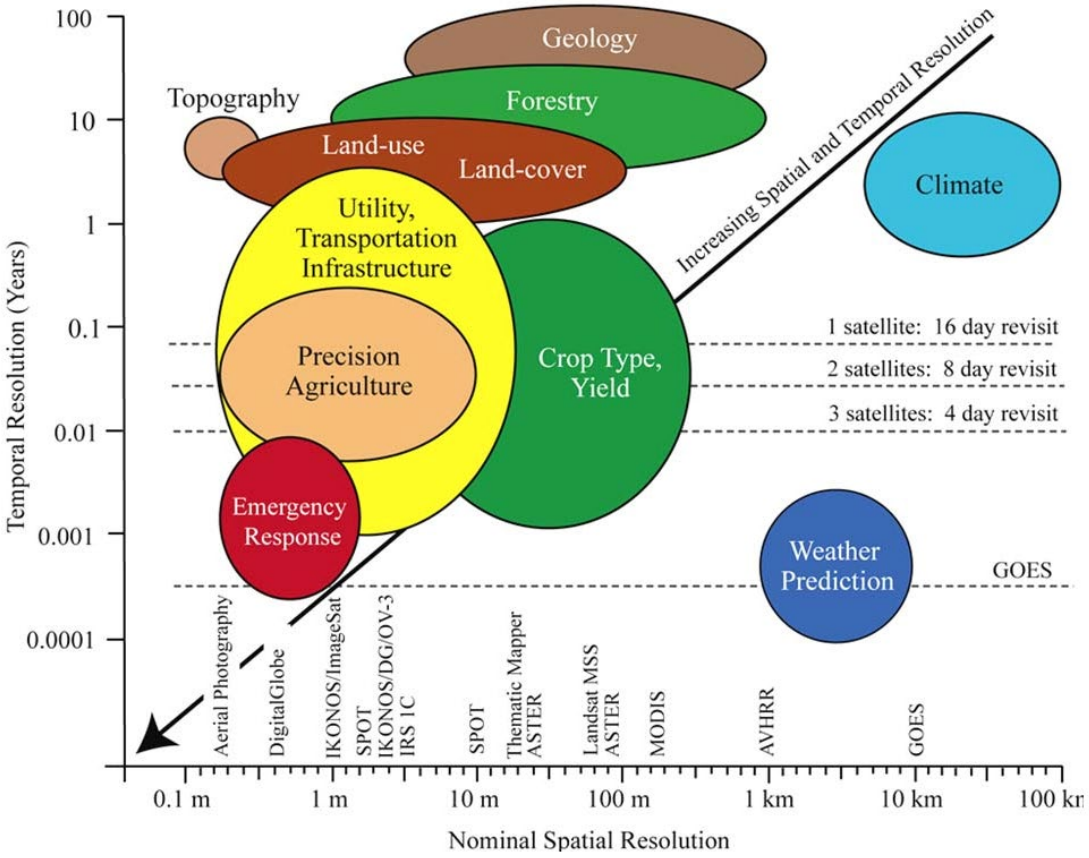

Figure 1 - Spatial and Temporal Resolution of Selected Applications (from Jensen 2007)

2. IMAGERY SOURCES

COMMERCIAL IMAGERY

Aside from a few key exceptions, VHR imagery is only available through commercial providers. Again there are many, but the primary commercial providers in the market are: Maxar (formerly Digital Globe) and Airbus.

The Maxar/Digital Globe sensors with sub-meter resolution are GeoEye, WorldView-1, WorldView-2 and WorldView-3. Fortunately, UNOSAT is able to provide some Maxar/Digital Globe imagery to UN agency and NGO partners free of charge under the NextView license. *Note: there are specific requirements related to the use of imagery under the NextView license, please refer to Section 5 for guidance on requesting and referencing imagery.*

When NextView imagery is not available, Pleiades, the Airbus VHR product, is among the most common type of imagery purchase, both archive imagery or satellite tasking requests. (Note: archive refers to imagery already collected whereas tasking refers to a new image collection). Airbus also offers useful high resolution products SPOT (at 1.5 m resolution) and its WorldDEM elevation/terrain data at superior resolution to those available in the public domain (see below).

Planet, a relatively new provider, offers multiple high resolution products, 3m and higher, and is likely to be utilized more in the future. And other commercial digital elevation data sources have proved useful, notably a Japanese Space Agency affiliate.

A more exhaustive list of commercial products is available in the price sheet in the Appendix.

Note: both Digital Globe and Planet provide free imagery in certain emergency contexts, usually for larger scale disasters.

