Monitoring Of Irrigated Areas In Gujarat State Using Gee Cloud Based Algorithm

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Abstract - **The main aim of this study to identify the irrigated areas in Gujarat state using GEE using Sentinel-2 satellite imagery for crop year 2018-19. Traditionally, the classification is carried by downloading satellite images from available websites and processing of images in available software like Erdas, ArcGIS etc. The freely available high spatial resolution satellite datasets like Landsat-8, Sentinel -1 and Sentinel-2 consumes large amount of storage and also requires high end computers for processing and analyzing. In order to overcome some of the difficulties, Google Earth Engine (GEE), the most advanced cloud-based geospatial processing platform is being used. The download of satellite imagery, image processing and image classification etc. will be carried out in GEE with the help of Random Forest Algorithm. The results include LULC map, Rice crop extent map, Identification of rice crop extent The above maps will be validated using independent samples. These results help Government agencies and policy makers for quick decision making and implementation of their programmes**

keywords - **Google Earth Engine, Irrigated area**

Introduction:-

Cloud computing:-

Cloud computing ((Gumma et al., (2019) platforms are efficient ways of storing, accessing, and analyzing datasets on very powerful servers, which virtualizes supercomputers for the user. These systems provide infrastructure, platform, storage services, and software packages in a variety of ways for the customers; several cloud computing platforms have so far been developed. For example, Amazon Web Services (AWS) is a pay-as-you-go platform, where users pay based on the hours that they use the services .AWS has a dedicated cloud Earth Observation (EO) offering called "Earth on AWS" as part of its Public Dataset Program, which includes open data from several satellites such as Landsat-8, Sentinel-1, Sentinel-2, China–Brazil Earth Resources Satellite program, National Oceanographic, and Atmospheric Administration Advanced (NOAA) image datasets, as well as global model outputs.AWS also hosts open data supplied by Digital Globe with its Space Net challenges. Moreover, AWS hosts the largest suite of machine learning services. Azureis another cloud computing platform hosted by Microsoft. This platform has established the Artificial Intelligence (AI) for earth initiative to facilitate the use of its AI tools for addressing environmental challenges in four main areas of climate, agriculture, biodiversity, and water. Azure only contains Landsat and Sentinel-2 products for North America, since 2013, as well as moderate resolution imaging spectroradiometer (MODIS) imagery. Azure is also a pay-as-you-go platform which provides virtual systems for the users .Google Earth Engine (GEE) is another cloud computing platform which was launched by Google, in 2010. GEE uses Google's computational infrastructure and available open access RS datasets. GEE is the most popular big geo data processing platform, facilitating the scientific discovery process by providing users with free access to numerous remotely sensed datasets . Users can access GEE via an internet-based Application Programming Interface (API) and a web-based Interactive Development Environment. Additionally, users do not need to have expertise in web programming or HyperTextMarkup Language to use GEE for different applications .GEE has the features of an automatic parallel processing and fast computational platform to effectively deal with the challenges of big data processing For instance, according to Hansenet al. it only took 100 h to process 654 178 Landsat-7 images (about 707 terabytes) within GEE and produces a global map offorests. This was reported as a great achievement because if they did not use GEE, this process would have taken a million hours to complete. Furthermore, users do not need to download the available dataset within GEE in order to use them or install any software to perform the processing tasks existing in GEE. However, GEE users can utilize complementary software packages or process their own private datasets within this platform.

Google earth engine:

The Google Earth Engine platform may be a cloud computing platform for geographical data Analysis. It gives access to a full complete catalog of remote sensing products alongside the potential to process these products quickly online through massive parallelization. The GEE data catalog includes data from Land sat 4, 5, 7 and eight processed by the us Geological Survey(USGS), several MODIS products, including global composites, recently imagery from Sentinel 1, 2 and three satellites, and lots of more. The processing, Georeferencing are prepared for the direct use, user data in raster or vector formats are often uploaded (ingested using GEE terminology) and processed within the GEE. We took advantage of this feature for doing image classification u used as ground truth in our experiments.

In this work, all required sentinel2 images were retrieved from the (COPERNICUS/S2_SR) Image Collection available within the GEE. These images contains top of atmosphere (TOA) reflectance (calibration coefficients are included in metadata). These products also include two additional bands: the standard assessment band (BQA) and therefore the FMask cloud mask. We use the cloud flag included within the BQA nominal product to assess if previous images over each test site location are cloud free or not, which allows us to simply and automatically retrieve cloud-free images from the whole archive. Additionally download of satellite imagery; image processing and image classification are going to be done using Sentinel-2 satellite imagery for crop year 2018-19. With the assistance of Random Forest Algorithm. The GEE computation engine offers both JavaScript and Python application programming interfaces (API), which permit to simply develop algorithms that employment in parallel on the Google data computer facilities. The programming model is object oriented and supported the Map Reduce paradigm. The GEE engine is also accessioned from web-based integrated development environment (IDE) using the JavaScript API. The web-based IDE allows the user to see images, results, tables and charts which will be easily exported. On the opposite hand, the Python.

