EO–SAR Change Detection – Analytical Report

1. Overview

This report summarizes the Python implementation of the EO–SAR change detection workflow using Google Earth Engine (GEE) and Geemap. The workflow combines Sentinel-1 SAR and Sentinel-2 optical datasets to analyze multi-temporal land surface dynamics between the years 2018 and 2024. The Python version provides a flexible, locally executable alternative to the Earth Engine Code Editor version, enabling deeper customization and export functionality.

2. Area of Interest (AOI)

The area of interest (AOI) is defined using a pre-uploaded Earth Engine asset ('projects/lala-285fb/assets/blr_dst') representing the spatial boundary of Bengaluru district.

3. Dataset and Temporal Range

The workflow analyzes Sentinel-2 Surface Reflectance (SR) and Sentinel-1 Ground Range Detected (GRD) data for two distinct temporal windows: the pre-change period (2018) and the post-change period (2024). The selected duration captures long-term land cover and land use transitions across a six-year gap.

4. Sentinel-2 Optical Processing

Sentinel-2 images are filtered to include scenes with less than 20% cloud cover and are processed using a scene classification (SCL) mask to remove cloud, shadow, and cirrus contamination. The images are normalized by dividing reflectance values by 10,000 to standardize digital number scaling. Pre- and post-change median composites are generated and clipped to the AOI boundary.

5. Spectral Indices Computation

Three spectral indices are derived from Sentinel-2 composites to assess different surface conditions:

- NDVI – Normalized Difference Vegetation Index: (B8 - B4) / (B8 + B4)
- NDBI – Normalized Difference Built-up Index: (B11 - B8) / (B11 + B8)
- NDWI – Normalized Difference Water Index: (B3 - B8) / (B3 + B8)

These indices collectively highlight vegetation health, urban growth, and water body dynamics, respectively.

6. Sentinel-1 SAR Processing

Sentinel-1 GRD images in Interferometric Wide (IW) mode are filtered for both VV and VH polarizations, descending orbits, and 10-meter resolution. Pre- and post-event median

composites are created for backscatter analysis. SAR data complements optical data by providing surface roughness and moisture information, unaffected by cloud cover.

9. Confidence Layer Development

Confidence layers are computed as the absolute difference values of each respective index change (|ΔNDVI|, |ΔNDBI|, |ΔNDWI|). These layers indicate the degree of change magnitude for each thematic category—vegetation, urban, and water—helping prioritize high-confidence zones during interpretation.

10. Export and Output Generation

All processed layers—including Sentinel-1 and Sentinel-2 composites, thematic maps, and confidence layers—are exported to the specified local directory as GeoTIFF files. This ensures compatibility with GIS software such as QGIS and ArcGIS for post-processing and further spatial analysis.

11. Summary of Workflow Capabilities

The implemented workflow provides a robust, replicable framework for large-scale change detection using EO–SAR integration. Key advantages include:

- Automated preprocessing of optical and radar datasets
- Multi-index evaluation for vegetation, urban, and water changes
- Thematic and confidence-based visualization for interpretation
- Batch export of results for advanced GIS analytics

This approach is scalable for regional or national assessments, suitable for urban expansion studies, wetland monitoring, and long-term land use analysis.