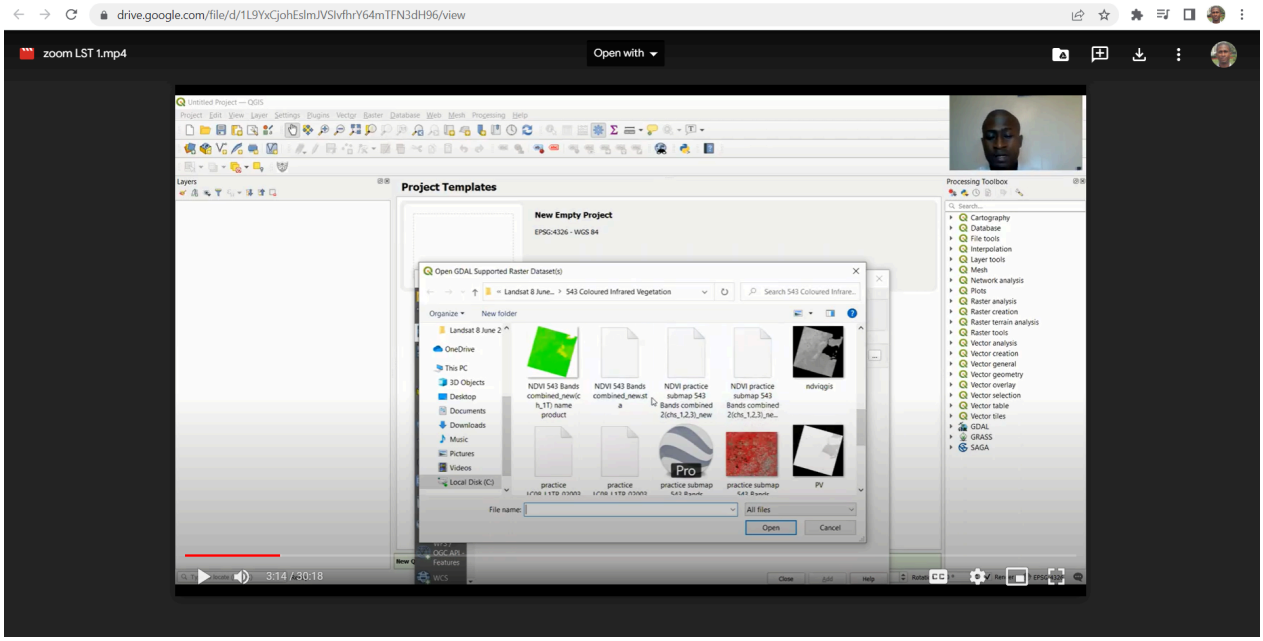
QGIS Tutorial 3: For Surface Temperature Analysis with LandSat 8

Please watch Femi's video on zoom showing the LST Analysis with the Google links below:



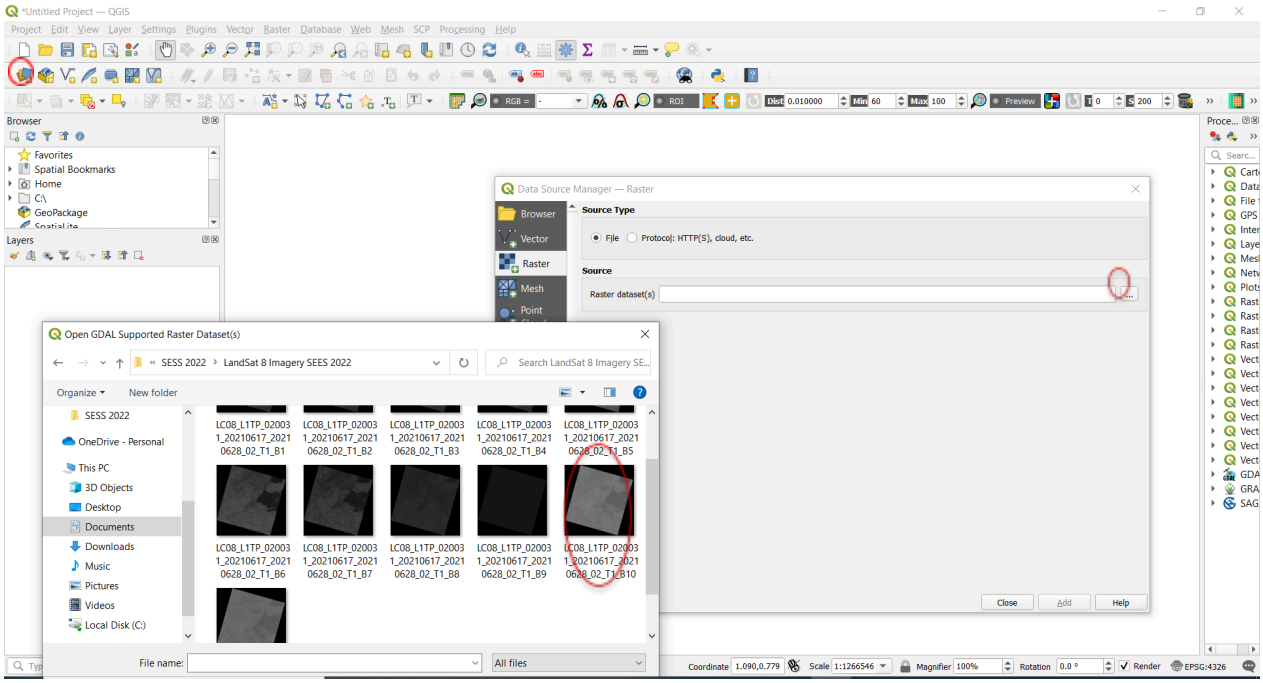
https://drive.google.com/file/d/1L9YxCjohEslmJVSIvfhrY64mTFN3dH96/view?usp=sharing

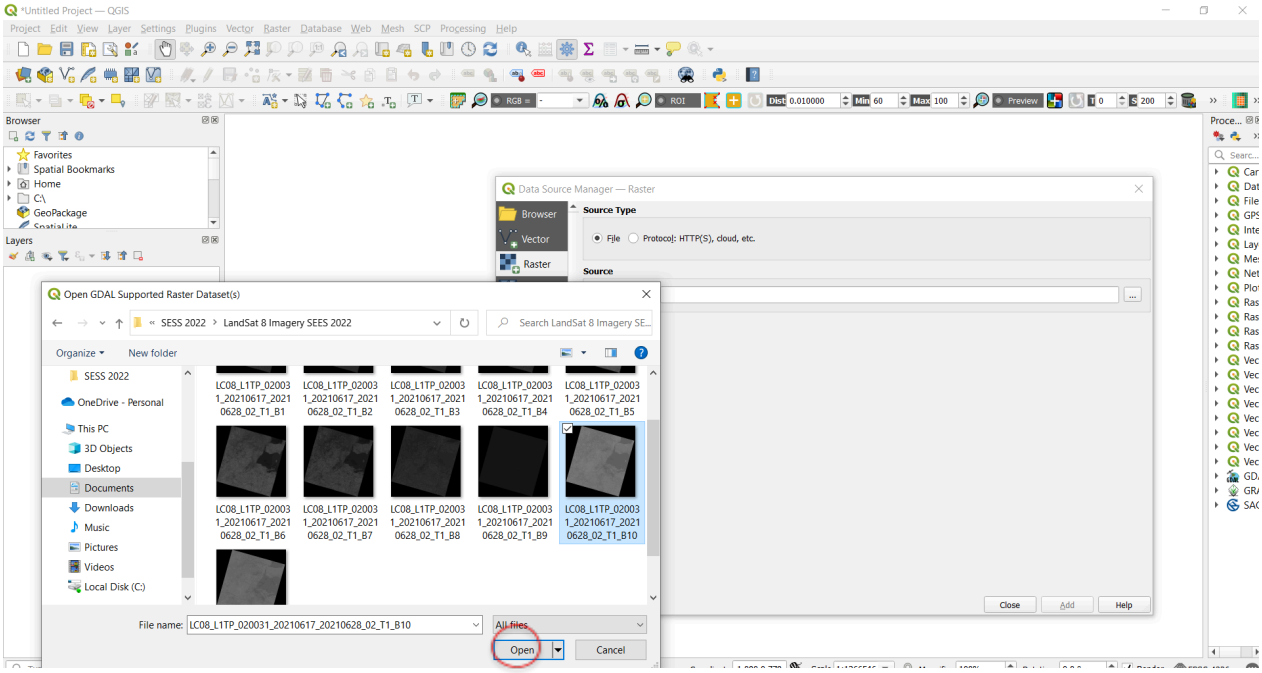
https://drive.google.com/file/d/1QiWNIub_jDrbPlDBmqUoXLzme39Mhi3e/view?usp=sharing