However, we chose the JavaScript API to develop our image classifications because it's easier to integrate with long running tasks, which are essential to run the complete validation study in an automatic manner.

Methodology:

The aim of this study was to produce an accurate farmland range product derived from Sentinel-2 (10m) of Gujarat. Random Forest Classification which was a moderated pixel-based classification used in the GEE cloud computing platform to develop Crop Land Range product for Gujarat using Sentinel-2 time series data (10m) for 15 days for the 2018-2019 time period. An overview of the methodology is shown in Fig.4.3.1.

In this project I used how to generate random forest classifier in the Google earth engine. (Gumma et al., (2019)) And i also used integrating pixel-based &object based algorithms using sentinel-2(. (Gumma et al., (2017)) which is useful to find irrigated areas to do cropland classifications.

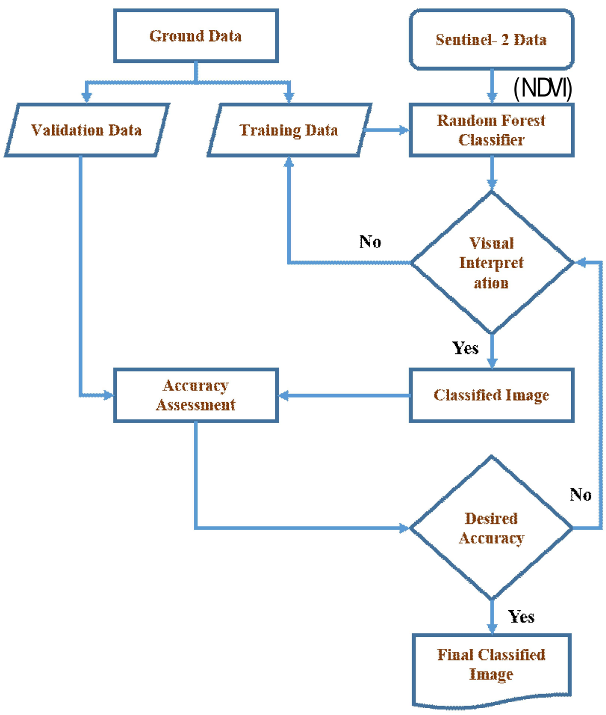

Figure 1: - Flow chart showing methodology

Overview of methodology for cropland mapping. This study used a pixel-based random forest supervised machine learning algorithm for classification Analysis executed on Google Earth Engine cloud-computing platform

Application of Random Forest machine learning algorithm on cloud computing platform. These methods consist of pixel-based, object-based, or a combination of both approaches that used either supervised or unsupervised classification techniques. Pixel-based approaches include: a) Random forest algorithm (Tatsumi et al., 2015, Wang et al., 2015, Gislason et al., 2006) (Gumma et al., (2018)).

Here comes flow chart methodology in Google earth engine. [GEE]

•The process starts with taking sentinel- 2Datawith 10m resolution satellite data. It has total 13 bands [b4-red], [b8-nearinfrared]. We generate the NDVI
Image by applying formula by using two bandsb4, b8.

$$NDVI = \frac{(NIR - Red)}{(NIR + Red)}$$

- Using NDVI image we will run random forest classification.
- On performing NDVI we download sentinel-2 data.

Training data

Training data is the data which is train by classifier

- .Taking training data which we obtain from survey [ground data] by that it creates training samples.
- About 390 points are used for training purpose

Validation data

The independent ground data was collected for validation i.e. about 403 points.The process of assessing the uncertainty of higher levels, the satellite sensors derive products through analytical comparison with reference data. What is the assumption that the truth value of an attribute is the validation?
Both take values at the same time and then classify in the random forest classifier

Random forest classifier

Supervised learning algorithm that randomly creates and merges multiple decision trees in to one forest as a group is Random Forest

- Here random forest classifier is that in such way that by taking the sentinel-2 data (NDVI) and training data pixels values near to NDVI data will from us one tree and form as groups.

Visual image interpretation

Visual interpretation of an Image is a first analysis approach to the Remote Sensing Imagery.
Here in this work size shape position of objects as well as the contrast and color saturation is analyzed.

- It checks the wrong data in Google earth engine. if it is wrong it goes to training data and new point.[and process going on]

Accuracy assessment

- Evaluating accuracy assessment is a crucial part of any grading project. It compares the classified image to another data source that is considered to be accurate or ground truth data.
- Accuracy assessment checks the accuracy and processing data for both classified image from NDVI and validation data
- Accuracy assessment done using error matrix method. We compared both classified image and ground data to form matrix.
- Example: - if I give point as crop but in classified image it shows some built up it means wrong pixel. But it shows crop means correct.

Desired accuracy

- Desired accuracy means is how close you are to the true value.
- In desired accuracy assessment correct means it goes to final classified image .if not again it goes to visual interpretation and recheck if any missing.

