Toitū Te Whenua
Land Information
New Zealand

Requesting Imagery during an Emergency Handbook

Information for Controllers, Recovery Managers, Intelligence Functions and GIS Teams

October 2024
Objective ID: A6677744
Version 1.0

Toitū Te Whenua
Land Information
New Zealand

Contact LINZ Geospatial Duty Officer for geospatial support in an emergency

emergency@linz.govt.nz

027 357 0029

Acknowledgements

LINZ would like to thank all the CDEM groups, emergency response agencies, councils, data suppliers, NEMA, GEMA and other stakeholders who provided feedback to ensure this guidance provides valuable information for requesting imagery in an emergency.

Nāu te rourou, nāku te rourou, ka ora ai te iwi.

With your food basket and my food basket the people will thrive.

Working in partnership we can make the biggest difference.

Front page is the comparision of Mohaka River, Te Haroto, before and after Cyclone Gabrielle, February 2023, 0.5 metre imagery available from LINZ Basemaps.

Contents

This document is now version 1.0. Version 0.1 covered aerial imagery guidance. Version 0.2 extended the document to include satellite imagery and amended to include definitions of reconnaissance and drone imagery, cost information, contact details of potential data suppliers and case studies from Cyclone Gabrielle. Version 0.3 included feedback from NEMA, Fire and Emergency NZ and GeoInt NZ Defence Force.

Please share any suggestions for improving this document by emailing imagery@linz.govt.nz

1 Introduction

During an emergency Toitū Te Whenua Land Information New Zealand (LINZ) can provide geospatial support to response agencies.

This includes the coordination of data requirements, capture, processing, licensing, funding, and hosting of imagery, including aerial, satellite, LiDAR and bathymetry.

Please note LINZ coordinates funding across multiple agencies but has no dedicated budget for response or recovery data capture.

1.1 Purpose

The purpose of this document is to:

- demonstrate the value of imagery to support decision making in an emergency.
- provide guidance for capturing aerial imagery for response and recovery.
- provide an overview of satellite imagery options for response and recovery.
- share emergency contact details for LINZ Geospatial Duty Officer.

1.2 Overview

This document includes:

- information specifically for **Controllers and Recovery Managers** to explain the different data options, and the terminology used by your Intel and GIS Teams.
- information for **Intel Functions and GIS Teams** to support your own data acquisition, and to set out the parameters used by LINZ in a response.
- a review of what data may add the most value for different emergency **scenarios,** including case studies for Pigeon Valley Fire and Cyclone Gabrielle.
- a checklist for acquiring **aerial imagery** in an emergency, potential supplier contacts and estimated costs.
- a checklist for acquiring **satellite imagery** in an emergency, potential supplier contacts and estimated costs.

Figure 1 – Reconnaissance flight over Canterbury flood in May 2021

2 Information for Controllers and Recovery Managers

Waiapua River, Gisborne after Cyclone Gabrielle February 2023
0.2 metre image available in 3D from LINZ Data Service

2.1 Why is it important to understand imagery?

Imagery plays a vital role in helping inform decision making during all 4 Rs of emergency management – risk reduction, readiness, response, and recovery.

During a response, a Controller may be asked to approve budget for imagery. The following section provides information to help inform that decision. Often imagery is most valuable during recovery, so your Recovery Manager will be a key stakeholder.

2.2 What is imagery?

Imagery captures a snapshot of the area of interest, giving you a bird's eye view of what has happened on the ground. Imagery includes both satellite imagery and aerial imagery and you may also be asked to consider radar, drone and reconnaissance photos. Examples of each type are provided below, plus recommendations of when to use them.

Reconnaissance

Reconnaissance photos and video, often taken from a helicopter, provides an immediate wide area assessment of the extent of damage, and are often taken in the first 24 hours. Ensure the reconnaissance images are taken with location tracking turned on to enable the images to be located and viewed from a map to provide more valuable intelligence.

Reconnaissance photos will create individual snapshots, which is different to aerial imagery which can be displayed as a map layer.

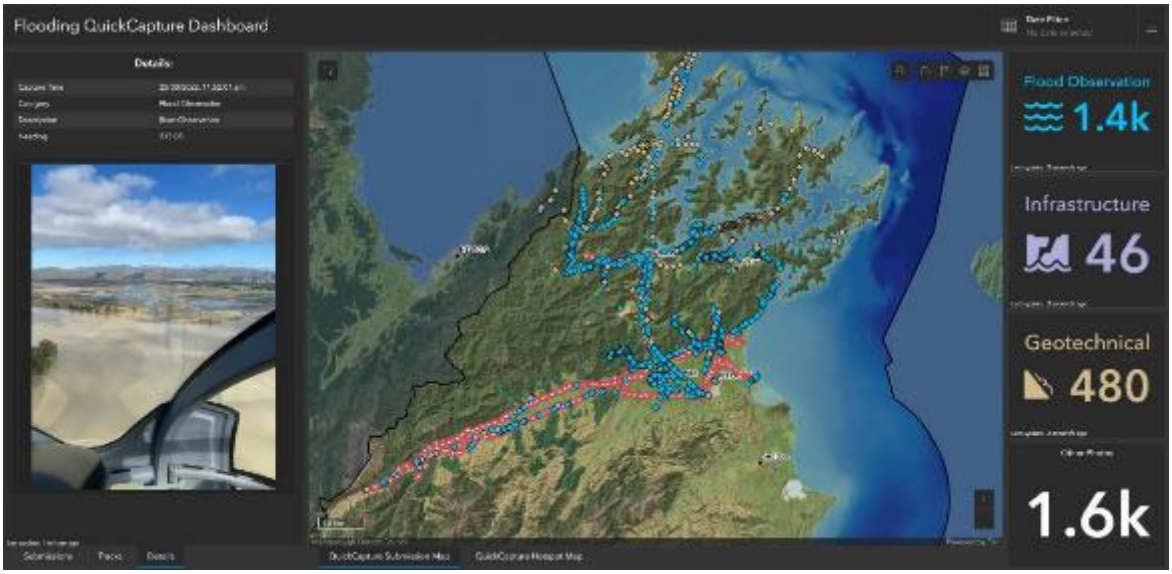

Figure 2 – Reconnaissance photo taken of Top of the South Floods August 2022 supplied by Marlborough District Council.

Drone imagery

Drones or Uncrewed Aerial Systems (UAS) can quickly provide situational awareness of a localised area through rapid deployment and the collection of photographs, videos, ortho mosaics, and 3D models.

Operating UAS in emergencies requires strict adherence to NZ Civil Aviation Authority regulations to ensure safe operations in restricted airspace. Fire and Emergency New Zealand, in collaboration with NZ Police and NZ Defence Force, deploys UAS for both strategic and tactical purposes. UAS complements other data sources to enrich the information available to response teams. As the technology and battery life evolves, the role of UAS in will continue to grow.

Figure 3 – Drone imagery of fire at Macaulay Metals July 2018 captured by Fire and Emergency NZ.

Aerial imagery

Aerial imagery is captured from a plane and can generate high resolution images. There is a cost to capturing the data, and it can take days or even weeks to capture and process the imagery but is likely to provide a detailed record of the impact of the event. Capturing imagery close to event will provide the most valuable information.

Figure 4 – Aerial imagery captured for NZ Transport Agency by AAM following the 2016 Kaikōura Earthquake identifies the rail track displacement and land uplift in the tidal area.