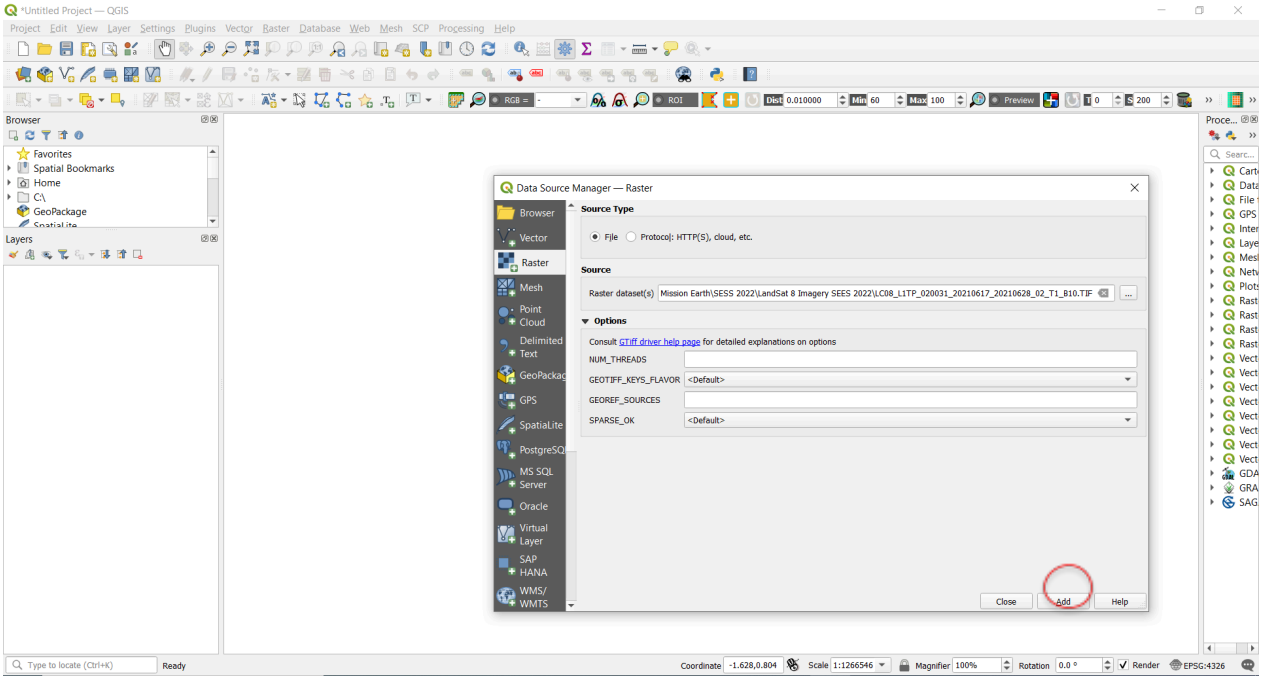
This section includes basic and step-by-step instructions for performing LST

Step 1: Launch QGIS 3.24

Step 2: Load Band 10 TIRS imagery from the folder to QGIS, To do this, Click add data on the QGIS menu bar, then a dialog box appears, click on the left box to locate where the Landsat 8 Bands are saved, then Click on “Open” then a dialog box appears, then click add to import Band 10 TIRS.




*Untitled Project — QGIS
Data Source Manager — Raster
Open GDAL Supported Raster Dataset(s)
SESS 2022 › LandSat 8 Imagery SEES 2022
File name: LC08_L1TP_020031_20210617_20210628_02_T1_B10
Open
Cancel

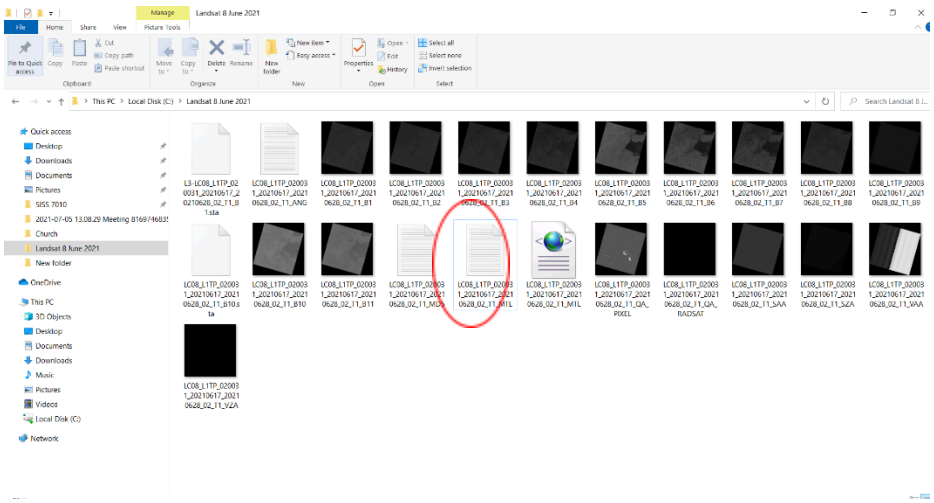

*Untitled Project — QGIS
Data Source Manager — Raster
Source Type
Source
Raster dataset(s)
Mission Earth\SESS 2022\LandSat 8 Imagery SEES 2022\LC08_L1TP_020031_20210617_20210628_02_T1_B10.TIF
Options
Close
Add
Help

Here are the six steps to determine the LST

Step 1: Convert DN to RAD
Step 2: Convert RAD to TOABT
Step 3: Calculate NDVI
Step 4: Calculate PV
Step 5: Calculate E
Step 6: Calculate LST