Final classified image

In final classified image, we get Kharif crop and Rabi crop.
Kharif [June to November] it depends on rain fed.

- Rabi [December to march] it depend on irrigated.
- Rain fed crops lands were identified by subtracting Rabi crops from Kharif crop lands.

Overview of coding approaching in Google earth engine

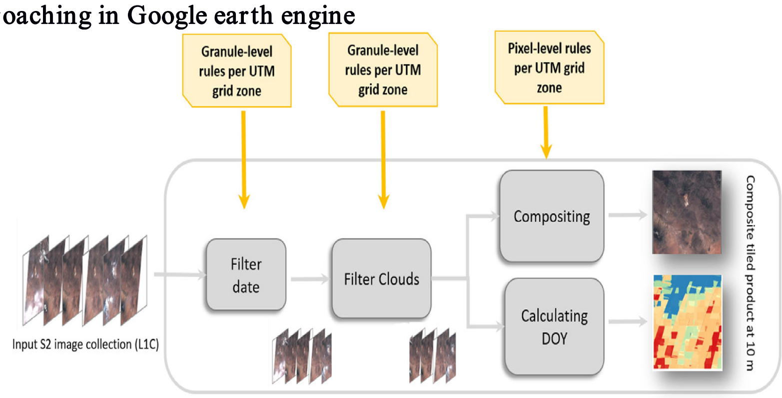

Figure 2: - Overview of coding approaching in Google earth engine

Approaching of Google earth engine [GEE]

Managing Assets

Geospatial datasets can be upload using asset manager which will be at left side of the code editor [figure1]When the user uploads the datasets from a specific folder by using the assets Manager those assets become the Private assets which only the user can assess and when he shares the Assets then they became shared assets . For Storing the Assets the Space allocated is limited by a quota. The use of the quota depends on the total number and size of the stored asset pouches. For data usage details, click users / username and click the data usage icon

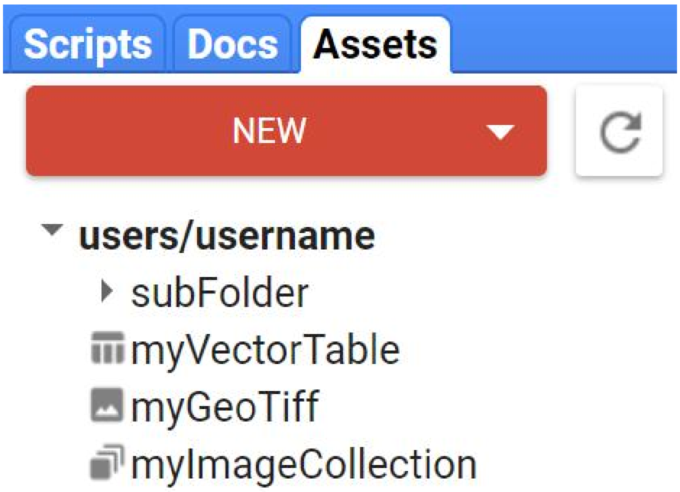

Figure 3: Approaching managing assets

Sharing assets

To configure access to your private assets click the **Share** button. By hovering over the asset and clicking the share icon sharing also done and by using the share button from we can assess to private assets also. The Figure.4 the Sharing Dialog makes user to configure read or write access for individuals, members of a specified Google Group (learn more about Google Groups) and Earth Engine Apps. To make an asset public, check the 'Anyone can read' box.
To allow an Earth Engine application to display an item, select the application name from the drop-down list.

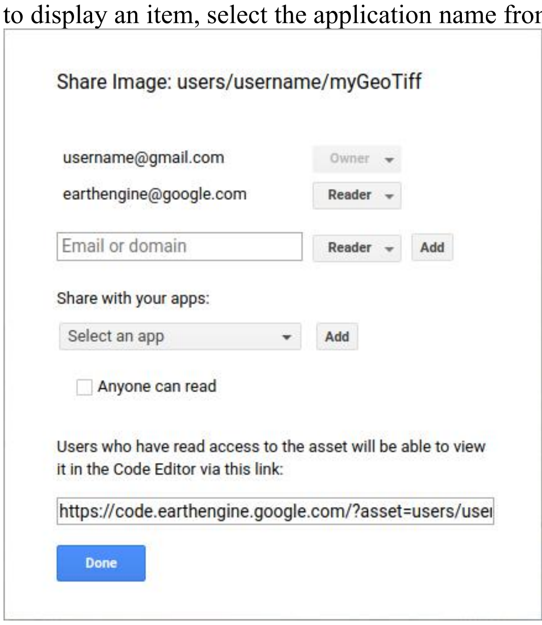

Figure 4: Approaching sharing assets

Importing Raster Data

Uploading image asset

For uploading the image or other georeferenced raster datasets in GeoTIFF or TFRecordformat. (See Importing Vector Data for details on importing vectors using the Code Editor.) We can use Asset Manager or the command line interface (CLI)

Uploading image assets

GeoTIFF

In the Google Earth Engine there is a limitation of only 10 GB of the TIFF images files. (For larger files, use the command-line upload option.) Up to 10GB data we can upload click the 

button, **then select Image upload for**

uploading the GeoTIFF using the Code Editor. Earth Engine presents a loading dialog which should look similar to Figure 1 Click the **SELECT** button and navigate to a GeoTIFF on your local file system. In the specified Users folder, Appropriate Asset ID should be given to the Image. If you want to upload the image to an existing folder or collection, precede the asset ID with the folder or collection ID.

