Country Use Case of EO Use for SDG Indicator	
SDG Indicator/Sub-indicator	15.1.1. Forest area as a proportion of total land area 15.4.2 Mountain Green Cover Index
Country or region	New Zealand
Status (please check)	I believe that local EO data is being used in official SDG Indicator reporting of 15.1.1 I am unsure whether local EO data or FAO data was used for !5.4.2. (Data provided by FAO was validated against local data (LUCAS Land Use Map) in January 2018). Perhaps it would be better to say that we are at the verification stage for this one.
Earth Observation Data Used and its links	Sentinel-2 data
Additional/ Other Data Used and its links	Sentinel-2 data forms the basis for 2 national land use maps: 1) Land Cover database (used for 15.1.1) https://lris.scinfo.org.nz/layer/48423-lcdb-v41-land-cover-database-version-41-mainland-new-zealand/ 2) LUCAS Land Use Map, developed for international greenhouse gas reporting (possibly used for 15.4.2) https://data.mfe.govt.nz/layer/52375-lucas-nz-land-use-map-1990-2008-2012-2016-v006/
Description of data access, processing, and analysis, including methodology that was developed, associated tools or applications, and how these are applied to compute SDG Indicator	Sentinel-2 imagery is collected over New Zealand through the summer months (October to March). Individual S-2 images are converted to surface reflectance by atmospheric and BRDF correction methods (Dymond and Shepherd 2004; Newsome et al., 2013) and from this data a cloud minimised national mosaic is created. This uses automated cloud clearing methods developed at a national research institute – Manaaki Whenua – Landcare Research (paper in preparation for publication). (Thumbnail representations of thee mosaics can be viewed here.) The national mosaic is compared to the national mosaic used to make the previous map in the time series and a spectral differencing approach is used to detect areas of change. These areas of change are mapped into the previous map to create a new map. For each of the above mapping programmes, this process is carried out once every 4-5 years on average. Initial maps in the time series were created based on 2001 Landsat 7 data using automated classification techniques and significant manual editing. Areas of forest are then derived from the land cover map.
Work flow	*Please show the work flow using a process flow diagram.*

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<tr>
<td>Lessons learned, any gaps, key issues and recommendations</td>
<td>Lessons in relation to using EO data to monitor change in forest extent in New Zealand:
1) Resolution (spectral and spatial) needs to be fit for purpose and match granularity of land use activity in a country.
a. 10m resolution is ideal for our purposes: coarser (MODIS, DMC) and we miss change occurring at farm scale; finer and we have unnecessary processing and storage overhead.
b. New Zealand needs a short-wave infrared band to map forest types accurately. SPOT-5 worked well for us but not SPOT-6 for this reason.

2) Accurate automatic cloud clearing is now essential with the significant volumes of free imagery available.

In the past we manually cloud-cleared expensive commercial imagery (which had been purchased with <10% cloud cover). This is now not a realistic approach.

Out-of-the-box algorithms and cloud masks supplied with imagery are not good enough for our purposes. We have developed improved methods to detect clouds and cloud shadows to eliminate them from our national mosaics, making it possible to detect actual change (particularly forest loss) between imaging dates without having the detection confounded by cloud contamination.

3) Terrain effects matter.

In a country like New Zealand with steep terrain, hill shadows can confound change detection and classification algorithms. Imagery should be spectrally “flattened” before processing.

4) Temporary forest loss needs to be identified though field checking.

In New Zealand, plantation forest is clear-felled and generally subsequently replanted. A small fraction of this forest will be deforested and therefore change land cover and use permanently.

It is not possibly to determine whether deforestation has occurred from 10m resolution satellite imagery alone (except by waiting 4-5 years until replanting is evident), so field checking is required to identify areas of deforestation (permanent forest loss).

Key issues:

1) The practice of clear-felling and replanting plantation forest in New Zealand means that global earth observation monitoring programmes often report forest losses in New Zealand, which are substantially greater than actual figures mapped by New Zealand because harvesting activity is detected.

2) The continuous availability of S-2 data is creating both challenges and opportunities for New Zealand – challenges in terms of processing, storage and access; and opportunities in terms of using time series analysis to map forest types more accurately.</td>
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	3) The change mapping approach used minimises the risk of artefacts being mapped as actual change but it also means that unchanged areas potentially inherit the misclassifications of the past, which were based on imagery from older sensors with lower resolution. We need to consider options for a complete remapping to take advantage of the improved resolution of imagery currently available and the potential of new spectral bands such as red-edge bands. If such a remapping is undertaken, we will need a method to back cast improvements through the time series of maps to ensure accuracy of trends in land cover change is maintained.
Supporting material about this use case. Include links, publications, etc.	Dymond, J.R., Shepherd, J.D., 2004. The spatial distribution of indigenous forest and its composition in the Wellington region, New Zealand, from ETM+ satellite imagery. Remote Sensing of Environment, 90, 116–125 Dymond, J.R., Shepherd, J.D., & Qi, J., 2001. A simple physical model of vegetation reflectance for standardising optical satellite imagery. Remote Sensing of the Environment, 77, 230–239. Shepherd, J.D., & Dymond, J.R., 2003. Correcting satellite imagery for the variance of reflectance and illumination with topography. International Journal of Remote Sensing, 24, 3503– 3514.
Name(s) and email address of individual(s) involved in this effort. Please note the principal point(s) of contact (POCs).	Deborah Burgess, New Zealand Ministry for the Environment, Deborah.burgess@mfe.govt.nz (POC)