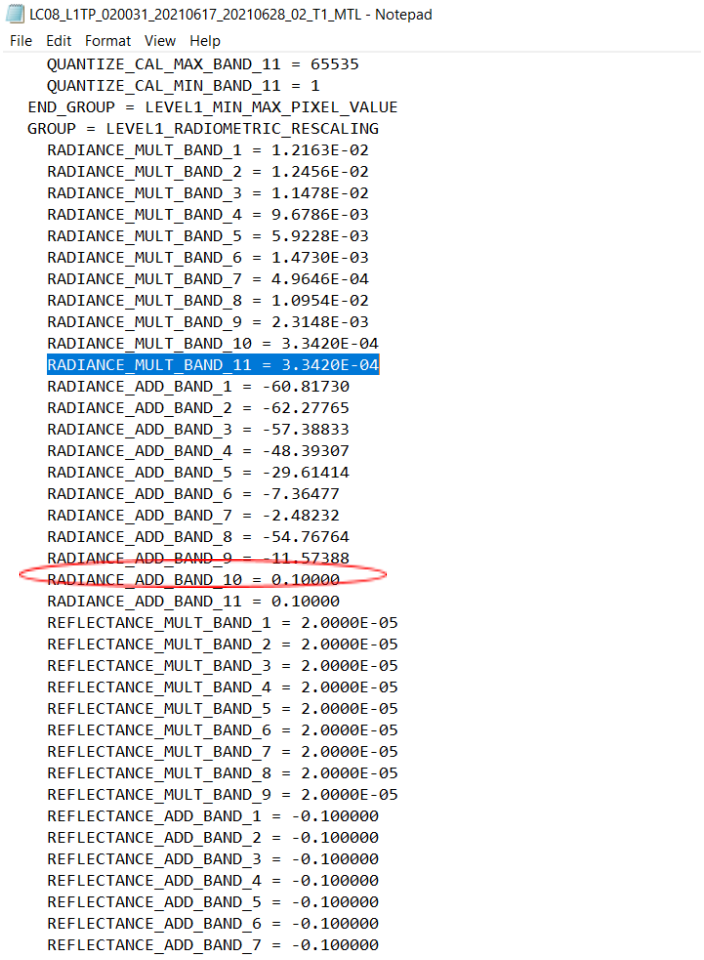
Section 1: Conversion DN to RAD

Step 1: Open the Band 10 TIRS (Please look at the steps above)
Step 2: Open the Metadata included in the Landsat 8 Imagery folder



Step 3: Look for "**Radiance Multi Band 10**". The values: for example; 3.3420E-04 or 0.0003342

Step 4: Look for "**Radiance ADD Band 10**" in the metadata for example 0.10000



Step 5: Look for the Formular for converting **DN to Radiance**

Formular

Equation 1

$L\lambda = M_L * Q_{cal} + A_L - O_i$

where,

M_L= the band-specific multiplicaptive rescalling factor,

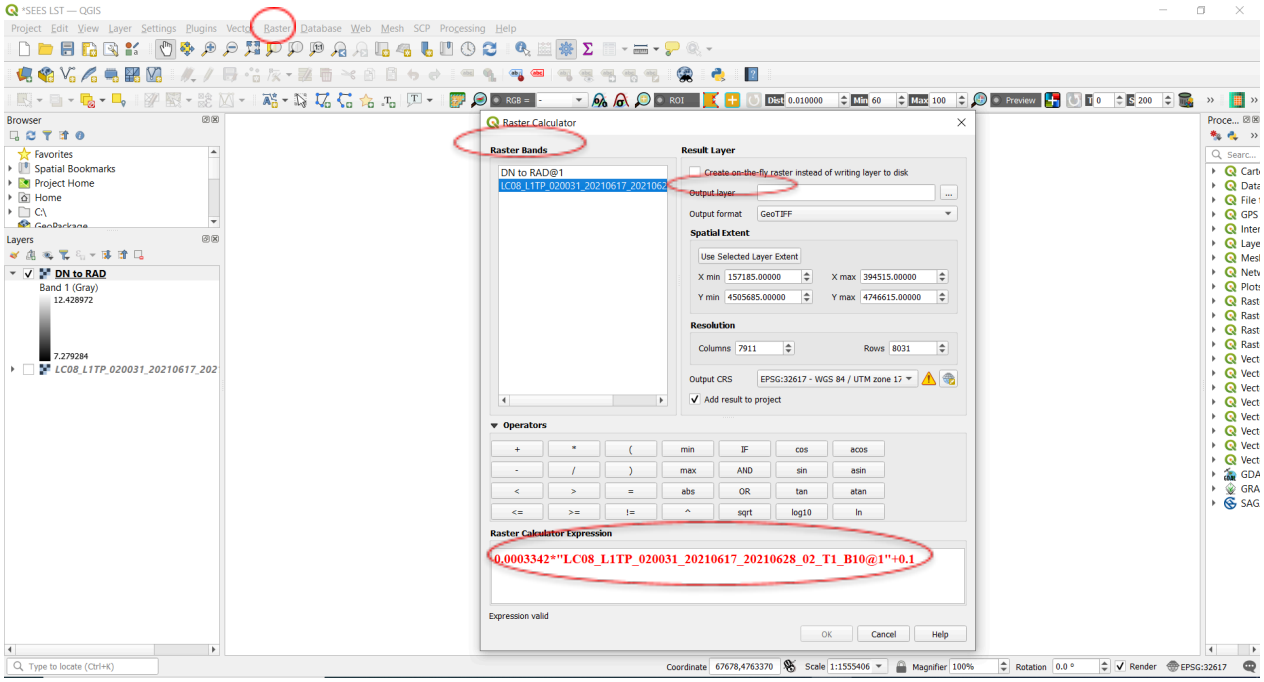
Q_{cal}= the Band 10 image.

$A_{L=}$ the band-specific additive rescaling factors,
O_i= the correction for Band 10.

Step 6: Do the Calculation in Raster Calculator

For example: 0.0003342*Band 10+0.1

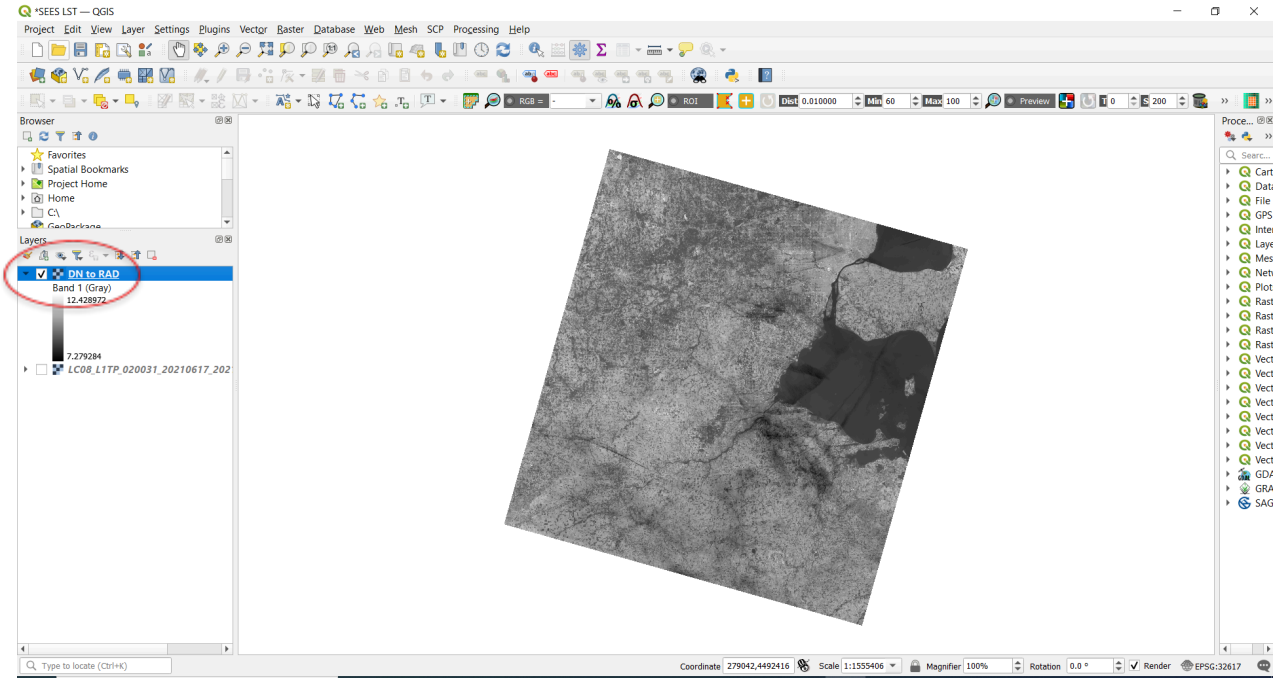
Step 7: Click “Raster” on the menu, then click “Raster Calculator”