PUBLIC DOMAIN

There are a significant number of satellite data sets in the public domain courtesy of the various scientific missions conducted by national/international space agencies. Some commonly use datasets include:

- MODIS – 250m resolution, multi-spectral (36 bands)
- Landsat – 30m resolution, multi-spectral (11 bands)
- Sentinel 2 – 10m resolution, multi-spectral (12 bands)
- Sentinel 1 – 25m resolution, synthetic aperture radar (SAR)
- ASTER and SRTM - 30m resolution digital elevation data

And with many others yet to be fully explored and leveraged.

What's Next?

New satellite sensors are being developed all the time. On the commercial side, some of the more intersesing advancements will be rapid revisit VHR, like Planet Skysat or WorldView Legion, that will capture imagery of the same location mulitple times per day; VHR SAR, like Iceye or Capella, and in-between technology like the 'stratollite.'

3. Analysis Options

Earth observation is such an expansive field that there are simply too many potential analyses to make a comprehensive list for this document. It is more practical to breakdown what is typically done by type of emergency, phase and thematic area within the humanitarian sector.

Natural Disasters

In natural disaster settings, there are some relatively standard approaches followed in terms of analysis:

- For events with advanced warning (eg. typhoon), scenarios can be prepared in advance (eg. storm track maps);
- Population exposure exercises can be conducted either based on scenarios or after the event itself;
- Following the event, affected areas can be delineated (eg. flood extent, shake map);
- Damage to buildings and other infrastructure can be identified and categorized, when suitable imagery is available and damage is observable from above.

UNOSAT has developed a 'geospatial catalog' for sudden on sudden onset natural disasters (see Appendix).

Generally, two types of analysis are most common in post-disaster settings:

- **Flood analysis** – which can be done using both optical imagery and synthetic aperture radar (SAR), see Mozambique example here. Note: there are some tradeoffs, as optical imagery needs to be cloud free and SAR is notoriously difficult to use in built up / urban areas.
- **Damage analysis** – the gold standard is detailed manual analysis of damage, which is more accurate/precise but can be time consuming. It is possible to conduct a more rapid manual analysis, where findings are generalized to an area unit (eg. gridcell or hexagon), however this is generally less desirable. Advances are being made with AI / machine learning to automate or semi-automate this process and this will become a complementary analysis in the near future. Further, there is potential to more effectively leverage aerial imagery acquisition to support damage analysis, as well as integrate approaches (see diagrams on opposite page highlighting damage assessment ecosystem and potential feedback loop).

The International Charter Space and Major Disasters

The Charter is a worldwide collaboration, through which satellite data are made available for the benefit of disaster management. By combining Earth observation assets from different space agencies, the Charter allows resources and expertise to be coordinated for rapid response to major disaster situations; thereby helping civil protection authorities and the international humanitarian community.

For more information on how the charter works, read here.

The Global Disaster Alert and Coordination System (GDACS)

GDACS is a cooperation framework between the United Nations, the European Commission and disaster managers worldwide to improve alerts, information exchange and coordination in the first phase after major sudden-onset disasters.