Satellite imagery

Optical satellite imagery is captured from space and generates imagery of a lower resolution than aerial imagery. Some satellite imagery is available for free, but the timing of the capture cannot be controlled, and often during a flood the area of interest may be covered by cloud. Commercial satellite imagery is available and can be tasked to cover an area of interest. Most satellite imagery can be processed and shared in hours to days.

Figure 5 – Satellite imagery sourced from Planet helped prioritise properties requiring assistance during 2020 Southland flood. The imagery was captured within one hour of peak river flow.

Radar Imagery

Radar imagery is another form of satellite imagery. It may be referred to as Synthetic Aperture Radar (SAR) or Interferometric SAR (InSAR). We use the term "radar" in an emergency to avoid confusion with Search and Rescue.

Radar can help identify approximate flood extents. The main advantage is that radar can be captured at night and through cloud cover which is important during a flood. The output is a greyscale image, and further processing can extract approximate flood extents.

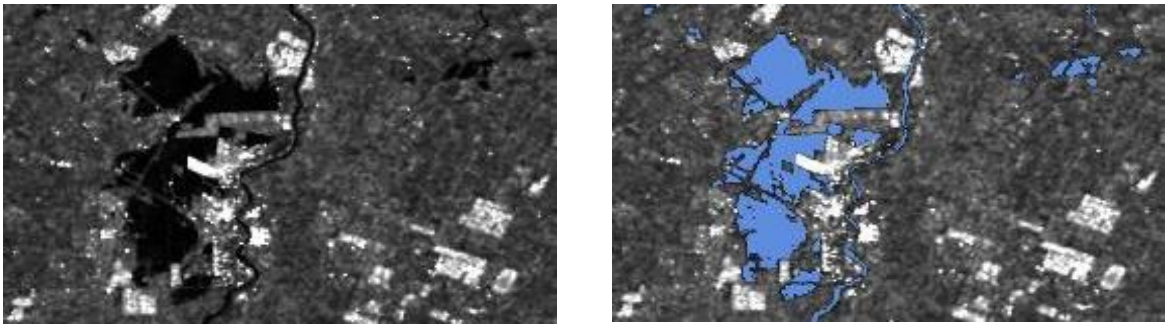

Figure 6 – Processed Sentinel-1 radar image compared with the results of flood extent extraction analysis showing the receding floodwaters of Edgecombe on 9th April 2017.

2.3 What is LiDAR?

Imagine if you could view the area of interest in 3D. LiDAR data will enable you to do just that. LiDAR captures high resolution height data which can be used to create elevation models and contours.

LiDAR is another dataset where your local Council is likely to be collaborating with LINZ outside of an emergency. Be aware that most LiDAR is captured by plane and takes months to capture and process. As a result, it is only applicable to recovery and future readiness rather than a response. It may be possible to capture LiDAR and aerial imagery at the same time depending on the sensors available.

Capturing aerial imagery and LiDAR at the same time provides 3D and spatial context and is recommended when the ground surface has changed, for example slips, debris fields, erosion, and deposition. This is often possible from a single camera and flight plan.

LiDAR can be captured for localised areas more quickly using helicopters and drones. For example, LiDAR was captured for the Esk Valley immediately following Cyclone Gabrielle. The silt deposition was calculated by comparing the change in elevation between the new LiDAR and the LiDAR previously captured by Gisborne District Council and the Government's Provincial Growth Fund. This work was carried out by University of Canterbury, NIWA and Christchurch Helicopters.

Elevation Aotearoa provides more information about LiDAR, including availability, how to guides and the national specification for capturing LiDAR.

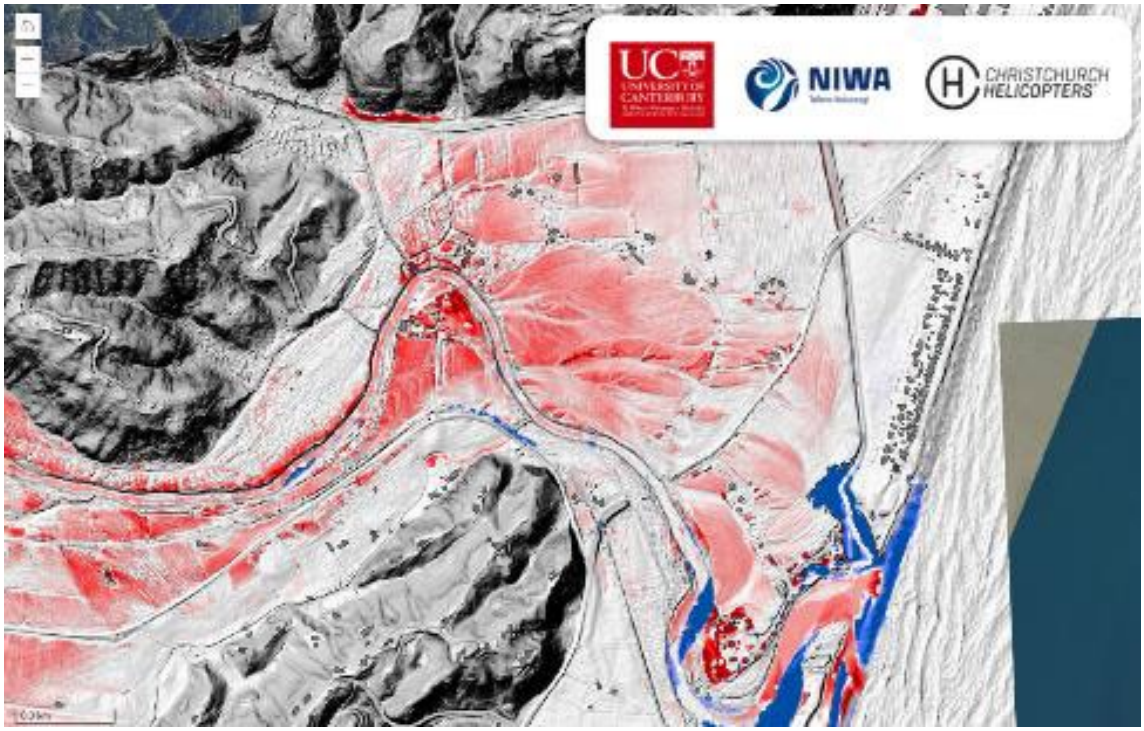

Figure 7 - Silt deposits, shown in red, in the Esk Valley were identified by comparing LiDAR captured before and after Cyclone Gabrielle.

2.4 Time versus Cost and Quality

Whichever data source is chosen, capturing the imagery as close as possible to the time of the actual event will generate the most value. This means a decision about budget is likely to be required in the middle of a response.

Careful consideration should be given to time versus cost and quality. Feedback from Councils suggest the long-term benefits of capturing the imagery as a record of the event are significant and are often the preferred option to support recovery for local events.

If speed is critical, a well-timed satellite image may be a better option, but availability will be reliant on predetermined satellite flight paths and cloud cover. Satellites can be tasked but this can be an expensive option for large areas. Aerial photography capture can be deployed at short notice, but again this relies on aircraft, camera and data processing availability and the creation of a flight plan in time to catch any suitable weather window close to the event.

Will the imagery be just a visual representation of the event, or will you want to carry out analysis to measure change detection. To perform analysis either pre-event imagery must be available to enable a comparison or consider capturing more than three bands to inform analysis.