Step 8: Input the formular for calculating RAD

For example: 0.0003342*Band 10+0.1

Input the file name, Save it as RN to RAD 10, and Click Ok



Section 2: Conversion of RAD to Top of Atmosphere Brightness Temperature (TOABT)

Step 1: Open the Metadata in the LandSat Bundle Folder

Using the Formular below:

(b) Conversion of radiance to At-Sensor temperature

Equation 2

$BT=K_2/(In(k_1/L\lambda)+1)-273.15,$

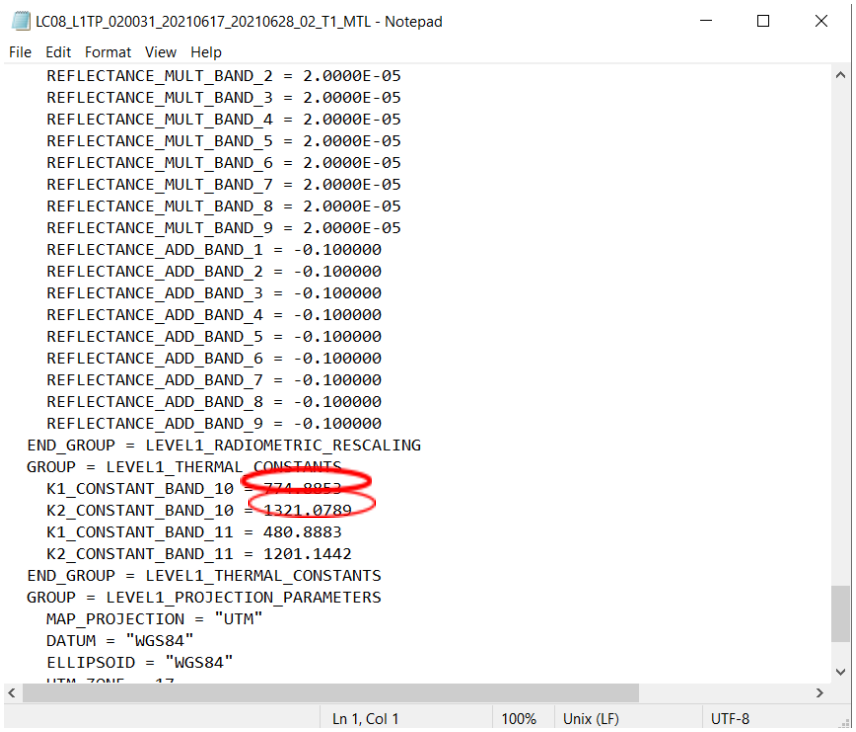
Where,

$k_{1\ and}\ k_{2=}$ specific thermal conversion constants from the metadata

(For obtaining the result in Celsius, the radiant temperature is revised by adding the absolute zero (approx.. -273.15^o C)

Step 2: Pick K1 constant band 10=774.8853 from the metadata file

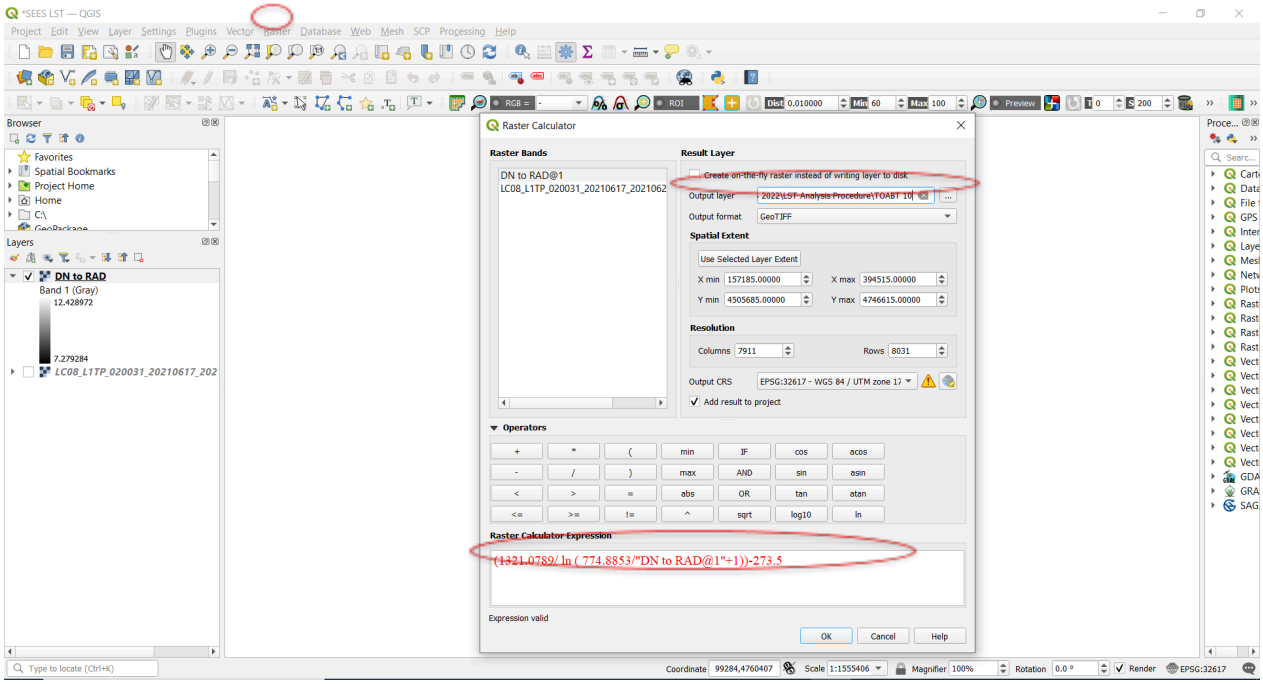
Pick K2 constant band 10=1321.0789 from the metadata file