Click **UPLOAD** to start the upload. GeoTIFF

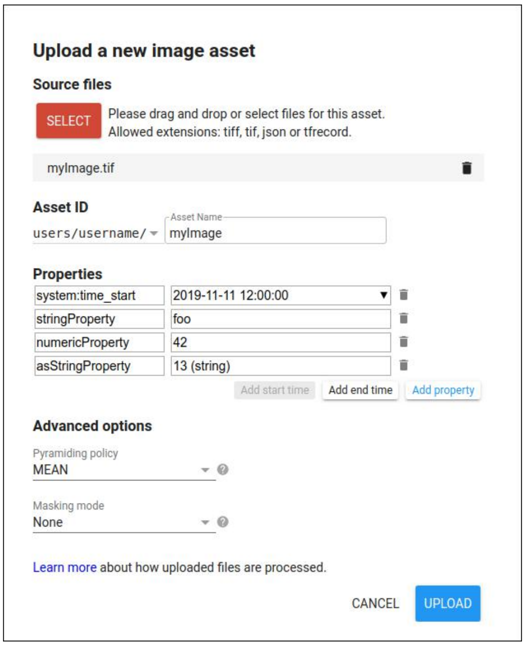

Figure 5: Uploading image assets geotiff

Importing Table Data

Uploading table assets

For uploading the Shape files and CSU files Asset Manager or command line interface (CLI) is used. And they are private and when we share they become shared assets

Upload a Shape file

For uploading the form files from the Code Editor, click the button 

, then select Shape files under the Table Upload section. Uploading dialogue box appears Figure 1 Click the SELECT button and navigate to a Shape file or Zip archive containing a Shape file on the local storage system. When selecting a .shp file, make sure to select the related .dbf, .shx and .prj files. The default projection system in GEE is WGS84 coordinate system until we give a specific projection. .

The shape file should contain shp, .dbf, .shx, .prj and all the supporting files and no duplicate filenames.Confirm filenames don't include additional periods or dots. (Filenames will include one period before the extension.)Whenever we create a table it should be unique if already existed it won't accept. Click UPLOAD to start out the upload

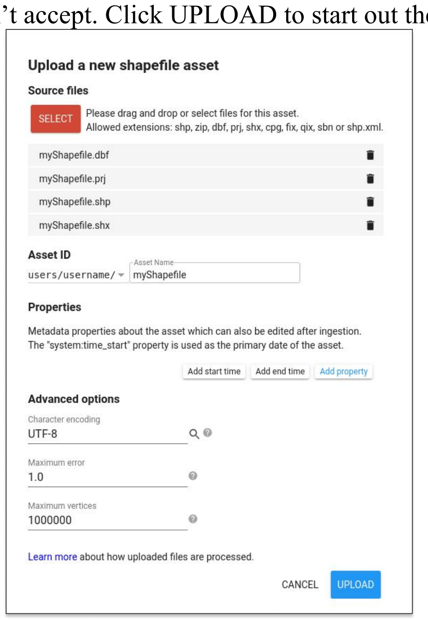

Figure 6: Upload a Shape file

Upload a CSV file

Activate assets tab for uploading csv file under the Table upload section. Click the SELECT button  and navigate to a .csv file on your local file system. Table need to be given an Unique one, and asset ID name should be in the table. Click OK to start the upload. An upload dialog similar to Figure 2 will be presents

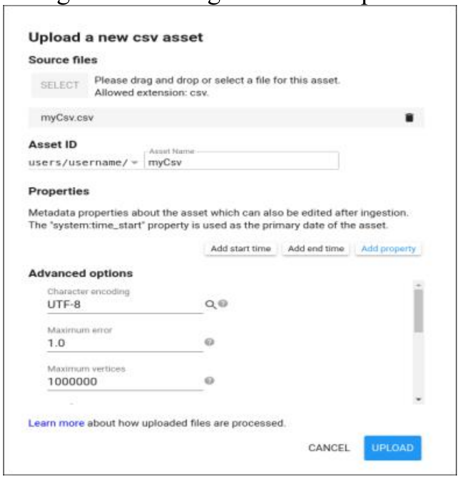

Figure 7: Upload a CSV file

The CSV file should contain a row for every feature and because the many columns as there are properties or variables for a feature set. If the features are geospatial, they must have a geo location defined by either a geometry string (GeoJSON, WKT) or x and y position properties. If the CSV file is an export from a GIS or geospatial data tool like the GDAL/OGR, a properly formatted and therefore the named geometry column should already been exist. Alternatively, two columns for x and y coordinates representing the point locations can be defined in the spreadsheet application and the exported as CSV format along with any other variables

Exporting Data

Exporting the Images, Map Tiles, Tables and video from Google Earth Engine. The Exports will directly send to the Associated Google drive o Google Cloud Storage or to a new Earth Engine asset. .To use Google Cloud Storage (a paid service), you need to set up a project, enable billing for the project, and create a storage bucket. See the Cloud Storage quick start page for instructions. Refer to this guide for more information on naming storage compartments. The data exported to the cloud storage container will contain the object's default ACL for the container.