Also consider who the imagery will be shared with. The preference is to purchase imagery with an open licence which is freely available to all agencies working on the response and recovery, but an open licence is likely to cost more.

If the event covers more than one CDEM Region NEMA will help establish prioritises.

A summary of the most common imagery options for each stage of an emergency are suggested below. For further detail please see Section 3.1 below (Data options in an emergency). Other issues which will influence the choice of imagery are environmental factors e.g. cloud cover, are there flying restrictions, and size of area of interest.

Wide Area Impact Assessment	Rapid Impact Assessment	Damage Assessment	Recovery
First 8 hours	Within 48 hours	Within two weeks	Months
			
Reconnaissance photos and drones	Satellite imagery and drones	Satellite imagery and aerial proofs	Orthorectified aerial imagery and LiDAR

2.5 Questions to ask your Intel Team

a. When do you need the imagery to be captured? For example, close to peak flood.
b. What features do you need to see? What are the smallest objects that matter?
c. What will you do with the data? Do you want to see a visual representation of the event, or do you need to analyse the data to extract additional information?
d. Who do you need to share the imagery with?
e. What software will you use to view the imagery?
f. What budget is available?

2.6 How can LINZ help?

It is likely that your Intel Team will have GIS staff who are well resourced and able to request imagery. Under these circumstances, the following aerial imagery specification and review of satellite imagery options may serve as a useful guide for your team.

However, if key staff are not available or your GIS resourcing is limited, LINZ can provide support. Our Geospatial Duty Officer will be on standby, ready to assist you with requesting aerial and satellite imagery during a response.

After the 2016 Kaikōura Earthquake, LINZ was tasked to coordinate the data requirements for multiple agencies, including the New Zealand Transport Agency, GNS, Environment Canterbury and Marlborough District Council to enable effective capture of aerial photography, LiDAR and bathymetry. Pulling together the data requirements of multiple agencies, and securing joint funding is where LINZ can contribute to support agencies responding to an event.

A more recent example is the satellite imagery captured immediately after Cyclone Gabrielle. LINZ and the Ministry for Primary Industries co-funded the purchase of this imagery, and LINZ published the data on LINZ Basemaps.

LINZ also coordinated the funding, procurement and publishing of aerial imagery and LiDAR to support Cyclone Gabrielle recovery, working with local Councils, CDEM groups and central government.

Contact the LINZ Duty Team emergency@linz.govt.nz 027 357 0029

2.7 Case Study – Pigeon Valley Fire

Nelson Tasman Civil Defence Emergency Management (CDEM) Group requested the capture of aerial imagery following the Pigeon Valley Fire.

Aerial imagery is often captured to look like a photo made up of three bands of colour: red, green, and blue. For Pigeon Valley Fire, a fourth, infra-red band was captured.

Figure 8 – Infra red image of Pigeon Valley Fire, with the black area showing the extent of the fire, and the red indicating healthy vegetation.

The Pigeon Valley Fire aerial imagery had many uses in recovery, including:

- informing discussions with community groups
- supporting online data collection, for example damaged fencing
- planning helicopter flights to re-seed pasture on private property
- updating forestry company inventory
- verifying private property insurance claims
- a map prepared for each of 57 property owners within the fire cordon

Lessons identified during Pigeon Valley Fire debrief:

- Include the Recovery Manager in discussions to authorise imagery capture, as they will have important data requirements.
- Engage with the supplier early and involve them in discussions about what is achievable given the conditions and response time required.
- Imagery formats, resolution, delivery methods and costs should all be part of the formal authorisation process during an event. Ensure all relevant agencies authorise the requirements and costs.
- Start conversations about potential budget allocation for imagery before an emergency, to minimise lengthy discussions in the middle of a response.

2.8 Case Study – Cyclone Gabrielle

A national emergency was declared in response to Cyclone Gabrielle on 14 February 2023. LINZ coordinated satellite, aerial and radar imagery to support both the response and recovery.

Figure 9 - Data captured during Cyclone Gabrielle including aerial imagery, satellite imagery and approximate flood extents.

Aerial imagery was purchased by Hawke's Bay Regional Council and Gisborne District Council and published by LINZ. The aerial imagery was captured within one week, processed and delivered to LINZ in the second week and available on LINZ Basemaps two days after supply. The aerial imagery was used to assess immediate hazards including stop bank breaches, slips, bridge damage and inundation. Imagery was also used to locate landslips and support insurance claims.

In addition, satellite imagery was purchased via joint funding between LINZ and Ministry for Primary Industries. This enabled a detailed assessment of the damage across a much wider area than the aerial imagery and identified how flooding had impacted local infrastructure such as houses, roads, and communities. It went on to inform decision making for those involved in the response and recovery including the work of GNS who have identified more than 140,000 landslides caused by the Cyclone.

Radar from Sentinel 1 satellite was used to extract approximate flood extents, which were published on the LINZ Data Service within nine days of the national declaration.

Lessons identified during Cyclone Gabrielle debrief:

- Commercial satellite imagery usually comes with a restricted access licence.
- Resolution was sacrificed for timeliness, due to the large area impacted.
- Specifications and requirements defined ahead of time, plus knowledge of supplier's capabilities and commercial terms will ensure timely data collection.
- Coordinating data requirements and funding across multiple agencies will deliver the best value and is likely to extend data coverage but does take longer to achieve.

3 Information for Intelligence Function and GIS Teams

Hikuwai River, Gisborne after Cyclone Gabrielle February 2023
0.1 metre image available from LINZ Basemaps

3.1 Data options in an emergency

Different imagery data options will add value depending on the type of emergency. Here are some examples:

Type of Event	Data sources	Example
Local Flood 	High resolution commercial optical satellite imagery High resolution commercial radar imagery	A well timed commercial optical satellite image identified the flood close to peak river flow in the 2020 Southland Flood.
Regional Flood 	Medium resolution freely available optical satellite imagery Medium resolution freely available radar imagery High resolution aerial imagery - RGB	Low resolution satellite imagery helped identify approximate flood extents in broad river plains in Marlborough, but not the narrow Maitai Valley in Nelson during 2022 floods. Aerial imagery was captured as a record of this event.
National flood 	Medium resolution freely available optical satellite imagery Medium resolution freely available radar imagery Medium resolution commercial optical satellite imagery High resolution commercial radar and flood extents High resolution aerial imagery - RGB High resolution LiDAR	High resolution commercial satellite imagery was estimated to be too costly and take too long to capture the large area of interest which covered much of the North Island following Cyclone Gabrielle. Medium resolution satellite imagery captured over 44,000 km^2 in under two minutes close to the peak of the cyclone. ICEYE provided flood extents at cost and restricted access. High resolution aerial imagery and LiDAR capture was funded by central government as part of Cyclone Gabrielle recovery.

Type of Event	Data sources	Example
Earthquake 	Low resolution freely available optical satellite imagery Low resolution freely available radar imagery High resolution commercial optical satellite imagery High resolution aerial imagery – RGBI with infrared High resolution LiDAR	High resolution imagery and LiDAR data are used to map fault ruptures, measure fault offsets, define areas of uplift and subsidence and areas of liquefaction, plus buildings and infrastructure damage. Radar, imagery and LiDAR analyses were used to measure land movement following the 2016 Kaikōura earthquake.
Landslides 	High resolution commercial optical satellite imagery High resolution aerial imagery – RGBI with infrared High resolution LiDAR Medium resolution radar data	High resolution commercial optical satellite imagery has been extensively used for mapping and monitoring and landslide movement, including avalanches. Medium resolution radar data is used to monitor landslides. GNS landslide database https://data.gns.cri.nz/landslides/
Fire 	Low resolution freely available VIIRS data Medium to high resolution imagery with SWIR band Satellite or aerial imagery with RGBI infrared band	Visible Infrared Radiometer Suite (VIIRS) data can indicate fire activity for an initial overview. Shortwave Infrared (SWIR) data is useful for detecting active fire and anomalous heat. Any imagery with an infrared band will detect vegetation health which can be used to define the extent of a fire. Infrared imagery was used to capture Port Hills Fire extent.