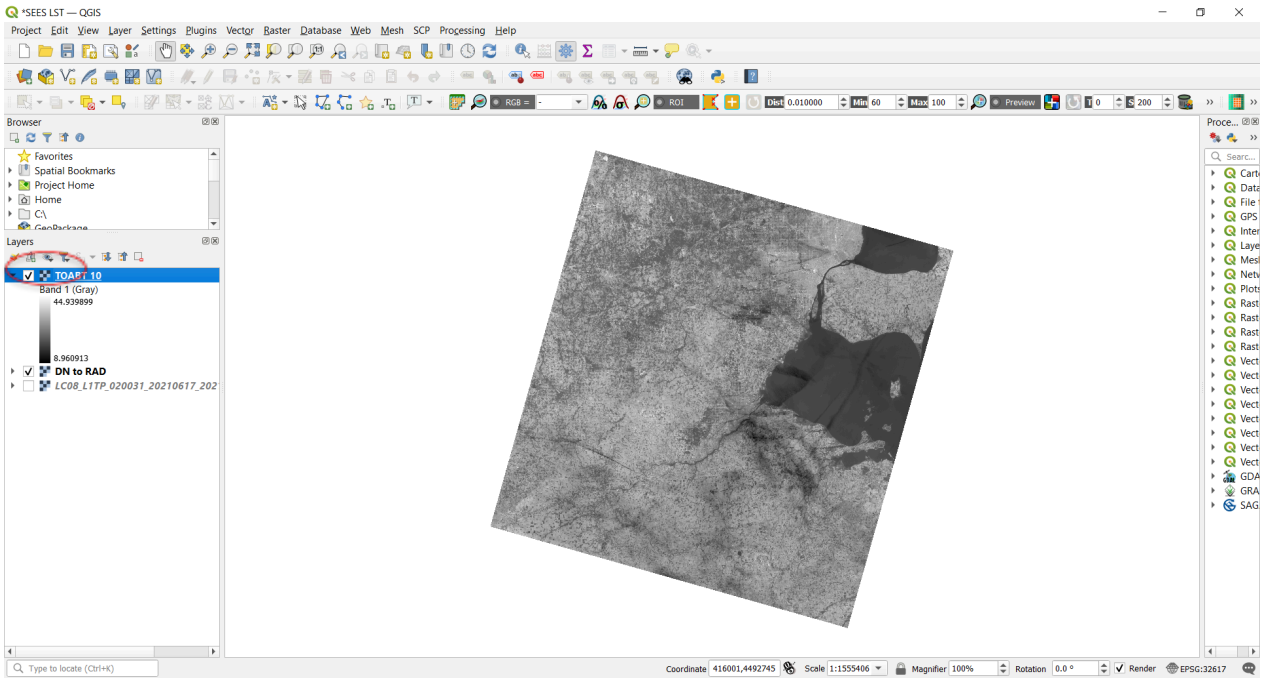


Step 3: Perform the calculation in Raster calculator

(1321.0789/ln(774.8853/"RAD 10"+1))-273.5

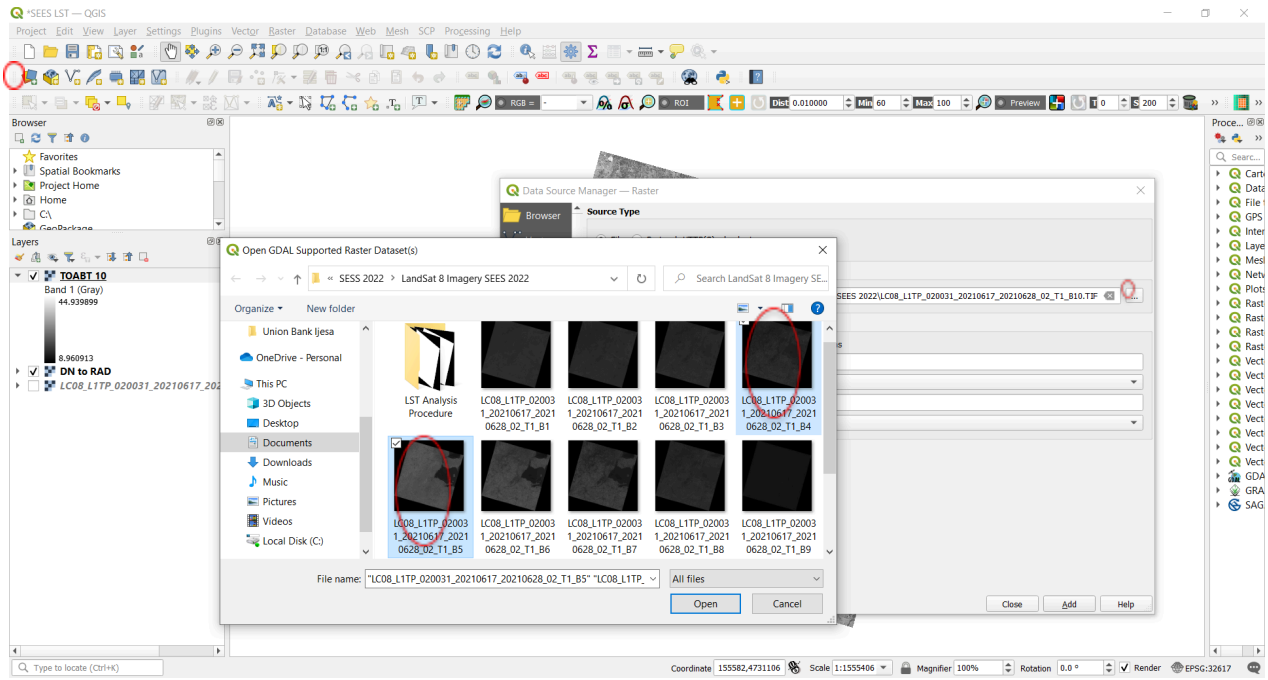
Step 4: Save as TOABT 10

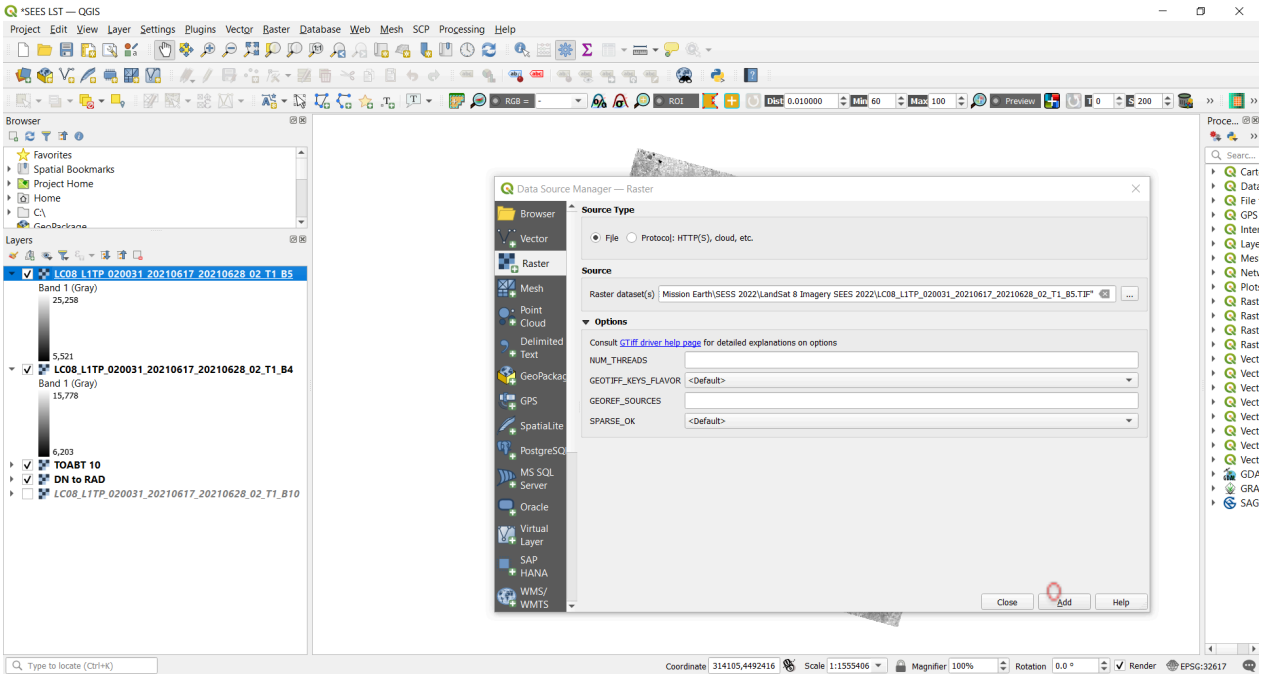

*SEES LST — QGIS
Project Edit View Layer Settings Plugins Vector Raster Database Web Mesh SCP Processing Help
Raster Calculator
Raster Bands
DN to RAD@1
LC08_L1TP_020031_20210617_2021062
Result Layer
Create on-the-fly raster instead of writing layer to disk
Output layer
2022\LST Analysis Procedure\TOABT 10
Output format
GeoTIFF
Spatial Extent
Use Selected Layer Extent
X min 157185.00000
X max 394515.00000
Y min 4505685.00000
Y max 4746615.00000
Resolution
Columns 7911
Rows 8031
Output CRS
EPSG:32617 - WGS 84 / UTM zone 17
Add result to project
Operators
+ * (min IF cos acos
- /) max AND sin asin
< > = abs OR tan atan
<= >= != ^ sqrt log10 ln
Raster Calculator Expression
(1321.0789/ ln (774.8853/"DN to RAD@1"+1))-273.5
Expression valid
OK Cancel Help
Browser