The individual export types are described in detail in the following sections

Exporting images

Exporting of the Images from GEE in geoTIFF or TFRecord format. See Configuration Parameters for the more output options.

To Drive

For exporting an Image to drive account, use export.image.to drive ().for example, to export the portions of the Sentinel-2 Image, define a region to export, then callExport.Image.toDrive ()

GEE Code

```
// Load a sentinel image and select three bands.
Var sentinel = ee.Image ('ee.ImageCollection ("COPERNICUS/S2_SR")') .select (['B4', 'B3', 'B2']);
// Create a geometry representing an export region.
Var geometry = ee.Geometry.Rectangle ([116.2621, 39.8412, 116.4849, 40.01236]);
// Export the image, specifying scale and region.
Export.image.toDrive ({
image: sentinel,
description: 'imageToDriveExample',
scale: 30,
region: geometry
});
```

When this code is run, the export tasks will be created within the task as tab of the code editor. Click the run buttons next to the task to start it (learn more about the task manger from the code editor section).the images are going to be created in your drive account with the required file format.

MaxPixels

The maxPixels parameter is so intended to prevent a very large export from the inadvertently being created. If the default value is just too low for your intended output image, you'll increase the maxPixels. For example:

```
Export.image.toDrive ({
Image: sentinel-2, Export.image.toDrive ({
 description:
'maxPixelsExample',
 scale: 30,
 region: geometry,
maxPixels:1e9
});
```

Results and Discussions

Land Use Land Cover Mapping

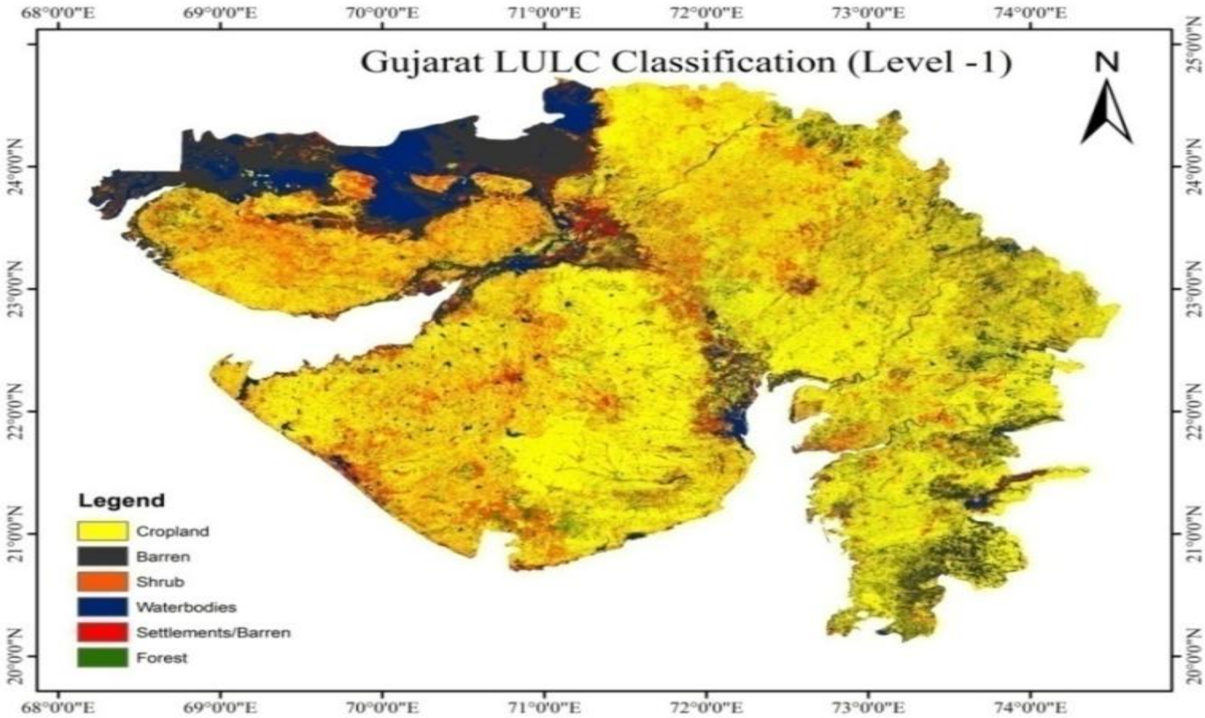

Figure 8: Gujarat land use land cover mapping

Gujarat LULC classification (above image) (figure 5.1) was carried out using GEE with the help of ground data. The classified classes are Cropland, Barren, Shrub, Water bodies, Settlements and Forest. Training data was collected within GEE interface by selecting different LULC. The northern part of Gujarat is covered with barren water bodies and the south-eastern part contains forest areas contains forest areas.