Type of Event	Data sources	Example
Oil spill 	✈ Low resolution freely available radar imagery ✈ High resolution commercial radar imagery ✈ Satellite or aerial imagery with RGBI infrared band	An oil slick returns a different reflection in radar data to the surrounding water, enabling the identification of an oil spill. Infrared bands can also be used to identify oil spill. Infrared data was used during the 2011 Rena oil spill.
Volcano 	✈ High and medium resolution commercial radar imagery	Radar data can be used to measure the distribution and depth of ash deposits and landscape change through the geothermal and eruptive steam. Radar measured the 2019 Whakaari/White Island eruption.
Tsunami 	✈ High resolution imagery with RGBI infrared band ✈ High resolution commercial LiDAR imagery	High resolution imagery and LiDAR can be used to map the inland extents of tsunami inundation and damage A local tsunami generated by the 2016 Kaikōura earthquake.

3.2 Data costs in an emergency

It is not possible to provide a set price for data capture due to the variables of extent, resolution, distance from take-off and availability. Instead, a list of costs from past emergencies has been shared to give an indication of potential costs for future events.

Product	Event	Date	Provider	Area sq km	Resolution* metres	Licence	Cost
Aerial Imagery							
A	Pigeon Valley Fire	Feb 2019	Aerial Surveys	36	0.25	CC-BY	$6,000
B	West Coast Flood	Jul 2021	Aerial Surveys	40	0.125	CC-BY	$20,000
C	Canterbury Flood	Jun 2021	LandPro	4,500	0.3	CC-BY	$30,000
D	Kaikōura Earthquake	Nov 2016	Aerial Surveys	14,000	0.3	CC-BY	$250,000
E	Cyclone Gabrielle	Feb 2023	SKYCAN	2,000	0.1	CC-BY	$117,000
Satellite Imagery							
F	Southland flood	Feb 2020	Planet	3,000	3.0	Restricted	$4,000
G	Cyclone Gabrielle	Feb 2023	Capella	525	1.2	Restricted	$9,550
H	Cyclone Gabrielle	Feb 2023	Sentinel 2	200,000	10	CC-BY	Free
I	Cyclone Gabrielle	Feb 2023	EarthScanner	55,000	0.5	CC-BY	info@critchlow.co.nz
Derived Products							
J	Cyclone Gabrielle	Feb 2023	ICEYE	1,260	3.0	Restricted	emsupport@eagle.co.nz

Refer to Appendix D for the extent of each product

*Resolution is Ground Sample Distance (GSD) the distance represented by each pixel.

3.3 How can LINZ help?

LINZ Duty Team

If a local or national emergency is declared or if MetService issues a severe red weather warning for rain the LINZ Geospatial Duty Team will activate and automatically carry out the following steps:

a. Inform lead agency the LINZ Geospatial Duty Team has activated and offer support.

b. Identify the area of interest.

   LINZ will define the initial area of interest based on available intelligence.

   View the area of interest and requests for emergency response data via the dashboard.

   You are able to add your own areas of interest using the data request editor.

   If you cannot access the dashboard or editor, request access here.

c. Monitor freely available satellite imagery, including Sentinel 1 and 2, and share regular updates with the lead agency (see Section 5.3).

d. Contact NEMA to confirm activation of the International Disasters Charter (see Section 5.5).

e. Contact commercial data suppliers to confirm their availability (see Section 4.2 and 5.4)

f. Publish imagery via LINZ Basemaps, ArcGIS Online and Amazon Web Services.

Contact LINZ Duty Team	**emergency@linz.govt.nz**	**027 357 0029**
Share info with LINZ ArcGIS Online Account Name		**emergencyintel_linz**
Access AGOL Emergency Imagery Toolbox		**link**

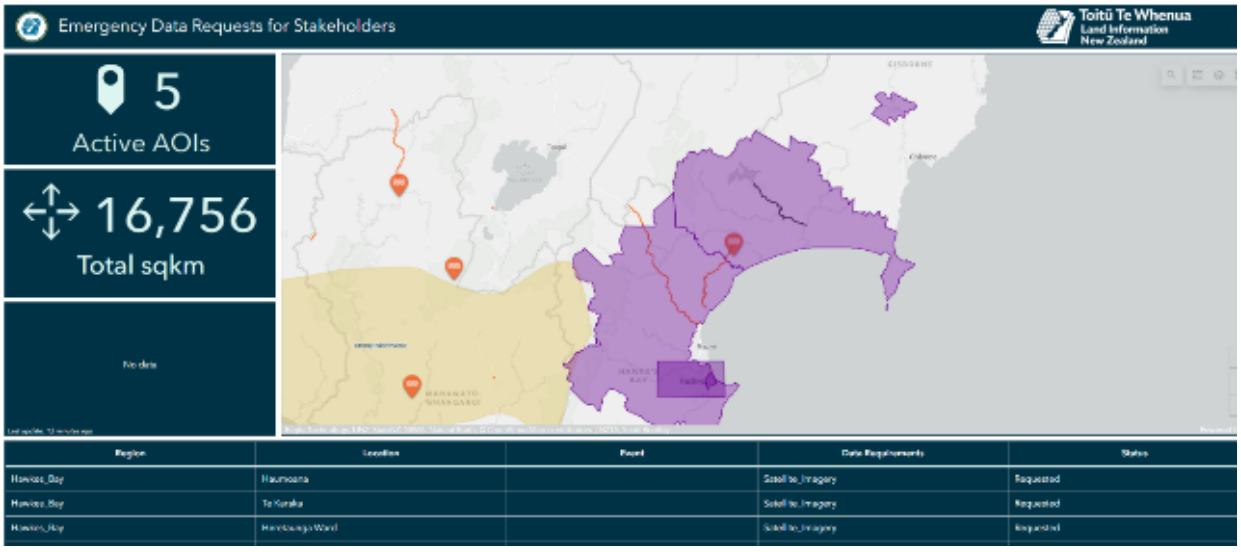

Figure 10 Emergency Data Requests for Stakeholders dashboard.

LINZ Basemaps

Any emergency response imagery which is available under an open CC-BY licence will be published on LINZ Basemaps. This enables you to create a URL and easily share new imagery as soon as it becomes available with your Controller and Recovery Manager.

https://basemaps.linz.govt.nz

LINZ ArcGIS Online – WMTS

LINZ will generate an ArcGIS Online item for each emergency response dataset published on LINZ Basemaps to make it easier to discover and add to ArcGIS Online without having to request an API key. The imagery will be provided in WMTS format and access to this imagery will continue to be provided after the emergency.

LINZ Emergency Resonse Imagery Collection link

LINZ ArcGIS Online – Tile Layer

LINZ will also publish the imagery as a Esri tile layer specifically for response agencies. This will enable the imagery to be used in ArcGIS field apps and allow the data to be taken offline, which is not available in the WMTS format.