Favorites
Spatial Bookmarks
Project Home
Home
C:\
GeoPackage
Layers
DN to RAD
Band 1 (Gray)
12.428972
7.279284
LC08_L1TP_020031_20210617_202
Coordinate 99284,4760407
Scale 1:1555406
Magnifier 100%
Rotation 0.0 °
Render
EPSG:32617


*SEES LST — QGIS
Project Edit View Layer Settings Plugins Vector Raster Database Web Mesh SCP Processing Help
Browser
Favorites
Spatial Bookmarks
Project Home
Home
C:\
GeoPackage
Layers
TOABT 10
Band 1 (Gray)
44.939899
8.960913
DN to RAD
LC08_L1TP_020031_20210617_202
Coordinate 416001,4492745
Scale 1:1555406
Magnifier 100%
Rotation 0.0 °
Render
EPSG:32617

Session 3: Calculating NDVI

Step 1: Pick **Band 4 and 5** from the metadata file, Click on Add data menu, locate where the Bands 4 and 5 are located, and highlight the bands 4 and 5 the click open.

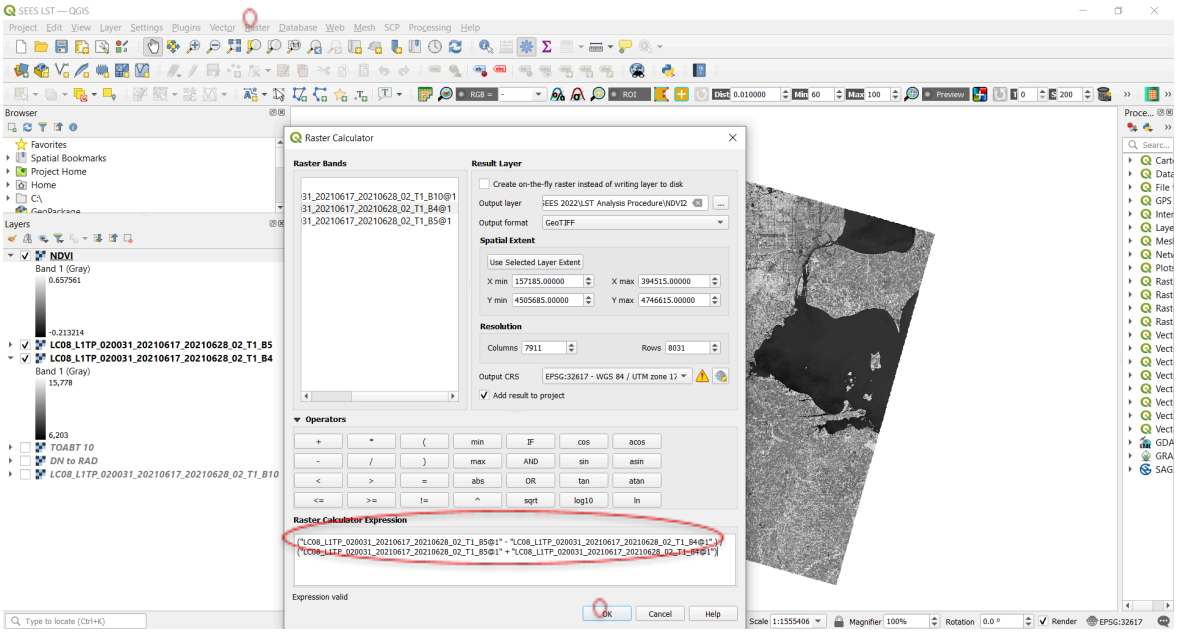




Step 2: Use the formula below to calculate NDVI in QGIS

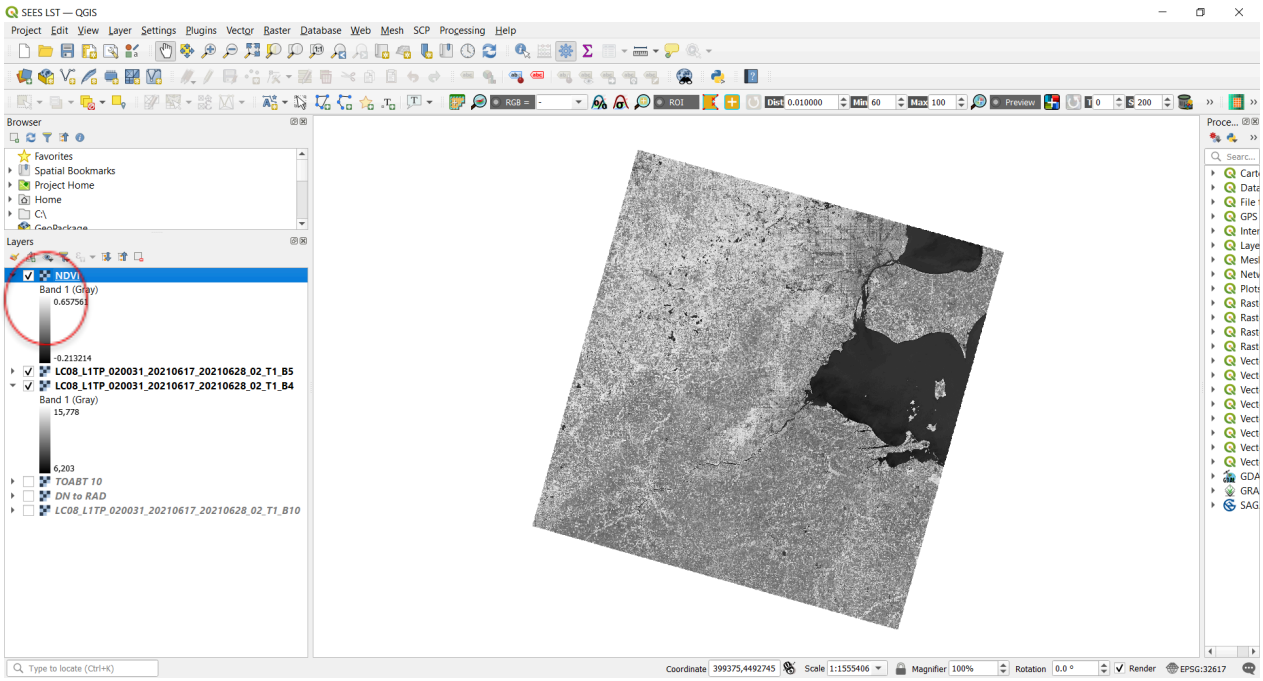
Step 3: Do the calculation in Raster calculator

(Band5-Band4)/(Band 5+Band 4)