LULC	Area (Ha)

Crop	8628900
Built-up	1777944
Shrub land	3469159
Barren	1181983
Forest	1945309
Water	1742352

Table 1 LandUseLandCoverMapping table

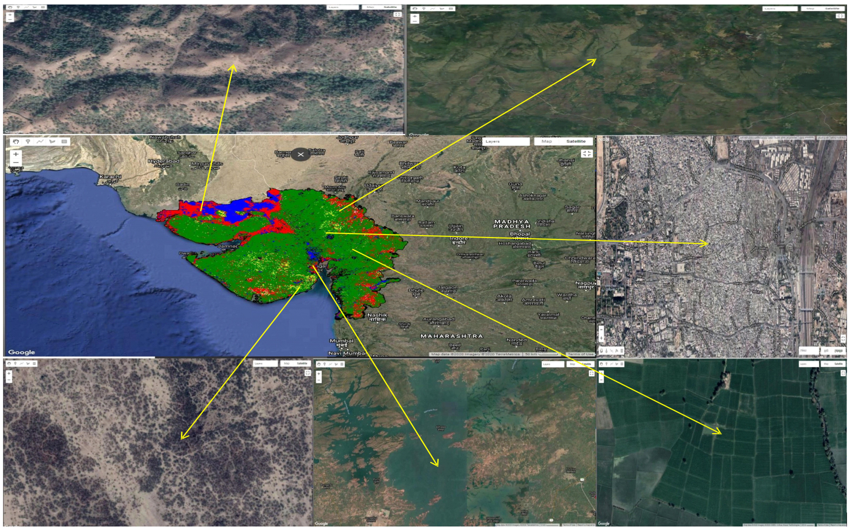

Figure 9: The major LULC areas and related Google Earth high resolution image

The above image shows the major LULC areas and related Google Earth high resolution image. Cropland, water bodies, and barren lands are clearly seen from above image. With the visual interpretation, the LULC map was finalized.

2) Kharif and Rabi Season -Cropland Maps

Kharif season crop (Fig)6.2 was mapped with the help of Random Forest algorithm using ground data collected during that period. Most of the croplands were located in South West region of Gujarat

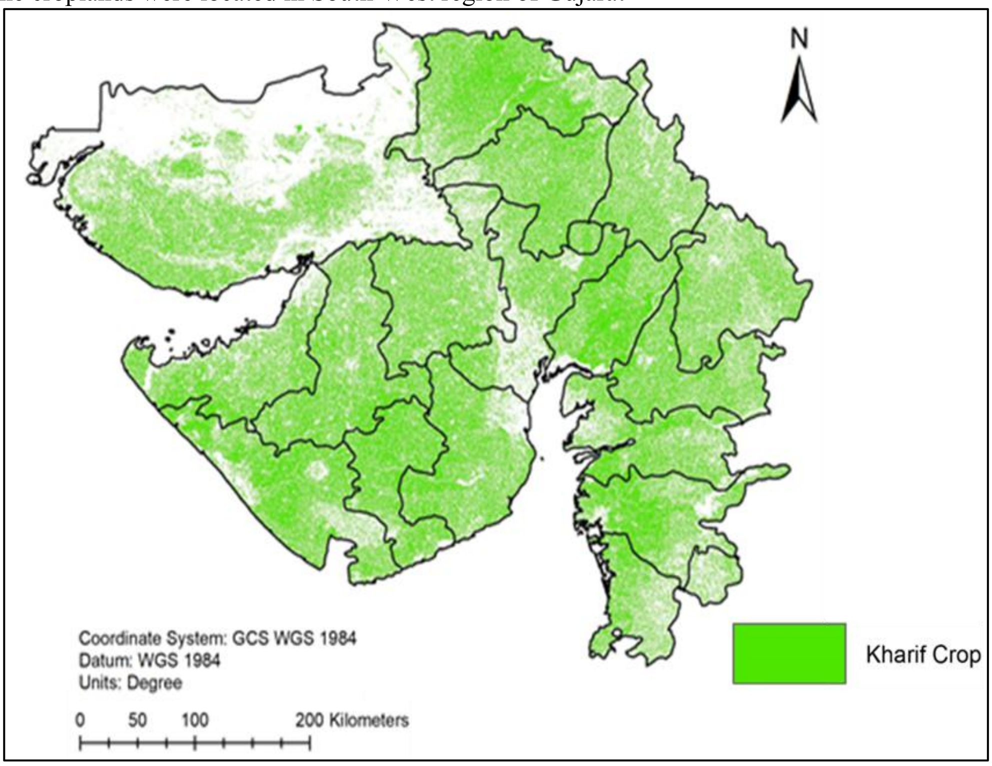

Figure: 10 spatial distributions of Kharif croplands

Same Procedure as Kharif croplands was carried out to extract croplands in Rabi season **(Fig) 5.2**