Access to this imagery will be restricted to response agencies and there will be a short delay while the imagery is processed into the Esri tile layer format. The data will only be available for a short period of time after the response.

Alongside the imagery tile layer LINZ have published a layer for hosting approximate flood extents extracted for satellite imagery and an Area of Interest dashboard for stakeholders.

LINZ Emergency Imagery Toolbox link
Request access to the LINZ Emergency Imagery Toolbox link

Amazon Web Services

The imagery will also be available in its original format to download from Amazon Web Services. This will be useful for organisations wanting to use the imagery for analysis. Thanks to Eagle Technology for preparing a StoryMap to describe how to connect to the imagery in AWS using Esri software. Instructions are also available via LINZ GitHub. To request access to the LINZ Amazon Web Services please email imagery@linz.govt.nz.

4 Aerial Imagery

Glenduan, Nelson after Top of the South floods August 2022, 0.15 metre imagery available from LINZ Basemaps

4.1 Aerial imagery checklist

Below is a summary of things to consider when requesting aerial imagery in an emergency response. This checklist will be used either by your Intel Team, or by LINZ if you task us to help coordinate aerial imagery. It is recommended to discuss data requirements and timeframes with the data supplier to ensure the best outcome.

For an explanation of each issue please refer to Appendix A – Aerial imagery guidance

	Issue	Suggested example to discuss with data supplier
☐	**Emergency**	Name of emergency response
☐	**Capture Date**	Required timeframe
☐	**Controller**	Controller name and contact details
☐	**Imagery Contact**	Name, email and mobile number
☐	**Purchase Order**	Purchase order number
☐	**Area of Interest**	Define extent of emergency imagery request
☐	**Products**	Orthorectified / Low order / Unprocessed
☐	**Ground Sampling Distance**	0.3 metres
☐	**Horizontal Accuracy**	<= +/- 2.0 metres. 90% confidence interval
☐	**Spatial control**	Supplier to provide any required ground control
☐	**Image Bands**	Natural Colour RGB / 4 Band RGBI
☐	**Sun angle**	More than 30° above the horizon.
☐	**Atmospheric effects**	Minimise atmospheric conditions e.g. haze or smoke
☐	**Cloud cover**	Imagery must be 90% cloud free.
☐	**Projection**	NZTM2000
☐	**Orthorectification**	Maintain scale, resolution, contrast, and alignment
☐	**Tiling**	Align tiles with the appropriate Topo50 map sheet.
☐	**Format**	Uncompressed GeoTIFF / compressed mosaic / TIFF
☐	**Licence**	Creative Commons Attribution 4.0 International (CC BY 4.0)
☐	**Index**	Supply tile index

4.2 Aerial imagery suppliers

There are four aerial imagery suppliers LINZ has an existing working relationship with, listed below in alphabetical order:

- **Aerial Surveys**

Contact:	Steve Laming
Email:	steve.laming@aerialsurveys.co.nz
Mobile:	021 665 164
Generic contact:	info@aerialsurveys.co.nz
Website:	aerialsurveys.co.nz

- **LandPro**

Contact:	Andy Burrell
Email:	andy@landpro.co.nz
Mobile:	027 223 5753
Generic contact:	info@landpro.co.nz
Website:	landpro.co.nz

- **SKYVUW**

Contact:	David Napier
Email:	david@skyvuw.co.nz
Mobile:	021 441 579
Website:	skyvuw.co.nz

- **Woolpert**

Contact:	Lorraine Claydon	Fadia Zein
Email:	lorraine.claydon@woolpert.com	fadia.zein@woolpert.com
Mobile:	027 532 3382	027 235 0241
Generic contact:	info@woolpert.com	
Website:	woolpert.com	

5 Satellite Imagery

Port Hills Fire February 2024
10 metre satellite imagery available from LINZ Basemaps

5.1 Satellite imagery checklist

Below is a summary of things to consider when requesting satellite imagery in an emergency response. This checklist will be used either by your Intel Team, or by LINZ if you task us to help coordinate satellite imagery. It is recommended to discuss data requirements and timeframes with the data supplier to ensure the best outcome.

For an explanation of each item please refer to Appendix B – Satellite imagery guidance

	Issue	Suggested example to discuss with data supplier
☐	**Emergency**	Name of emergency response
☐	**Capture Date**	Required timeframe – convert UTC to NZ local time
☐	**Controller**	Controller name and contact details
☐	**Imagery Contact**	Name, email and mobile number
☐	**Purchase Order**	Purchase order number if required
☐	**Area of Interest**	Define extent of emergency imagery request
☐	**Purpose**	Visualisation or data analysis
☐	**Products**	Satellite Imagery / Radar / Derived data
☐	**Image Bands**	Optical RGB / 4 Band RGBI / Other
☐	**Ground Sampling Distance**	High, Medium or Low
☐	**Swath**	Narrow / Wide
☐	**Frequency**	Single capture / Daily / Weekly
☐	**Tasking**	Available / Not Available
☐	**Projection**	NZTM / WGS84 / UTM
☐	**Orthorectification**	Not required / required
☐	**Format**	Uncompressed GeoTIFF / compressed mosaic / TIFF
☐	**Licence**	Creative Commons Attribution 4.0 International (CC BY 4.0)

5.2 Satellite imagery products

Satellite imagery products, including commercial vendors where LINZ has an existing working relationship with New Zealand agent

Product	Image bands	Ground Sampling Distance	Swath (km)	Frequency	Tasking	Licence	Cost
Optical imagery							
Sentinel 2	13 bands	10	290	5 days	Not available	CC-BY	Free
Maxar	8 bands	0.3	9-16	24 hours	Available	Restricted	Commercial
PlanetScope	8 bands	3	25	12 hours	Not Available	Restricted	Commercial
Radar imagery							
Sentinel 1	1 band	20	250	6 days	Not available	CC-BY	Free
Capella	1 band	0.5	5	5 hours	Required	Restricted	Commercial
Derived products							
ICEYE flood extents	1 band	0.5	30	24 hours	Available	Restricted	Commercial

5.3 Free satellite imagery suppliers

There are many satellite imagery data providers for New Zealand, with the most common ones listed below including commercial vendors where LINZ has an existing working relationship with the New Zealand agent.

Freely available satellite imagery provider

Sentinel

Data supplier: European Space Agency

Website: apps.sentinel-hub.com/eo-browser (data access)
app.spectator.earth (imagery acquisition plans)

During an emergency LINZ will monitor Sentinel imagery and publish any useful imagery via LINZ Basemaps and LINZ ArcGIS Online. Updates on this information will be shared with the lead agency in regular imagery situation reports.

For more information contact emergencyintel@linz.govt.nz.

U.S. Geological Survey

Landsat

A long running satellite programme developed by NASA and managed by USGS which collects 30 metre resolution optical imagery every 8 days. earthexplorer.usgs.gov

LINZ do not currently monitor Landsat due to the low resolution of the imagery. The Australian Government recently announced it will join Landsat Next, a programme led by NASA and USGS to provide higher resolution data. This is due to be launched in 2030.

NASA

VIIRS

VIIRS or Visible Infrared Imaging Radiometer Suite can be used to help detect thermal hotspots and fire activity at 375 metre resolution over the last 7 days.

