The Future of Earth Observation – how innovations in technology are driving exploitation of Earth Observation for Sustainable Development: the example of IPP CommonSensing project

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Abstract. *The Sustainable Development Agenda aims to be relevant to all countries and leave no one behind. It has been widely recognised that Earth Observation (EO) and Geospatial technology are fundamental to supporting the successful delivery of the UN Sustainable Development Goals (Anderson et al., 2017). However, the need to recognise the best way to exploit the vast amounts of EO data now available is critical to ensure that solutions developed are fit for purpose for the needs of the end user. As such, it is necessary to understand the benefits and limitations of EO data and associated tools and ensure that the International Development community gain access to data and products that are appropriate for their requirements.*

CommonSensing is an innovative international project based on a partnership between Fiji, Vanuatu, the Solomon Islands and a consortium of international partners working together to improve food security, and climate and disaster risk resilience, using satellite remote sensing technology and contribute to sustainable development in these three selected Small Island Developing States (SIDS). By developing satellite-based information service that directly match challenges and needs, the project will support the three nations in their goals to (a) strengthen capacity on climate funds, (b) strengthen national and regional climate action policy and (c) reduce the impact and improve risk management of natural disasters and food security.

Scope and Purpose

A fundamental component of the proposed CommonSensing platform will be its ability to handle remotely sensed satellite imagery at scale. To address these challenges presented by EO Big Data it will be necessary to move away from traditional local processing (e.g. desktop computer) and data distribution methods (e.g. scene-based file download) and lower the barriers caused by data size and related complexities in data preparation, handling, storage and analysis. An approach that is receiving increasing attention internationally to address this is the concept of Open Data Cubes (ODC). The ODC provides a new solution to store, organise, manage and analyse EO data in a way that was not possible before. Data Cubes aim to realise the full potential of EO data repositories by addressing volume, velocity and variety challenges by providing access to large spatiotemporal data in an analysis ready form (Analysis Ready Data – ARD).

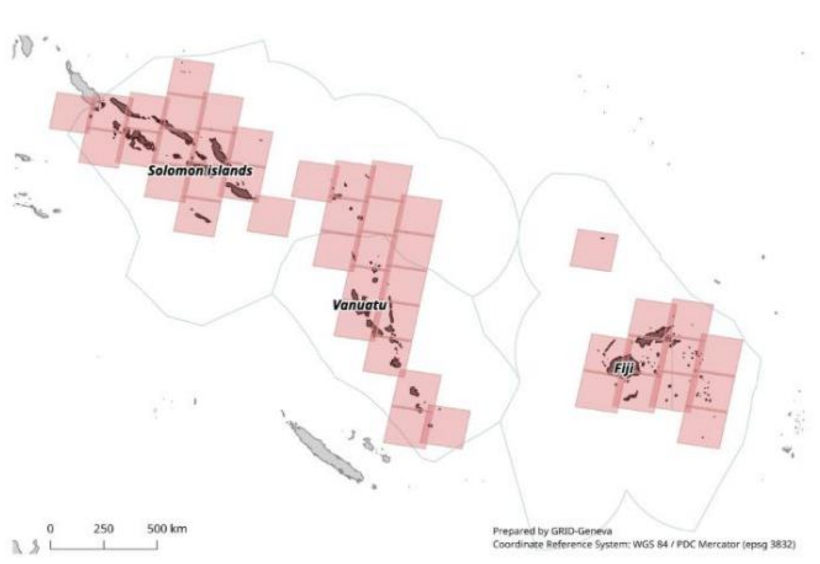
The EO data cubes will aim to accommodate the distribution and consumption of the Sentinel-1, Sentinel-2, Landsat 5/7/8 and SPOT datasets (table below) for the three partner countries.

Name of Sensor	Operator	Temporal Extent	Nominal Spatial Resolution	Nominal Revisit	Licensing
Optical					
Landsat-5	NASA/ USGS	1984-2013	60 m	16 days	Freely available – no license restrictions
Landsat-7		1999-ongoing	30 m		
Landsat-8		2013-ongoing			
Sentinel-2	ESA	2015-ongoing	10 m	5 days	
SPOT-5	CNES	2002-2015	2.5 m	2 days	Subject to costing
Synthetic Aperture Radar (SAR)					
Sentinel-1	ESA	2014-ongoing	5 x 20 m	6 days (12 days – SIDS)	Freely available – no license restrictions