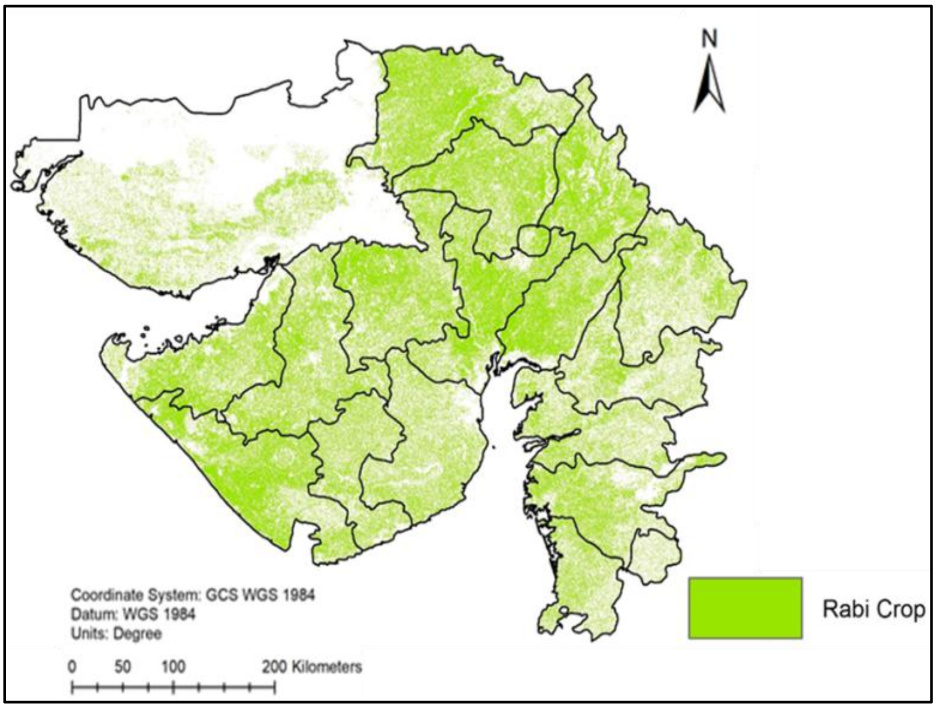

Figure 11: spatial distribution of Rabi croplands

5.3. Identification of Rice Crop Extent

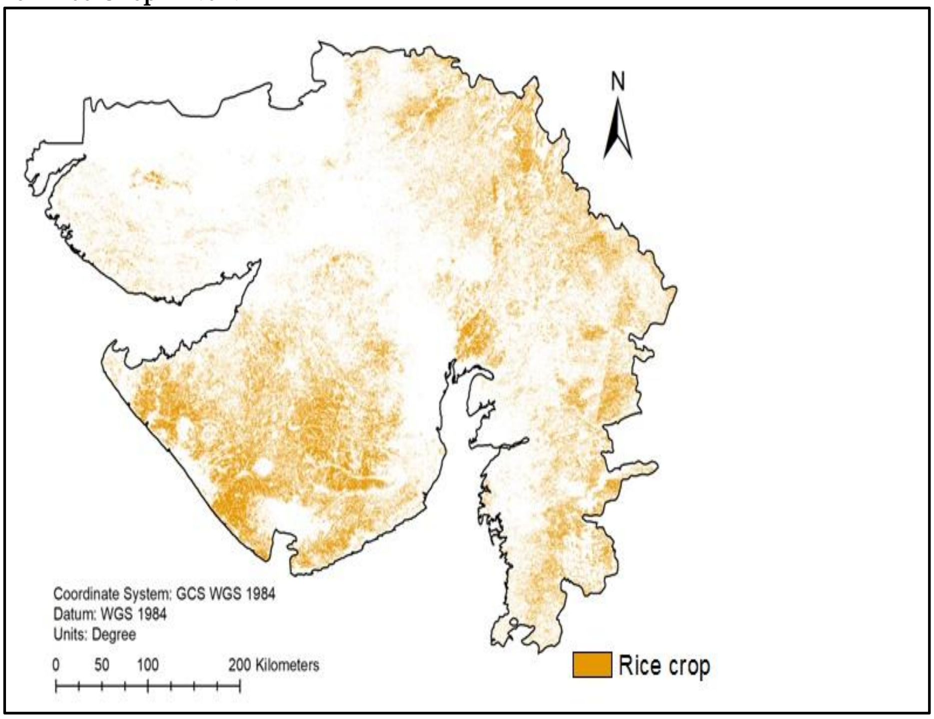

Figure 12: spatial distribution of rice crop extent

The figure above shows the spatial distribution of the extent of the rice crop for the whole of Gujarat. The identification of rice crop was mainly achieved by using NDVI thresholds with range greater than 0.7 values. Then with the help of ground data contains rice crop was used for validation. Most the Rice crop is in the South West of Gujarat.