Earth Data Search search.earthdata.nasa.gov/portal/idn/search?fi=VIIRS

ArcGIS Online arcgis.com/home/item.html?id=d0670e7433f447cda1ae8e6cef627c33

5.4 Commercial satellite imagery suppliers

There are many satellite imagery data providers for New Zealand. Commercial vendors where LINZ has an existing working relationship with the New Zealand agent are listed below in alphabetical order.

Note generic contacts listed below are monitored during a response and have been confirmed as the preferred contact during a response.

Critchlow Geospatial

NZ Vendor:	Capella
Contact:	Steve Critchlow
Email:	Steve.Critchlow@Critchlow.co.nz
Mobile:	021 702 130
Generic contact:	info@critchlow.co.nz
Website:	capellaspace.com

LINZ can task Capella capture, contact Duty Officer emergency@linz.govt.nz

Critchlow also supplies Maxar, Satellogic and KOMPSAT imagery

Eagle Technology Group Ltd

NZ Vendor for:	Maxar and ICEYE
Generic contact:	emsupport@eagle.co.nz
Phone:	0800 732 453
Maxar:	maxar.com
ICEYE:	iceye.com

5.5 International Disasters Charter

The International Charter Space and Major Disasters (International Disasters Charter) brings together space agencies and space system operators from around the world to work together to provide satellite imagery for disaster monitoring purposes.

There are 17 International Disasters Charter members and 270 satellites including GEOSAT, Airbus, Copernicus, ICEYE, Maxar, Planet, Satellogic and BlackSky.

More information: disasterscharter.org

Using the International Disasters Charter in New Zealand

New Zealand became an Authorised User of the International Disasters Charter in May 2024, represented by NEMA, and supported by LINZ, NZ Defence Force and NZ Space Agency.

International Disasters Charter membership enables New Zealand agencies to identify and access imagery and data derived products during a response. To provide context of when the International Disasters Charter might be activated, here is an overview of previous activations.

In a significant event, NEMA will activate the International Disasters Charter and confirm the area of interest for tasking data capture. This ensures the opportunity to immediately capture data is not missed. LINZ will then take on the Project Manager role to coordinate requests.

Licensing restrictions still apply to commercial data and products, and costs will normally apply if the data is to be used after the response, including for recovery. Charter members may generate value added products, such as the image below.

Activating the Charter for Papua New Guinea Landslide

NEMA activated the International Disasters Charter to support the Papua New Guinea landslide in May 2024. Data sourced via the International Disasters Charter was supplied to GNS Science to model landslide movement and assess risks in the local area.

Figure 11 A derived product supplied by CNES, the French Space Agency for PNG Landslide

APPENDIX A: Aerial Imagery Guidance

An overview of the issues to consider when sourcing aerial imagery during an emergency.

Note in peacetime, LINZ works with councils and regional consortiums to publish rural and urban aerial imagery for New Zealand. Guidance for requesting aerial imagery during an emergency is based on the original, national orthophotography acquisition specification: linz.govt.nz/sites/default/files/SpecificationRelatingAcquisitionOrthophotography.doc

LINZ can help Councils and response agencies source, procure, licence, and publish aerial imagery during an emergency, based on the following information:

Emergency

☐ Name of emergency response

State the emergency name to make it clear this work is urgent and relates to a response e.g. Pigeon Valley Fire Emergency Response, or Canterbury Flood Emergency Response.

Capture Date

☐ Required timeframe

Confirm the required timeframe for data capture, for example as soon as possible in the next available weather window; at the next high tide; or immediately after air traffic control restrictions have been lifted.

Controller

☐ Controller name and contact details

Provide contact details of the person responsible for coordinating the emergency response, who will authorise the budget for the aerial imagery purchase.

Imagery Contact

☐ Name, email and mobile number

Provide contact details of the person working in the response who can provide clarification about the imagery request.

Include both generic contact details for the Intelligence Team, plus specific names, emails and phone numbers of GIS staff.

Area of Interest

☐ Define area of interest or extent of emergency

Define the extent of the emergency, or the specific area of interest (AOI) for imagery.

You will need to provide a polygon of the extent of the imagery request to the data supplier.

A large area of interest will take longer to capture.

LINZ will draft an initial area of interest for your review. This will be available via the LINZ Emergency Data Requests for Stakeholders Dashboard – link.

Figure 12 – Example area of interest for Canterbury floods May 2021

Products

- ☐ Orthorectified aerial imagery
- ☐ Low order orthorectified aerial imagery
- ☐ Unprocessed aerial imagery

In an emergency response, any combination of the above aerial imagery product options may be requested.

Orthorectified aerial imagery will generate detailed data at the highest resolution, but takes longer to capture, process, and deliver. Use this option when quality of the imagery is more important than how quickly you receive the imagery.

An example is the Pigeon Valley Fire imagery was used as a record of the February 2019 event to inform community meetings and to support insurance claims during recovery.

Low order orthorectified aerial imagery provides a draft version of the final product. Low order imagery is supplied at a lower spatial accuracy, but is quicker to process and deliver. Minimum time would be spent on colour balancing, seam line editing or ground control by the supplier. Use this option if receiving the imagery quickly and cheaply is more important than the quality.

An example is the Port Hills Fire 2017 low order imagery was quickly sourced to inform decision making.

Unprocessed aerial imagery, or raw images, will not be orthorectified or tiled, however, these photographs may provide valuable intelligence during an initial response.

Raw images may have associated location and orientation data which can be displayed in specific software such as ArcGIS Pro Image Analyst. This may be a useful source of information while the orthophotos are being processed.

Ground Sampling Distance

☐ *Example:* 0.3 metres

Ground sampling distance refers to the size of the earth's surface as represented by each pixel in an image, and therefore the amount of detail visible in the image.

To give an indication of ground sampling distance, high resolution is 0.15 metres, medium resolution is 0.5 metres and low resolution is 10 metres.

A high-resolution image will take longer to capture and process than a low-resolution image but will show more detail. The resolution of satellite imagery is usually determined by extent required, time constraints and budget availability.

Consider what features you need to be able to see in the image. A car will not be visible on a 10 metre image, but this will be sufficient to identify an approximate fire perimeter of a 500 hectare bush fire.

Based on current technology, 0.3 metres is the suggested minimum resolution as it offers a suitable compromise between time, cost and quality in an emergency.

Figure 13 – Comparison of ground sampling distance options

Horizontal Accuracy

☐ *Example:* <= +/- 2.0 metres. 90% confidence interval

The spatial accuracy of imagery is a measure of the horizontal accuracy or distance of an image from its true position. Typically, greater horizontal accuracy is required in urban areas.

Improving horizontal accuracy can be achieved by more accurately determining the true location of the camera as the image is captured; by increasing the amount of ground control; or increasing the density and quality of the Digital Terrain Model. This will usually be accompanied by an increase in cost.

Ground Sampling Distance	Horizontal Accuracy
0.1 metres	<= +/- 0.3 metres
0.2 metres	<= +/- 1.0 metres
0.3 metres	<= +/- 2.0 metres
0.4 metres	<= +/- 3.0 metres

Spatial control

☐ The supplier is responsible for providing any ground control necessary to meet the spatial accuracy specified above.

Image Bands

☐ Natural Colour (RGB - red, blue, green)

☐ Four Band Colour (RGBI - red, blue, green, near infra-red)

The addition of the infra-red band (the I in RGBI) helps highlight healthy vegetation, and the occurrence of chlorophyll.

