

## Data Sources

### Imagery

Given the wide range of publicly available satellite imagery nowadays, there is a huge resource available. In the instance of the Inquiry however, obtaining the highest resolution imagery for specific date ranges was the driver.

In orbit during the specified date range and returning imagery of 0.5m GSD (Ground Sample Distance or Resolution) or better were three commercial satellites;

- WorldView01 – launched 18<sup>th</sup> September 2007
- WorldView02 – launched 8<sup>th</sup> October 2009
- GeoEye01 – 6<sup>th</sup> September 2008

Though all of these satellites are now under the operational control of Digital Globe, initially GeoEye 01 was launched and operated by GeoEye Ltd. GeoEye and Digital Globe merged in January 2013.

Approximate AOI's (Areas of Interest) for the areas under query were created in Google Earth and exported out as KMZ files. These KMZ AOI's were then utilised within the Digital Globe imagery portal to search for suitable images for the Inquiry.

Access to the Digital Globe catalogue was provided through their web portal - <https://discover.digitalglobe.com/>

Suitable imagery was identified as below;

	Date of capture	Image ID	Satellite	Radiometry	GSD (m)	Sun angle	Off Nadir	Comments
<b>Turmush</b>	1 November 2011	105041000364FF00	GE01	4 Band Colour	0.46	38	20	No snow, no cloud or shadow
	11 December 2010	10200100107BDB00	WV01	Panchromatic	0.5	31	3.3	No snow, no cloud or shadow
<b>Tirgiran</b>	26 December 2011	103001001085D700	WV02	8 Band Colour	0.51	31	19.3	Light snow, no cloud or shadow
	11 November 2010	1020010011BE6300	WV01	Panchromatic	0.55	37	19.3	No snow, no cloud or shadow
	25 April 2010	102001000C3A1E00	WV01	Panchromatic	0.51	65	10.5	No snow, some cloud and shadow
<b>Karimak</b>	26 December 2011	103001001085D700	WV02	8 Band Colour	0.51	31	19.3	No snow, no cloud or shadow but some topographical shadow from the low sun angle.
	21 September 2010	102001000F15FD00	WV01	Panchromatic	0.55	54	19	No snow, no cloud or shadow

Headings for the above table refer to;

- Date of Capture is the actual date that the image was created
- Image ID is the Digital Globe catalogue number for the actual image
- Satellite refers to the satellite capturing the image – WV01 = WorldView01, WV02 = WorldView02 and GE01 = GeoEye01
- Radiometry refers to the make up of the imagery. Panchromatic is effectively Black & White imagery sometimes referred to grayscale. 4 Band imagery refers to RGBi (Red, Green, Blue, Infrared) bands of the spectrum, 8 Band refers to a multispectral image that has divided the visible and invisible spectrum from 400nm to 1040nm (near Blue to Infrared) into 8 bands of data. For the purposes of the Inquiry, only Panchromatic or RGB imagery was utilised.
- GSD (Ground Sample Distance) refers to the size of the pixel of imagery in terms of the coverage of the pixel on the ground. Effectively, if you were able to take the pixel off the screen and lay it on the ground, how much would it cover.

- Sun Angle refers to the angle of elevation of the sun above the horizon. The lower the sun angle is, the longer the shadows are cast from an object on the ground or indeed topographical features like hills, therefore a higher sun angle is better as shadows do not obstruct viewing of objects on the ground.
- Off Nadir refers to the angle of view that the satellite is taking of the ground. Nadir refers to a perfectly vertical perspective, perpendicular to the ground below.
- Comments are added to indicate what the suitability of the imagery is to the Inquiry.

Imagery was ordered through Eagle Technology Ltd, the New Zealand agent for Digital Globe. Upon order, a download link was provided to the Inquiry to source the images ordered directly from Digital Globe.

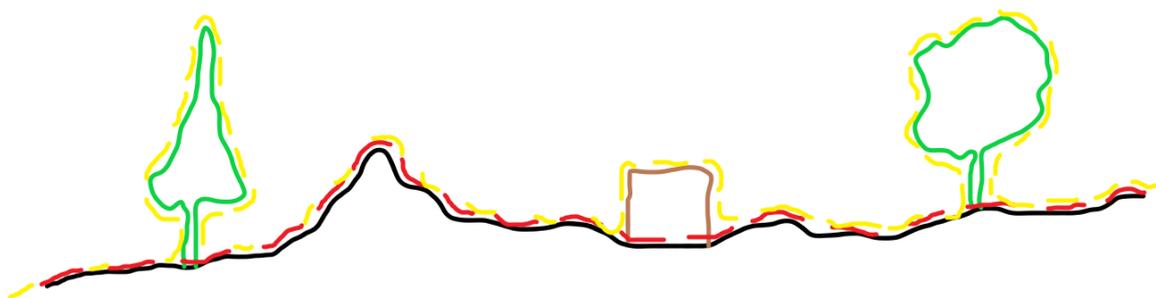
Images were ordered and delivered in GeoTIFF format. TIFF (Tagged Image File Format) is the usual format for high resolution imagery presentation. The Geo tagging of the image is added as a “header” within the image and supplies the geolocation or georeferenced of the image to GIS software.

The georeferencing data was ordered to be in terms of UTM zone 42 North on WGS84 (World Geodetic System 1984) datum.