5.4 Accuracy Assessment for LULC Mapping

Random Forest	Crop	Built-up	Shrub lands	Barren	Forest	Water	Total	Users
Crop	143	3	6	1	4	0	157	0.910
Built-up	3	50	0	1	0	0	54	0.920
Shrub lands	7	1	46	0	6	0	60	0.760
Barren	0	1	1	11	0	0	13	0.840
Forest	10	0	6	0	58	0	74	**0.78**

Water	1	1	0	0	0	43	45	**0.95**
Total	164	56	59	13	68	43	403	
Producers	0.870	0.890	0.770	0.840	0.850	1.000	**Overall**	**0.870**

Table: 2 accuracy Assessment for LULC Mapping table

For doing of accuracy assessment we use
1. Ground verification using Global Position System(Observing the area)
2. Compare the classified image with an assumed correct image (such as an aerial photograph, Google Earth Image)
This regard, images with high spatial resolution from Google earth that are liberal to the general public are an honest source of Imagery including satellite images and air photos. Earth (http://earth.google.com) provided by Google Inc., is a virtual globe programming that maps the world by Superimposition of high resolution satellite images. Since it was released in June 2005, Google Earth has aims to supply viewers with "a more Realistic view of the world". Beside Google Earth, map data and positional measurement can be obtained using different
Methods such as conventional or modern land survey Methods, Global positional System (GPS) and remote Sensing satellite imagery. Each of these known positional accuracy Google earth high-resolution imagery is important for Assessment of accuracy by comparing the point-by-point basis.A random set of points is generated for area and then Using Google Earth, the value of each point is identified. Therefore, this study aimed to analyze the accuracy of the Land Use Land Cover Classification using Google Earth in Gujarat.

- Based on analysis of satellite imagery and monitoring the current state of six major land uses and land cover types were identified within the study area. These include crop, built-up, shrub land, barren, forest, water.
- From **fig 5.1** a random set of points generated for area using Google earth pro.The lulc part is done using Arcgis software.
- From **fig 5.2** with the help of random forest algorithm using ground data collected during Kharif season The output obtained from the gee and by using Arcgis software I have done classified image.
- From **fig 5.3** with the help of random forest algorithm using ground data and training data collected during Rabi season. The output obtained from the gee and using Arcgis software I have done classified image.
- From **fig 5.4** the image is done using ndvi threshold with range greater than 0.7 values with the help of ground data and training data was used. Mosaicking of the rice part was done by using Erdas.

Land Use Land Cover Classification for 2019-20:-

The land use land cover classification of the area for 2019-20 from sentinel-2 satellite image (table 2) showed that the Majority of the study area is covered by **crop land** 8628900hectares (ha). the producer's accuracy and user's accuracy of croplands in fallow were 87%and 91% **Forestland** and cover an aerial size of 1945309 ha the producer's accuracy and user's accuracy of forest 85% and 78% and **shrub land** 3469159 ha respectively, producer's accuracy and user's accuracy is 77% and 76%whereas the aerial coverage of **Rocky/Barren land** and **Settlement land** is1181983 ha the producer's accuracy and user's accuracy is 84% and 84% and 1777944 ha producer's accuracy and user's accuracy is 89% and92%from the total area of the District. There are also **waters** which covers 1748352 ha. Producer's accuracy and user's accuracy is1%and 95%.By the land use land cover classification he over all accuracy what we obtained is 87% for the study area.

Conclusions

The study identified LULC, Kharif crop extent, Rabi Crop area extent and Rice crop extent for entire Gujarat using Google earth engine.. As traditional methods require satellite image downloads and the need for high-end computers with image processing software. But GEE makes ease of image processing through its interface by writing code.The satellite images in the Kharif season contain high clouds, which can also be corrected with various algorithms in GEE. The identification of Rabi and Kharif crop were identified with help of crop mask obtained from LULC map and run random forest algorithm for respective season croplands. The rice crop extent map was prepared with help of NDVI thresholds because of less ground data. In future, there are many technologies will be used for crop classification with the help of machine learning, deep learning and also integration of various cloud computing techniques.

1. **Mapping lulc of Gujarat state**

Using Google earth pro i called random set of points and collected data from training data these points are generated.
For the mapping of the lulc of the Gujarat state used Google earth pro software given classification are crop, built-up,shrub lands, barren,forest, water,further classification &mapping is done in arcgis.

2. **Mapping Kharif and rabi croplands**

Mapping of the Kharif and Rabi crop lands are done by using the arcgis software and the resultant outputs is obtained in the Google earth engine by the classification.

3. **Identification of rice crop extent**

By the erdas software using ndvi threshold signatures from the Rabi,
Kharif rain crops extracted only rice crops which value is greater than 0.7

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