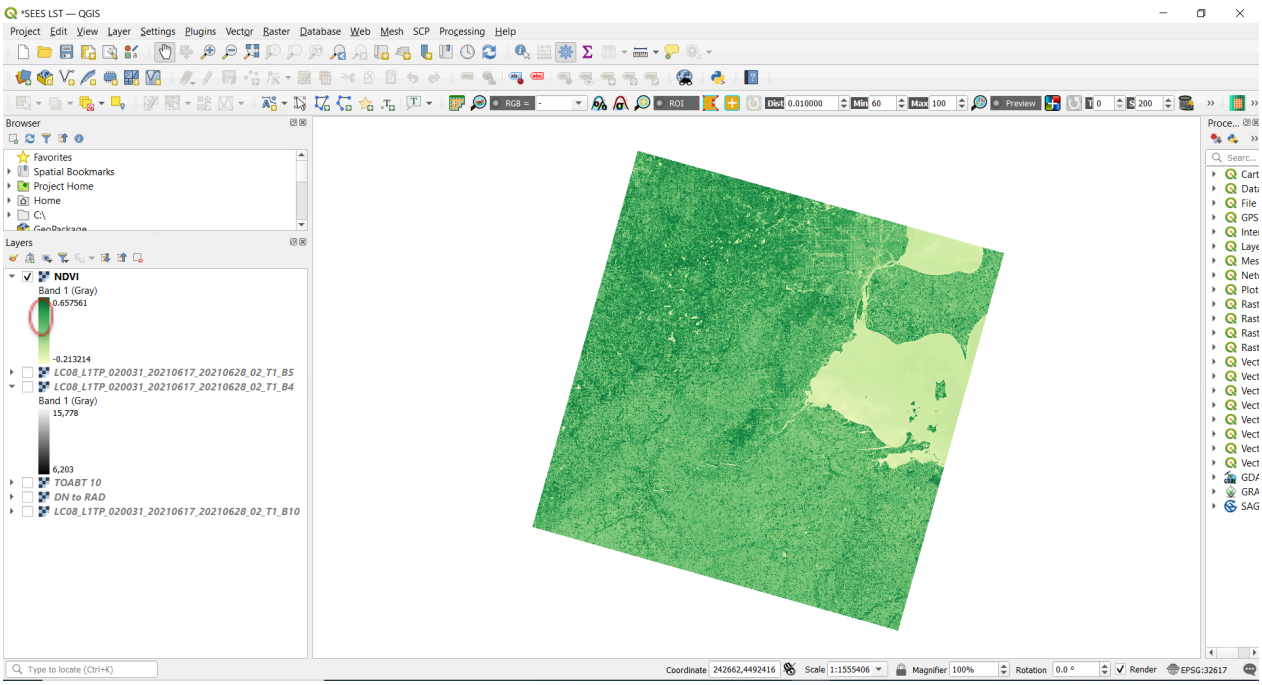


Step 4: Add the File name **NDVI** and Click Ok

The result comes up on the Table of Content on QGIS



Change the Symbology for the NDVI to suit your interest by double clicking the NDVI colour theme.



Session 4: Calculating Pv

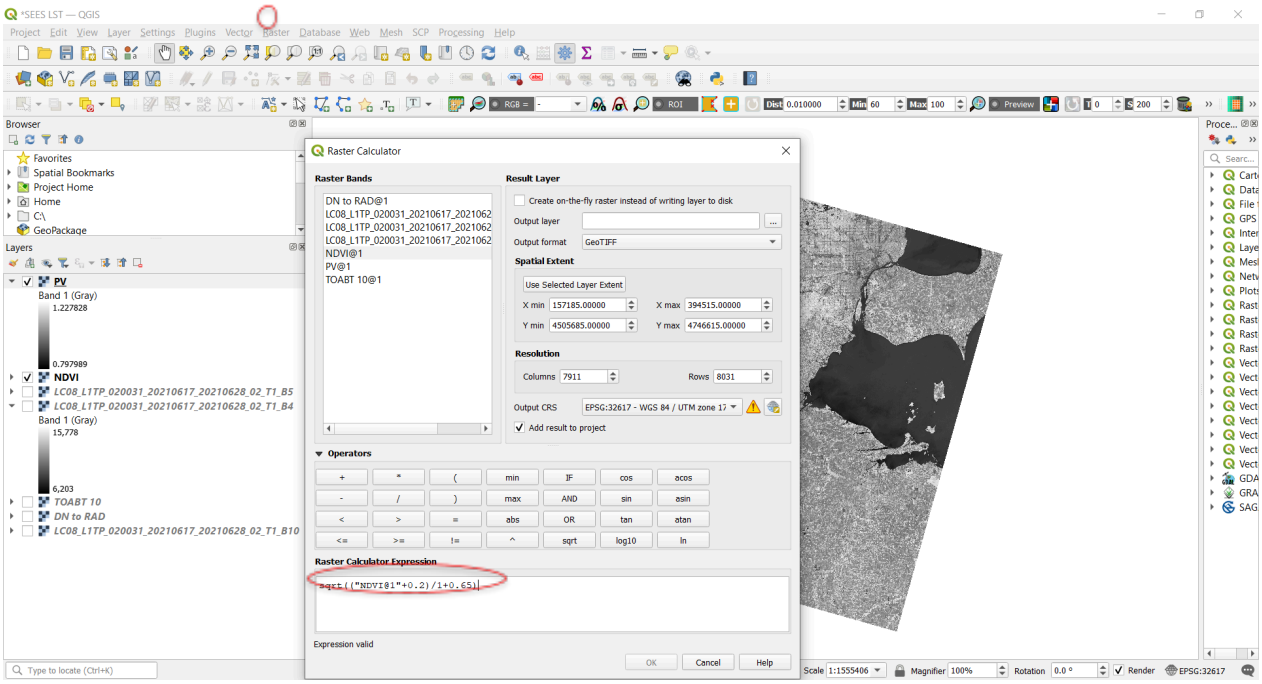
Step 1: Use the formular below:

$$Pv=((NDVI-NDVI_{min})/(NDVI_{max}-NDVI_{min}))^2$$

Note: Check for the max and min values of the NDVI for the Table of Content

Step 2: Do the calculation below in Raster Calculator

Step 3: Square((“NDVI”+1)/(1+1))

