**Methodology:**

1. **ISRO data –** 
   1. <https://bhuvan-app1.nrsc.gov.in/thematic/thematic/>
2. **QGIS Steps-**
   1. Adding of WMS layer from the 250K LULC WebServices option under the Thematic Services of Bhuvan into QGIS.
   2. Conversion of WMS layer of a ‘specific’ year to Raster layer, making sure to keep resolution sufficient enough for visual interpretation.
   3. Adding a shape file for only the district *(Dhule)* from the boundary material under the name “India\_District\_Boundary.shp”.
   4. Masking the previously converted Raster layer in the “mask by layer” option under the “raster” menu, mask layer is set to the district *(Dhule)* vector layer.
   5. A new masked Raster layer is formed.
   6. Repeat steps from *(b)* to *(e)* once more with a different ‘specific’ year, the specific year should be made after taking in the consideration of the crop pattern period of that place. In our case for Dhule district that period was around 4-5 years, so we took the data of the year 2008-09 and 2013-14.
   7. For our analysis, we would like to find areas of LULC change between 2008 and 2013. The way to accomplish this is by finding the difference between each grid’s pixel values in both the Raster layers; use “Raster Calculator” from the “raster” menu.
   8. In the “Raster bands section”, the bands are named after the raster name followed by @ and band number. The raster calculator can apply mathematical operations on the raster pixels. In this case we want to enter a simple formula to subtract the 2013 Raster layer’s pixel value from 2008 Raster layer’s pixel value to get a Raster layer which will represent the Positive changes, to find the Negative changes we can simply swap the years in subtraction formula.
   9. Once the operation is complete, you will see the new layer load in QGIS. This grayscale visualization is useful, but we can create a much more informative output by styling it.
   10. By going to the “Style” tab, select “Singleband pseudocolor” as the Render type under Band Rendering. Set the Color interpolation to “Discrete”. Add entry button to create unique classes. Click on an entry to change the values. The way color map works is that all values lower than the value entered will be given the color of that entry. Since the minimum value in our raster is just above -155, we choose 0 as the value entry of the first class and max value for the value entry of another class.
   11. The grayscale visualization is now converted to discrete points on the layer; these points can also be categorized as LULC hotspots and depending on the subtraction done on the layer it will further classify to either positive or negative change layer.
   12. Repeat the process to obtain both positive and negative change layer, this will generate one set of values of LULC change with hotspot data for the years 2008-09 to 2013-14.
   13. Repeat steps from *(b)* to *(l)* to generate another set of data by taking another 5 year period interval in between like 2013-14 to 2018-19.
   14. Generate maps using the “Composer Manager” under the “Project” menu.
3. **Complexities –**
   1. In step *(b)* of ‘QGIS steps’ the conversion of WMS file to Raster is a little complex in the nature of generating the raster *(.tiff)* files, one has to take care to get proper resolution and maintain the georeferencing.
   2. While using the “Raster Calculator” same “band number” of both raster images should be taken in the subtraction process to generate a valid change raster layer.
   3. In step *(j)* of ‘QGIS steps’ one of the class with the min value should have color value set to 0% opacity so as to see the layer beneath it.

**Application and Use:**

We are presenting two types of maps showcasing LULC in agriculture for Rabi and Kharif crops for the duration of years 2008-13 and 2013-18. The first is the LULC change with hotspot map. Here, the viewer can identify positive and negative changes on cultivation. The second is a temporal map in which they can recognize the limitation to positive and negative changes and their effect on terrestrial region.

There are two *(2)* LULC change with hotspots maps-

* LULC\_8\_13
* LULC\_13\_18

There are four *(4)* LULC positive and negative temporal maps:

* LULC\_temporal\_pos\_8\_13
* LULC\_temporal\_neg\_8\_13
* LULC\_temporal\_pos\_13\_18
* LULC\_temporal\_neg\_13\_18

Using these maps, the viewers can understand the net shift towards positive or negative trends in local areas on the map. This will help government bodies to plan agricultural practices for better yield.