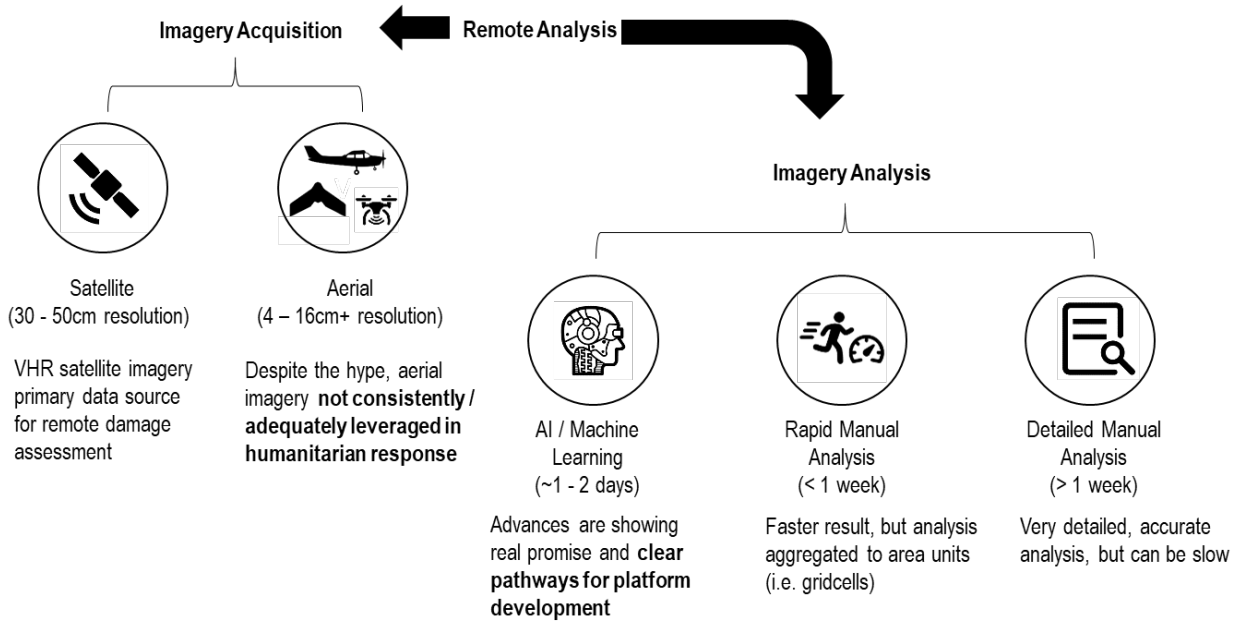

Figure 2 - Damage Assessment Process

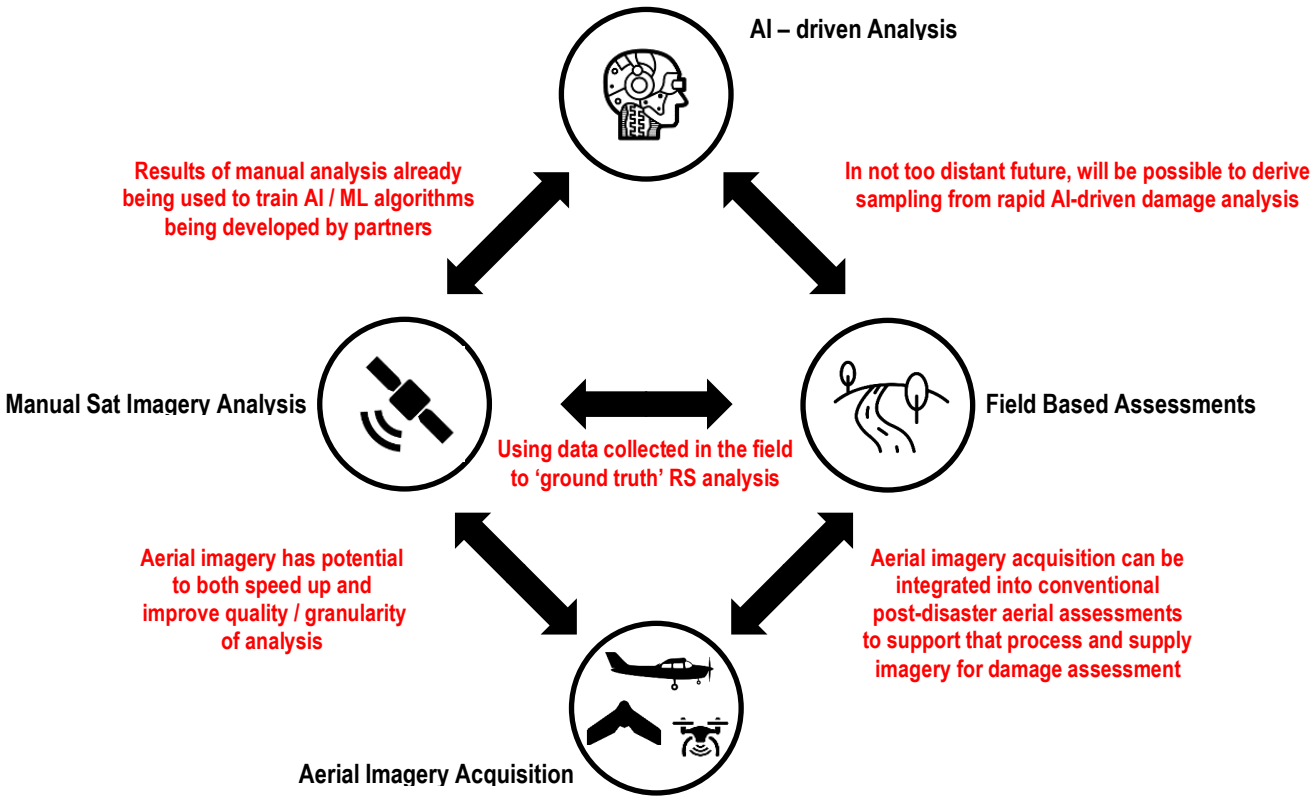

Figure 3 - Potential Damage Assessment Feedback Loop (Natural Disasters)

PROTRACTED CRISES / COMPLEX EMERGENCIES

In more protracted crises, or complex emergencies, there is very often ongoing or sporadic conflict. Consequently, buildings and infrastructure are typically damaged and populations get displaced, which are signification focus areas for remote sensing. However, there are numerous thematic areas in which remote sensing analysis can be useful in such emergencies.

