## ****Literature Review****

This section summarizes existing research and tools for land classification.

### ****Sentinel-2 & Remote Sensing****

* Sentinel-2 is a **multispectral imaging mission** with high-resolution bands designed for **land monitoring, vegetation assessment, and environmental studies**.
* The satellite provides images in **13 spectral bands**, which help in distinguishing land cover types.

### ****Deep Learning for Land Classification****

* **Traditional methods**: Classical Machine Learning models like Random Forest, SVM, and K-Means clustering have been used.
* **Deep Learning**: CNNs, U-Net, and transformer-based models outperform traditional approaches by extracting high-level spatial and spectral features.

### ****Multi-Spectral Analysis & NDPI****

* **NDPI (Normalized Difference Plant Index)** is crucial for vegetation classification: NDPI=NIR−RedNIR+RedNDPI = \frac{NIR - Red}{NIR + Red}NDPI=NIR+RedNIR−Red​ where **NIR** (Near-Infrared) and **Red** bands help differentiate healthy vegetation from non-vegetated areas.
* **Multi-Spectral Processing**: Different spectral bands provide **unique insights into land surfaces**:
  + **Red & NIR**: Vegetation health
  + **SWIR (Short-Wave Infrared)**: Soil and moisture levels
  + **Coastal & Blue Bands**: Water bodies

### ****Geospatial Tools for Land Classification****

* **GDAL**: Handles raster and vector geospatial data, critical for reading Sentinel-2 images.
* **Folium**: Enables interactive visualization of classification results.
* **GeoPandas**: Processes vector-based geospatial data, such as land boundaries.
* **Rasterio**: Reads and manipulates GeoTIFF satellite images.
* **Fiona**: Reads vector data formats (Shapefiles, GeoJSON).

### ****Gaps in Research & Proposed Solutions****

| **Existing Challenge** | **Proposed Improvement** |
| --- | --- |
| Low accuracy in land classification using traditional methods | Use deep learning models like U-Net with multispectral processing |
| Difficulty in handling large geospatial datasets | Use cloud-based processing tools (Google Earth Engine, AWS) |
| Lack of interactive visualization in existing studies | Implement interactive mapping with Folium |