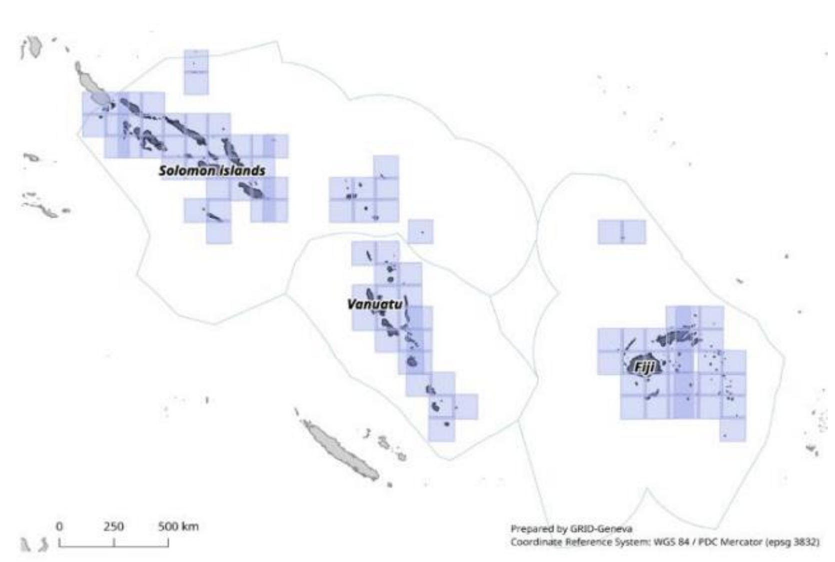
Earth Observation Acquisitions for SIDS

The CommonSensing project will implement and deploy ODC Infrastructure incorporating ARD from various EO satellite missions. These will include the provision of Sentinel-1, Sentinel-2, Landsat-8, Landsat-7, Landsat-5, SPOT 1-5 archive images. The diversity of datasets will facilitate time-series analysis for earth system processes for each SIDS.

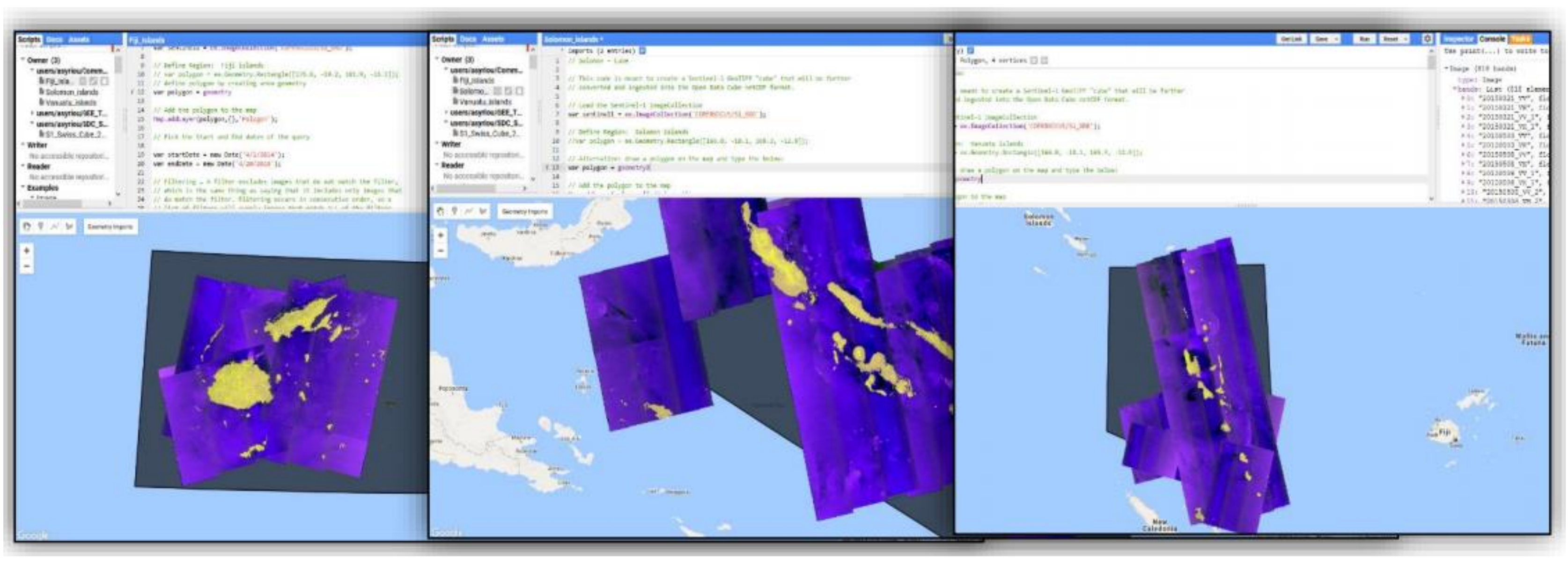
Figures below outline the spatial distribution of available data from these missions (excluding SPOT-5 – current spatial/temporal extent of data is not presently available).