## DEM

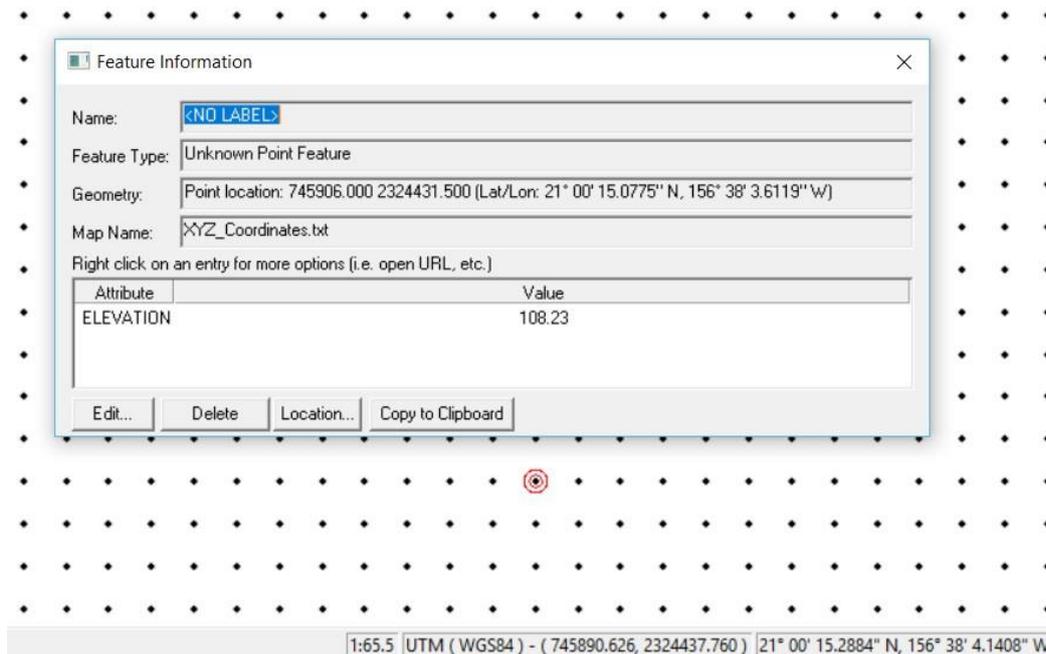
A DEM (Digital Elevation Model) is a digital representation of the topographical lie of the land derived from an original data source (DSM, DTM). It is a “raster” file which means that it is made up of a series of pixels, much like a photograph, that has a “Z” value attributed to it. The “Z” values represents the height of the ground within the pixel.

Black line = Ground  
 Red line = DTM (Digital Terrain Model)  
 Yellow line = DSM (Digital Surface Model)

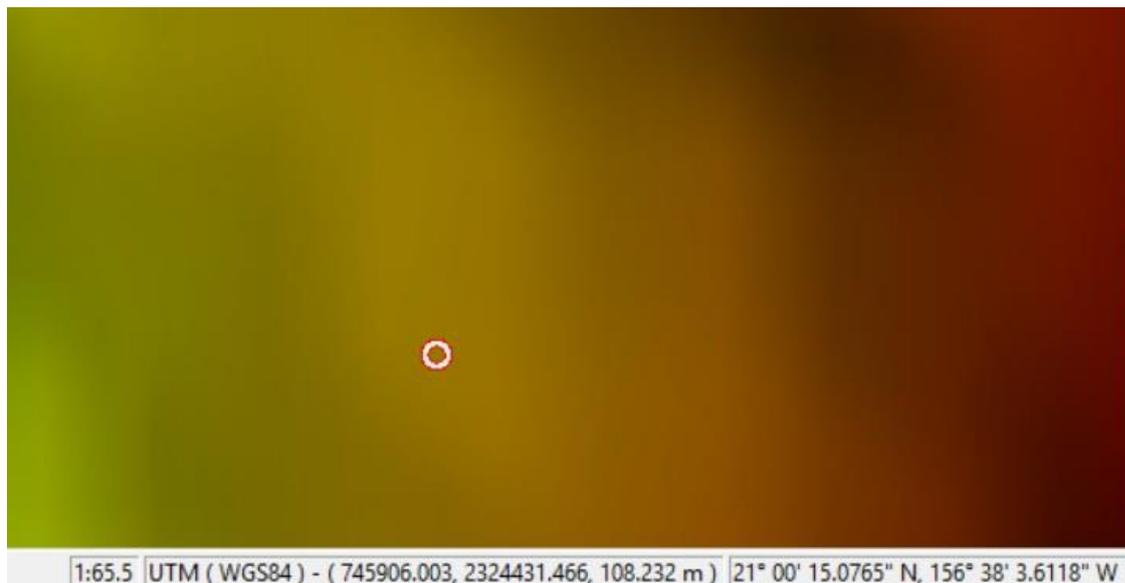


Whereas DTM and DSM data is general represented as a “vector” file, a DEM is generally represented as a “raster” file.

In explanation, a vector file can be represented by a matrix of spot heights on the ground and/or a series of 3D lines. A matrix of data is shown below;



The DEM however, has the heights of the ground expressed as an attribute against a pixel of an image as shown below;



In both these depictions, the same point is shown and has the same position and height value. It is simply the file format and method of display which is different.

The DEM data utilised for the Inquiry is a SRTM (Shuttle Radar Topography Mission) derived data set captured by NASA from the Space Shuttle Endeavour and was the most commonly used terrain data set at the time of the alleged raids.

The Shuttle Radar Topography Mission (SRTM) was an international effort that created an almost global data set, missing only the polar regions. Since its capture, many other data sets have been created and have supplanted the accuracy and resolution of the SRTM data set.

As is the nature of this data set, it is available from a broad range of geoportals all over the world and is probably still one of the most widely used, publicly available source of terrain data.