The bands required is likely to depend on the type of emergency response.

Figure 14 – RGB image of Christchurch post 2011 earthquake showing the extent of building damage

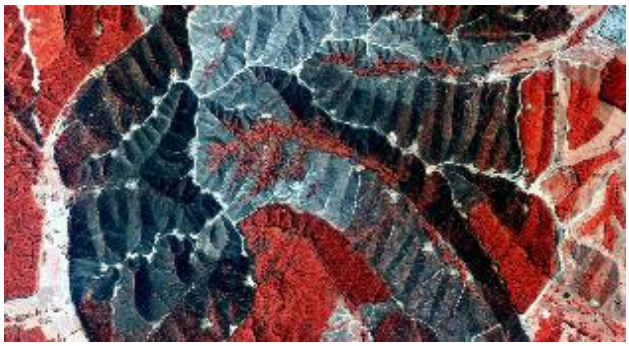

Figure 15 – RGBI image of Pigeon Valley Fire with the black area showing the extent of the fire, and the red indicating healthy vegetation and the occurrence of chlorophyll

Sun angle

☐ *Example:* The sun angle at the time of the imagery capture must be more than 30° above the horizon.

Imagery is usually captured at a time of the day to minimise shadows for example from tall buildings. This requirement may be excluded, if time is the most important factor.

Note if the emergency occurs in Winter, the ability to capture imagery at a 30° sun angle is limited.

Atmospheric effects

☐ Imagery detail and clarity must not be lost as a result of atmospheric conditions including haze, smoke, dust, and environmental factors.

This requirement may be excluded if time is the most important factor.

Cloud cover

☐ *Example:* Imagery must be 90% cloud free.

This requirement may be excluded if time is the most important factor.

Projection

☐ All imagery will be provided in New Zealand Transverse Mercator 2000 projection (NZTM2000).

Ortho rectification

☐ Orthorectification is the process of removing the effects of image perspective (tilt) and relief (terrain) effects from imagery. The process creates a constant scale with features represented in their 'true' positions.

The orthorectification statement is only required if the selected "Product" above is "orthorectified aerial imagery".

Orthorectification must ensure:

a) straight lines on the ground are straight in the image,

b) common overall scale and resolution is maintained,

c) building lean is minimised,

d) differences in contrast and brightness between images within a tile are minimised,

e) the joins between all tiles are seamless, with no gaps, overlaps, or visible join lines between adjacent images,

f) the pixels on adjacent tiles must align,

g) features at ground level are continuous across mosaic seam lines e.g. valleys, ridges, buildings, and roads etc,

h) no duplication of features occurs along seam lines, and

i) cloned features used to 'touch up' features that are obscured in images must be used with caution and kept to a minimum.

Tiling

☐ Orthorectified tiles to align with the appropriate LINZ Topo50 map sheet.

Ground Sampling Distance	Tile Index	Tile source data
0.2m – 0.3m	1:5,000	data.linz.govt.nz/layer/104691
0.1m - 0.2m	1:1,000	data.linz.govt.nz/layer/104692
<0.1m	1:500	data.linz.govt.nz/layer/106965

Each tile will be supplied complete, i.e. no partial tiles. (A 'complete tile' is the tile dimension and may not result in a complete tile of imagery).

The choice of tile index is determined by the ground sampling distance. To ensure the tile files are manageable, a higher resolution image will require a smaller tile size. This requirement may be excluded if time is the most important factor for a response.

Format

☐ GeoTIFF

- Uncompressed or LZW (lossless) compression

☐ a single compressed mosaic for the entire extent

Orthorectified and low order aerial imagery to be supplied as GeoTiffs or compressed mosaics. The GeoTiff can be uncompressed which results in a large file size or compressed using LZW.

JPEG is not recommended as this is not a lossless compression which means data may be lost.

Unprocessed aerial imagery to be supplied as a TIFF (8 bit).

Index

☐ An index of the tiles will be supplied as a shapefile, including:

Field	Data Type	Example
TILENAME	String(14)	BM13_5000_1006
MAPSHEET	String(4)	BM13
SCALE	String(4)	5000
TILE	String(4)	1006
GSDM	String(10)	0.3
ACCURACY	String(50)	+/- 2.0m at 90% confidence level.
YEAR	String(4)	2020
FLOWN	String	29/01/19,30/01/19
SUPPLIER	String	Photos from the Sky Limited
HCOORDSYS	String	NZTM2000
VDATUM	String	NZVD2016
CAMERA	String	UCE100
HTAGL	String	19000ft
PROJECT	String	Horizons 2020 Aerial Imagery

Licence

☐ All data and products to be provided with a licence that enables the purchaser to release the data to any person, group, or organisation under a Creative Commons Attribution 4.0 International (CC BY 4.0) licence with attribution to the purchaser in line with the New Zealand Government Open Access Licensing framework (NZGOAL).

APPENDIX B: Satellite Imagery guidance

An overview of the options to consider when sourcing satellite imagery during an emergency.

LINZ can help Councils and response agencies source, procure, licence, and publish satellite imagery during an emergency, based on the following information:

Emergency

☐ Name of emergency response

State the emergency name to make it clear this work is urgent and relates to a response e.g. Pigeon Valley Fire Emergency Response, or Canterbury Flood Emergency Response.

Capture Date

☐ Required timeframe

Confirm the required timeframe for data capture, for example as soon as possible; the time of the peak flood or next high tide.

The timing of satellite imagery capture is dictated by the satellite flight path.

Commercial satellites may allow capture over the area of interest. This is called tasking and requires at least six hours notice for the instruction to be relayed to the satellite.

Satellite imagery dates and times are often reported in Coordinated Universal Time (UTC). New Zealand Standard Time (NZST) time zone offset is 12 hours.

LINZ have developed an app to convert from UTC to NZST, which takes account of daylight saving.

linz.github.io/emergency-management-tools/machine-readable-to-human-readable-date-time

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Controller

☐ Controller name and contact details

Provide contact details of the person responsible for coordinating the emergency response, who will authorise the budget for the satellite imagery purchase.

Imagery Contact

☐ Name, email and mobile number

Provide contact details of the person working in the response who can provide clarification about the imagery request.

Include both generic contact details, for example the email for the Intelligence Team, (intel@cdsouthland.nz), plus specific names, emails and phone numbers of relevant GIS staff.

Area of Interest

☐ Define area of interest or extent of emergency

Define the extent of the emergency, or the specific area of interest (AOI) for imagery.

You will need to provide a polygon of the extent of the imagery request to the data supplier.

A large area of interest may take longer to capture, depending on the width or swath of the satellite – see swath below.

There may be a minimum order, for example 100 sq km.

LINZ will draft an initial area of interest for your review. This will be available via the LINZ Emergency Data Requests for Stakeholders Dashboard – link.

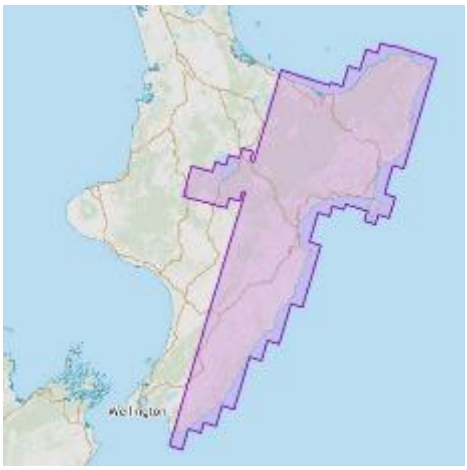


Figure 16 – Area of interest for Cyclone Gabrielle February 2023.