CommonSensing countries with their Landsat-8 tiles



CommonSensing countries with their Sentinel-2 tiles

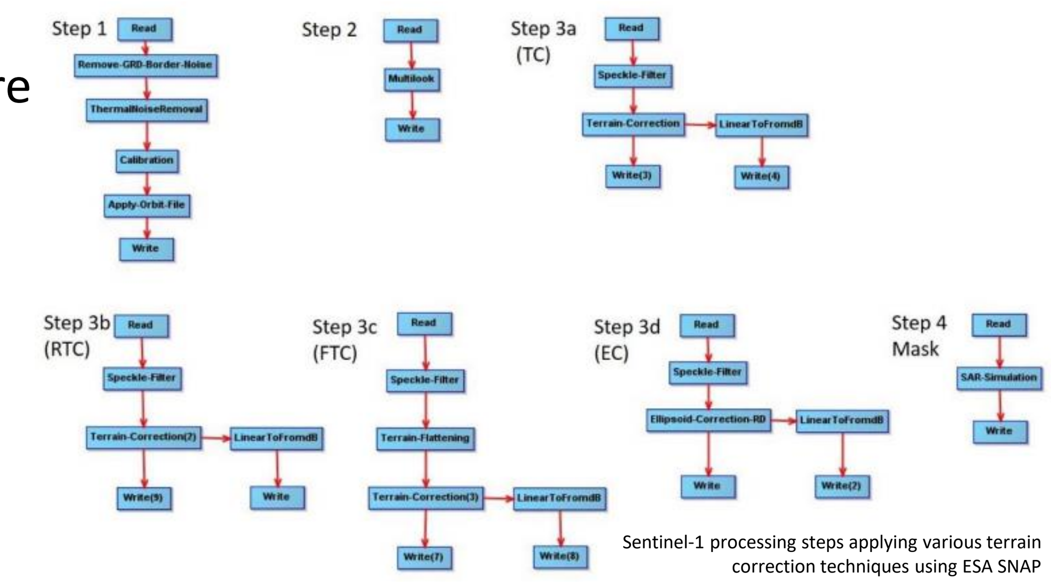


Sentinel-1 data availability over the islands, using GEE

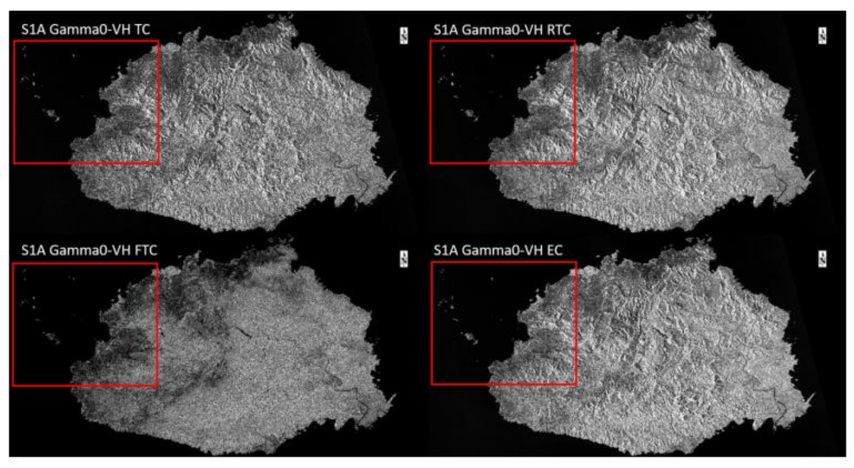
Preliminary assessment of Terrain Correction techniques for Sentinel-1 ARD

For this high-level appraisal, four terrain correction algorithms were implemented for investigation, using the ESA's SNAP toolbox:

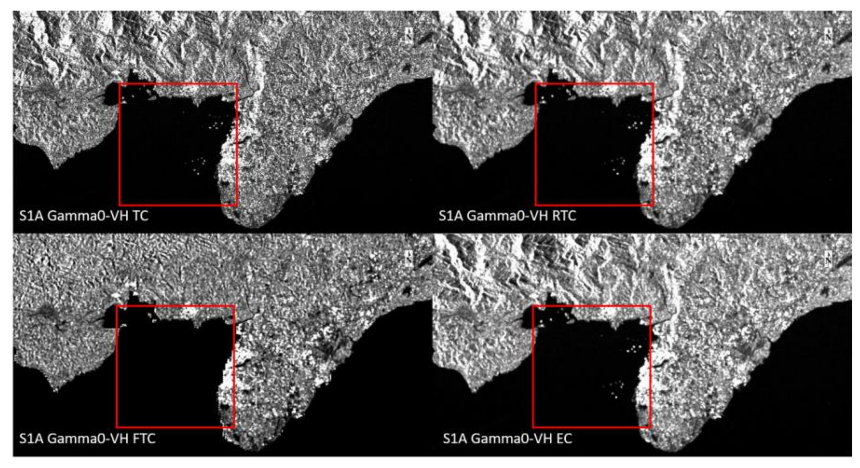
1. Terrain Correction
2. Radiometrically Normalised Terrain Correction
3. Filtered Terrain Correction
4. Ellipsoid Correction



