Estimation of Change in LU/LC Mapping with Classification of Digital Signature using AI/ML Techniques over Google Earth Engine

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Abstract:

In recent years, the data science and remote sensing communities have started to align due to user-friendly programming tools, access to high-end consumer computing power, and the availability of free satellite data. In particular, publicly available data from the European Space Agency's "Sentinel" and American Earth observation satellite" landsat" missions have been used in various remote sensing applications. Google Earth Engine (GEE) is such a tool that publicly allows the use of these available datasets, there is a large amount of available data in GEE, which is being used for computing and analyzing purposes. Land use land cover change (LULC) modeling is an important approach to evaluating global biodiversity loss and is the topic of a wide range of research. Remote sensing data are primary sources, extensively used for change detection in recent decades. We have divided our approach into two parts first we compare and find the relevance of available data sets over different land cover areas like (Dehradun, Lucknow, Kochi, and Sikkim), the reason behind choosing these different land cover areas is its different atmospheric, climate and soil condition. After analysis, we find that in regions having dense forest areas and low urban areas, Sentinel data sets perform better, and in another region, landsat data have better output. For finding significance in data sets we have tested its accuracy over different machine learning classification algorithms like CART, Random Forest, Gradient Tree Boost, and Support Vector machine. Here we find a classification algorithm that has an ensemble approach of classification performs better over both data sets. Accuracy is calculated by the confusion matrix and kappa coefficient. After finding the result from our first part which is a calculation of land cover changes over different study area we find forest land are degraded in most of the areas. So in the later part, we calculated different vegetation indices over study areas like Normalize Difference Vegetation Index, Enhanced Vegetation Index, Normalize Difference Water Index, Normalize Difference Built Index, Soil Adjusted Vegetation Index, Normalize Burn Rate, and advanced version of this vegetation index. These vegetation indices are the ratio of the available bands in data sets with some mathematical function. These indices also change with the change in land cover class, later we developed a graphical user interface that calculates mean and standard deviation values over the selected study area. We have added a number of indices and calculated changes in these indices over

Research Problem:

Many attempts have been made during the last decade to compute the change in land cover classes, especially in forest areas but most studies were limited in spatial or temporal resolution and accuracy. A number of questions remain open and the most important is how land cover classes are change rapidly during the last decades. Accurate and fully automated detection of land cover changes from multi-temporal satellite data at high spatial resolution is hard. For efficient and accurate land cover change detection from earth observation satellites, we are required to address the problem of global objectivity, accuracy, and applicability, as well as provide access for a broad range of users. In the present study, this will be done by answering the following questions:

1. Finding best data sets for different land use types.
2. Finding the best classification model over different land use types and data sets.
3. Computing long term changes over datasets and classification for each land use land cover types.
4. Computing reason of change mostly in vegetation area (Dense Vegetation and Sparse Vegetation) using different Vegetation Indices.
5. Developments of User Interface for easy computation of any land cover type using different vegetation indices.

Research Contribution:

The contributions can be summarized as follows:

- Initially we perform close observation over available data sets in Google Earth Engine (GEE) like Landsat, Sentinel, and MODIS. We have tested different versions of landsat and sentinel data sets (Surface Reflectance, Top of Atmospheric, and Raw Images) over different types of study areas like Dehradun, Sikkim, Lucknow, and Kochi. These study areas are different in terms of weather, climate, and soil condition. By the result, we found that Sentinel data sets are better for computation over forest areas and landsat data perform better in less vegetation and high urban areas because of their different spatial resolution.
- Google Earth Engine is known as a planetary-scale platform for earth science and data analysis it has a collection of different classification models in its repository. We have computed the accuracy of some supervised classification models over both data sets (landsat and sentinel) on the different study areas in all seasons of the year.
- By the output collected from the above we have computed change in land use land cover classes in long duration. Landsat data sets have availability of data from the year 1984 to the present date. We have computed change from the year 2000 to the year 2023 to calculate the change in the study area and we find loss in vegetation class and growth in urban classes.
- To find the type of loss in vegetation class we further tested the change in vegetation using different vegetation indices and the result from this computation is most of the study areas dense vegetation is converted into sparse vegetation due to deforestation or fire incident and sparse vegetation is change into urban or open areas.
- We have developed a user interface that calculates each vegetation index for the different study area and provide result in the form of mean and standard deviation value of vegetation indices.

Graphical Abstract:

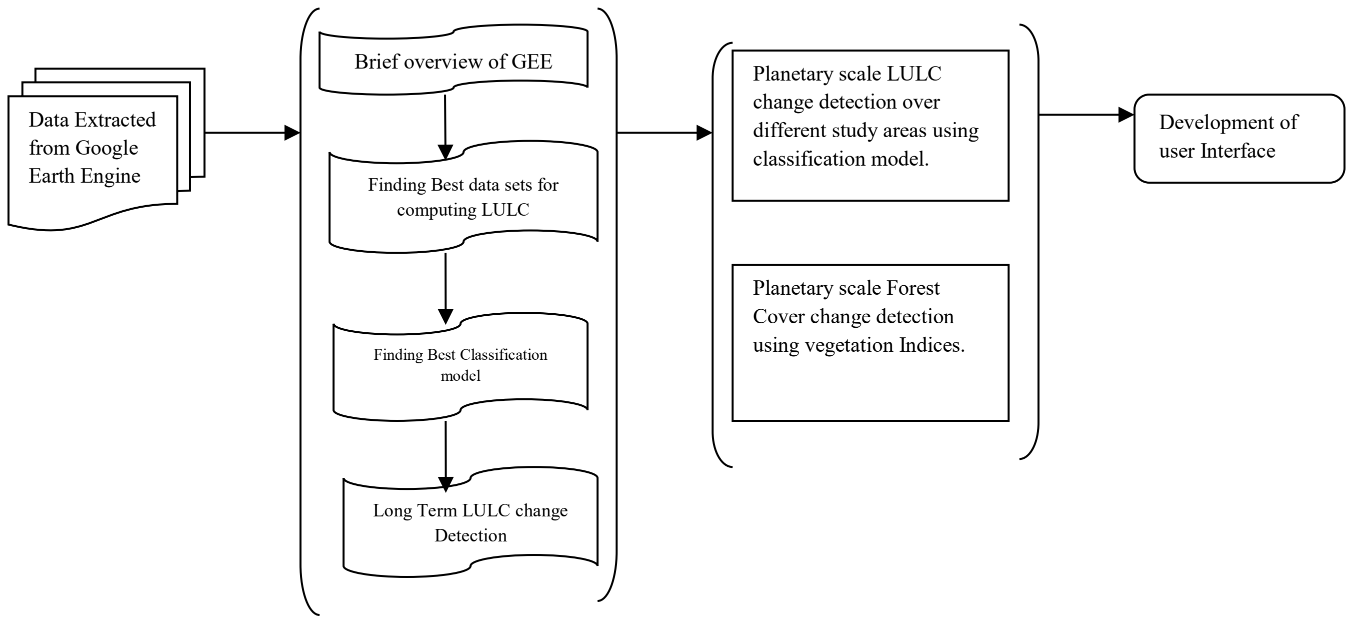

Figure: Research Visual Map

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