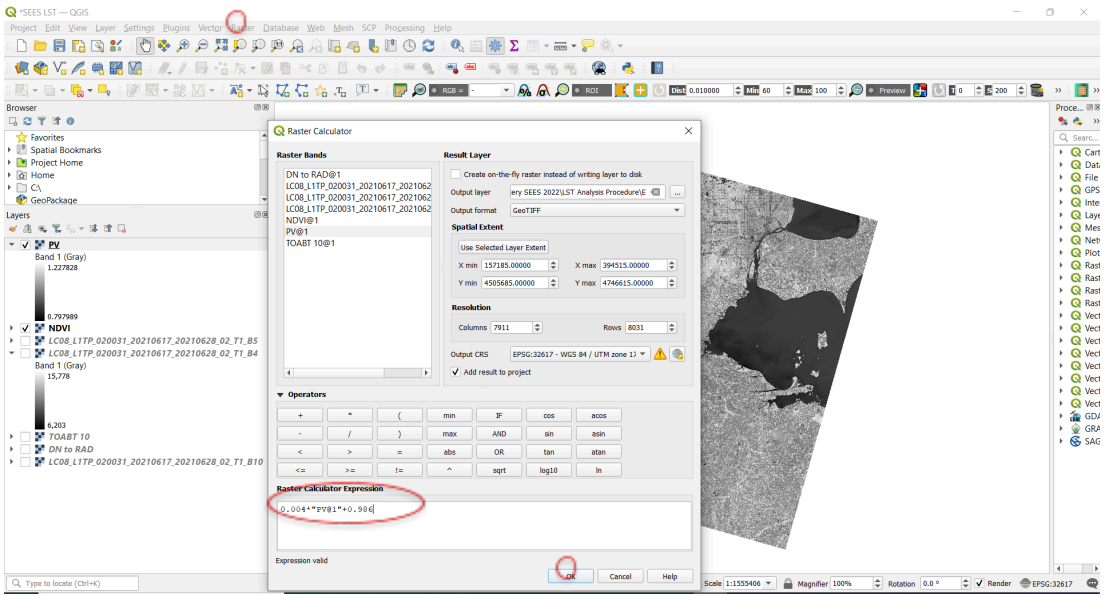


Step 4: Save an Pv and Click Ok

Session 5: Calculation e

Step 1: Do the calculation in Raster calculator

Step 2: Enter it in the Raster Calculator **e=0.004*Pv+0.986**



Session 6: Land Surface Temperature

Step 1: Do the calculation below in Raster Calculator

Step 2: Formular for LST

$$T=TB/(1+(\lambda*TB/C2)*\ln(e))$$

Where;

λ= wavelength of emitted radiance

C2= h*c/s=$1.4388*10^{-2}$ m k= 14388 micron K

h=Planck's constant =$6.626*10^{-14}$ Js

s=Boltzmann constant=$1.38*10^{-23}$ J/K

c=velocity of light=$2.998*10^{2}$ m/s

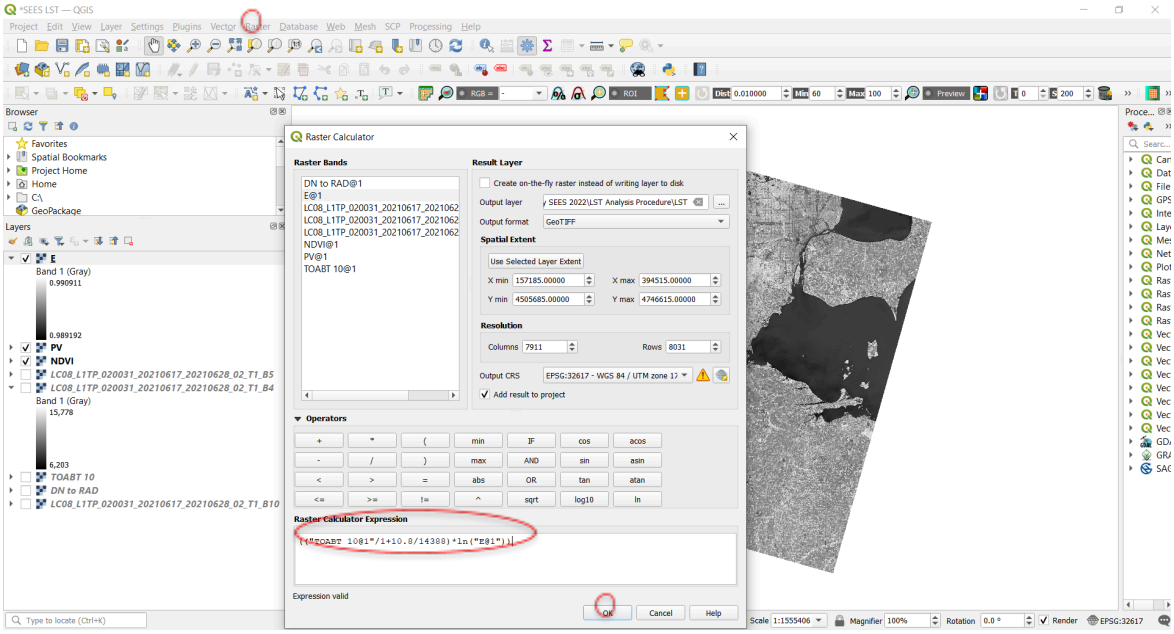
Equation : LST=("TB10"/(1+10.8/14388)*ln("E"))

Step 3: Enter the equation in the Raster Calculator ("TB10"/(1+10.8/14388)*ln("E"))

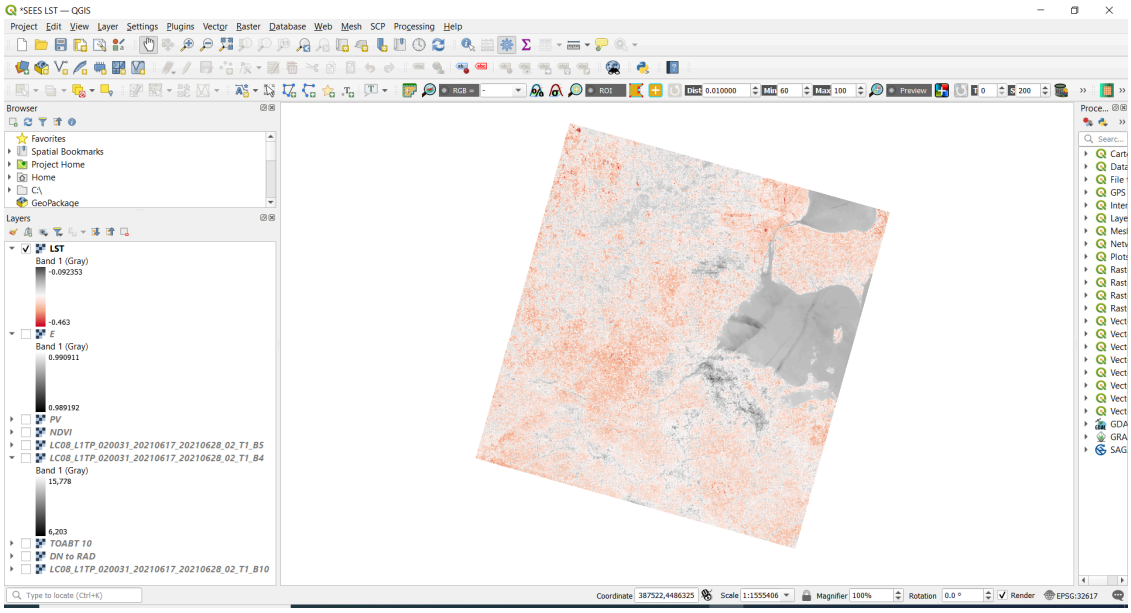
The values for λ for Landsat bands are listed in the following table

Satellite	**Bands**	**λ((microns)**
Landsat 4,5 and 7	6	11.45

Landsat 8	10	10.8
Landsat 8	11	12



Step 4: **Save as LST and click Ok**


*SEES LST — QGIS
Project Edit View Layer Settings Plugins Vector Raster Database Web Mesh SCP Processing Help
Browser
Favorites
Spatial Bookmarks
Project Home
Home
C:\
GeoPackage
Layers
LST
Band 1 (Gray)
-0.092353
-0.463
E
Band 1 (Gray)
0.990911
0.989192
PV
NDVI
LC08_L1TP_020031_20210617_20210628_02_T1_B5
LC08_L1TP_020031_20210617_20210628_02_T1_B4
Band 1 (Gray)
15,778
6,203
TOABT 10
DN to RAD
LC08_L1TP_020031_20210617_20210628_02_T1_B10
Type to locate (Ctrl+K)
Coordinate 387522,4486325
Scale 1:1555406
Magnifier 100%
Rotation 0.0 °
Render
EPSG:32617