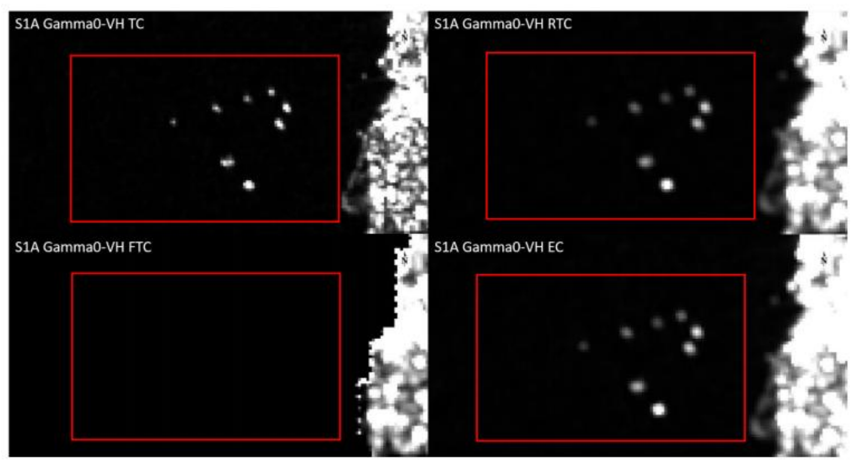
Sentinel-1 processing steps applying various terrain correction techniques using ESA SNAP



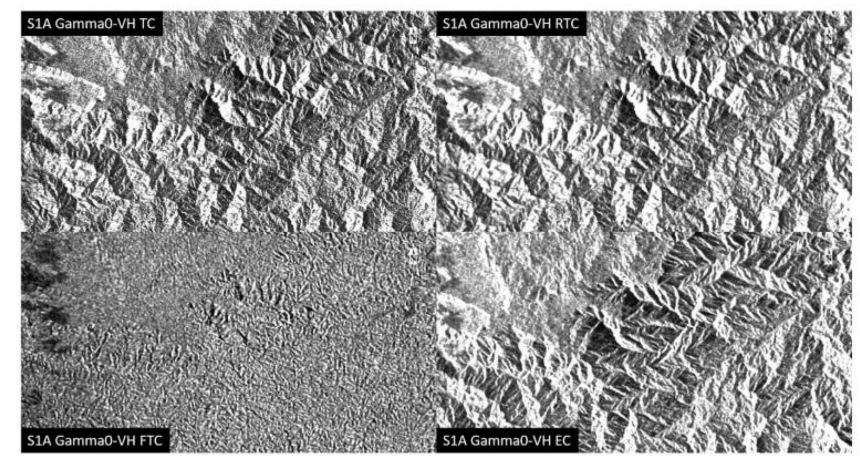
Sentinel-1A (17.09.2017) Gamma0-VH Terrain Correction Comparison



Sentinel-1A (17.09.2017) Gamma0-VH Terrain Correction Comparison – Urban area 'Suva' example



Sentinel-1A (17.09.2017) Gamma0-VH Terrain Correction Comparison – Islands example



Sentinel-1A (17.09.2017) Gamma0-VH Terrain Correction Comparison - Mountain area example

Conclusions

Data Cubes are currently transforming the way users interact with EO data by routinely translating EO information into useful and actionable knowledge for various users. The generation of ARD products minimizes the time and scientific knowledge required to access, prepare and exploit satellite data by having consistent and spatially aligned calibrated surface reflectance and backscatter observations for optical and SAR datasets, respectively.

In this preliminary study, a qualitative assessment has been undertaken for the range of Terrain Correction algorithms using open source ESA's SNAP software. The area of interest is the main island in Fiji. The statistical evaluation will be undertaken in Phase 2, together with the evaluation of the ARD algorithms for the optical datasets in coordination with UNEP/GRID.

Strengths of the Open Data Cube include:

- Free and open source solution
- Minimizes the time and capacity required to obtain and prepare satellite data
- Capability to process, interrogate and present EO satellite data in response to environmental issues
- Exploitation of multiple datasets (Landsat, Sentinel, etc.)
- The ability to own data and store it locally, critical consideration in regions with limited internet access

Limitations:

- The ODC core does not distribute power (CPU and memory) consumption to multiple nodes off-the-shelf (horizontal scaling). Adding more power (CPU and memory) to an existing machine is the simplest way to add scale (vertical scaling)
- Phase 2 of CommonSensing will investigate the most appropriate ARD algorithms and provide recommendations as to how to implement the CommonSensing platform