Purpose

☐ Visualisation

☐ Data analysis

Visualisation requires only optical imagery and three image bands, but to analyse the imagery additional bands are required, see image bands section below.

Commercial products may quote ground sampling distance at a pan sharpened resolution. The process of pan sharpening, which merges a high-resolution panchromatic image with a lower resolution multispectral image, can create distortion and may not be suitable for data analysis.

Products

☐ Optical Imagery

☐ Radar Imagery

☐ Derived Data

In an emergency response, any combination of the satellite imagery product options may be requested.

Optical imagery is similar to aerial imagery, but usually a lower resolution. Free optical imagery available from the European Space Agency is 10 metre resolution. Commercial optical imagery will be higher resolution and can be tasked to cover the area of interest but comes at a cost and often only with a restricted license, which does not allow data sharing.

It is important to note the area of interest will not be visible if the satellite pass is at night and may be obscured by cloud, particularly during a flood event.

Radar imagery or Synthetic-Aperture Radar, is another form of satellite imagery, which records surface characteristics including structures and moisture.

The output is a greyscale image which may not be easy to use, however analysis can extract valuable information such as approximate flood extents or fire perimeter. The main advantage of radar imagery over optical imagery is data capture can occur even if there is cloud cover, smoke haze or during the night.

Note LINZ refers to radar during an emergency to avoid any confusion with SAR being interpreted as Search and Rescue.

Derived data can be extracted from both the satellite imagery and the radar such as approximate flood extents or fire perimeter**.**

An example of a derived dataset is the ICEYE product which supplied flood extents during the Auckland Flood and Cyclone Gabrielle.

Image Bands

- ☐ Red – Green – Blue (RGB)
- ☐ Red – Green – Blue – Infrared (RGBI)
- ☐ Short wave infrared (SWIR)

An image band, or spectral band, refers to the range of electromagnetic wavelengths being measured and may be in both the visible and invisible spectrum. The number of bands captured varies between satellite imagery providers.

An optical image made up of three bands Red, Green and Blue, which are true colour which can be observed naturally by the human eye. This optical image looks similar to an aerial photo.

Additional bands, including near infrared and short wave infrared enable data analysis. Combining bands from the visible and invisible spectrum helps identify features which are otherwise undetected. For example, near infrared bands can help identify healthy vegetation to help define the extent of a fire, drought, or flood.

Radar data has a single band which return different values depending on the surface type. For example water returns a different value to vegetation using radar, which enables the possible identification of approximate flood extents.

Ground Sampling Distance

- ☐ *Example:* 10 meters

Ground sampling distance refers to the size of the earth's surface as represented by each pixel in an image, and therefore the amount of detail visible in the image.

To give an indication of ground sampling distance, high resolution is 0.15 metres, medium resolution is 5 metres and low resolution is 10 metres.

A high-resolution image will take longer to capture and process than a low resolution image, but will show more detail. The resolution of satellite imagery is usually determined by extent required, time constraints and budget availability.

Consider what features you need to be able to see in the image. A car will not be visible on a 10 metre image, but this will be sufficient to identify an approximate fire perimeter of a 500 hectare bush fire.

Swath

☐ Wide

☐ Narrow

The swath is the width of data capture and will determine the spatial resolution and time taken to capture the image.

High resolution satellite imagery will be captured using a narrow swath which may take some time to cover the area of interest. A wide swath will quickly capture a large area but at a lower resolution.

Aa an example a narrow swath is 15 kilometres, and a wide swath is 200 kilometres.

Frequency

☐ High

☐ Low

The frequency or revisit time is the number of days between each satellite pass. A high frequency will give a better chance of being able to capture imagery over a period of time.

A high frequency is daily, and a low frequency is weekly.

Tasking

Commercial satellite vendors offer the ability to task or focus the satellite on a specific area of interest.

Note tasking instructions must be issued at least six hours before time for capture to enable the satellite to receive the instructions.

Projection	☐ *Example:* WGS84 Confirm the projection the satellite and radar imagery in which the imagery will be provided. This is likely to be WGS84.
Orthorectification	Note that Sentinel-1 radar imagery will need to be terrain corrected, other satellites should come terrain corrected.
Format	☐ Uncompressed GeoTIFF or TIFF with TFW file Note a GeoTIFF can be viewed in ArcGIS Pro. Further processing is required to view the imagery in ArcGIS Online.
Licence	☐ Example: Creative Commons CC-BY The licence defines any data limitations, including the ability to share data, generated derived products from data analysis and costs. Refer to Appendix C for a list of organisations who are likely be eligible to share data under a restricted access all of government licence.

APPENDIX C: All of Government Restricted Licence

If data is not available under a Creative Commons CC-BY licence, data may be purchased with a licence which restricts access to all of government agencies. As an example, the agencies licenced to access ICEYE data generated during Cyclone Gabrielle included:

- Local Government organisations identified by Local Government NZ
  lgnz.co.nz/local-government-in-nz/councils-in-aotearoa/council-websites-and-maps
- Central Government organisations identify by Te Kawa Mataaho
  publicservice.govt.nz/system/central-government-organisations
    - Public Service departments, departmental agencies and interdepartmental executive boards
    - Non-Public Service departments
    - Crown entities, including CRIs
    - Independent Statutory Entities
    - Public Finance Act 1989 Schedule 4 Organisations
    - Public Finance Act 1989 Schedule 4A Companies
    - Reserve Bank of New Zealand
    - Officers of Parliament
    - KiwiRail
    - NZ Post

    Excluding

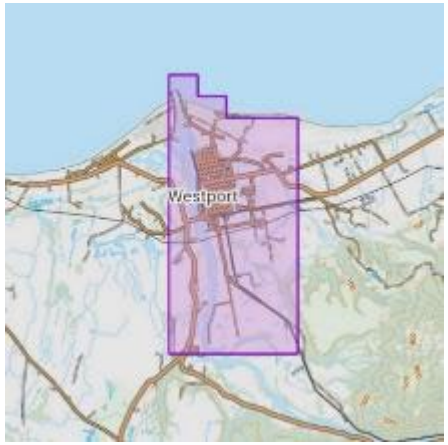
    - Other State-Owned Enterprises except for KiwiRail and NZ Post
- Mixed Ownership Model Companies

APPENDIX D: Extents of data cost examples

(Refer to Section 3.2 for costs)

A - Pigeon Valley Fire

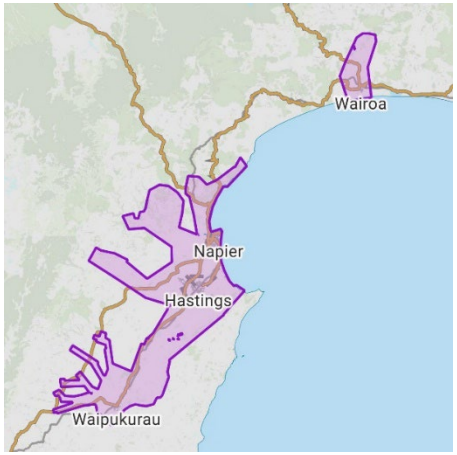
B - West Coast Flood



C - Canterbury Flood

D - Kaikōura Earthquake

E - Cyclone Gabrielle



J - Cyclone Gabrielle