For the Shelter Cluster in particular, there are three main categories of analysis often relevant during protracted crises:

Physical Presence

- Settlement location/identification – pinpointing the location of settlements, typically represented by point data
- Settlement delineation – digitally tracing the physical extent of a settlement
- Shelter counts – physically counting all shelters of interested, typically resulting in a centroid point per shelter
- Building / shelter footprint digitization – digitally tracing the extent of each shelter, resulting in a spatial dataset with a polygon for each shelter

Condition / Changes over time

- Settlement shelter / infrastructure monitoring – involves analyzing new imagery as it comes available to assess changes to settlements over time, often resulting in multiple iterations of physical presence datasets highlighted above
- Damage assessment (see Syria Damage Atlas or Sana'a) – in post-conflict related settings, detailed manual analysis of damage is often preferred to have as precise and accurate a picture as posible

Environment / DRR

- Winterization – both temperature and precipitation datasets can be leveraged to determine potential priority areas for winterization efforts
- Camp environmental degradation – new settlements have conserible impacts on the lands they inhabit, and can lead to resource depletion, a potential point of conflict with host communities
- Terrain analysis – for site suitability and hazard anlaysis (eg. steep slopes)
- Flood susceptibility and hazard analysis – see both Yemen and Syria examples

Additional analysis options

It is important to note that there are many other types or remote sensing analysis available. Some additional options, that can be used for proxies of human activity / presence include:

- Nighttime lights
- Vehicle monitoring

4. Tools and Training

Tools

Desktop GIS, either ArcGIS or Qgis, is commonly leveraged by humanitarian information managers and GIS officers. It is worth noting that in ArcGIS Pro, the latest version, there is now an Imagery Analyst Extension that facilates some common remote sensing tasks.

Some platforms to be aware of are:

Picterra is a cloud based platform, software as a service, for AI-driven object detection and feature extracton from satellite imagery. Now with plug ins for both ArcGIS and Qgis. Picterra has proved useful for rapid shelter analysis.

Google Earth Engine (GEE) is a cloud based, distributed computing platform with a multi-petabyte catalog of satellite imagery and geospatial datasets with planetary-scale (now with a QGIS plug in). It provides both rapid access to a variety of open source datasets and incredible capacity to perform large scale analysis.

SNAP is the Sentinel Application Platform, designed by ESA for working with Sentinel datasets. Largely superceded by GEE, but the graphic user interface may be preferable to some who are intimidated by code.

Training

Two excellent resource for remote sensing training:

UN-Spider's Knowledge Portal hosts a number of remote sensing tutorials.

NASA's Applied Remote Sensing Training (ARSET) Program is host to an expansive curriculum, ranging from fundamentals to advanced analysis.

5. Requesting Remote Sensing Support

Searching for Available Imagery

ImageHunter is an extremely helpful tool for browsing all available commercial imagery. Simply type in an area of interest or upload a KMZ or SHP and it will present a list of scenes that correspond to the search area. Make note of each image Catalog ID for later imagery requests.

Requesting Imagery

The Shelter Cluster can request imagery from UNOSAT but it needs to be on behalf of a UN agency. Ideally from a UN email address or with a UN colleague in Cc: that can confirm the request is on behalf of the UN.

REACH can also facilitate imagery requests. However, this is best done when REACH is actively supporting the cluster with an assessment or analysis exercise resulting in REACH information products.

In either case, imagery shared under the NextView license comes with specific requirements. First, prior to any publication, the use of imagery must be authorized through the US Dept of State Humanitarian Information Unit. Second, any published NextView imagery must but referenced in the proper format: *[sensor and date] [year] © DigitalGlobe Source: US Dept of State Humanitarian Information Unit, NextView License*

Requesting Analysis

Normally, remote sensing analysis requires dedicated budget to cover related costs. However, there are some instances where existing funding may be in place to cover at least some analysis. For instance, during Charter Activation post-disaster or if REACH or UNOSAT are already funded for related activities in a particular context.