National Aeronautics and Space Administration

Data Access and Analysis: Precipitation, Terrain, Socioeconomic Data

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Objectives

- Access Global Precipitation Measurement (GPM) Integrated Multi-satellite Retrievals for GPM (IMERG) precipitation data through Giovanni

- Analyze precipitation, soil moisture, terrain, and Socioeconomic Data and Applications Center (SEDAC) data for the Kerala flood using QGIS to identify low-lying areas with high flood potential and impacts

Requirements

- QGIS installed on your computer
  - https://arset.gsfc.nasa.gov/sites/default/files/users/QGIS-instructions.pdf
- A shapefile and associated raster files provided by trainers of Kerala saved on your computer

Note

- This is a two-part exercise:
  - Part 1 will focus on access and analysis of GPM IMERG precipitation data using Giovanni
  - Part 2 will use the GPM IMERG and Soil Moisture Active Passive (SMAP) data over Kerala, along with SRTM terrain and SEDAC population and Landsat-based urban/rural surface data for analysis

- After the completion of this exercise you will break into groups of 5
- Based on the results of this exercise the groups will put together a 5-7 minute presentation that each group will present in the last session of the day

Part 1: Outline

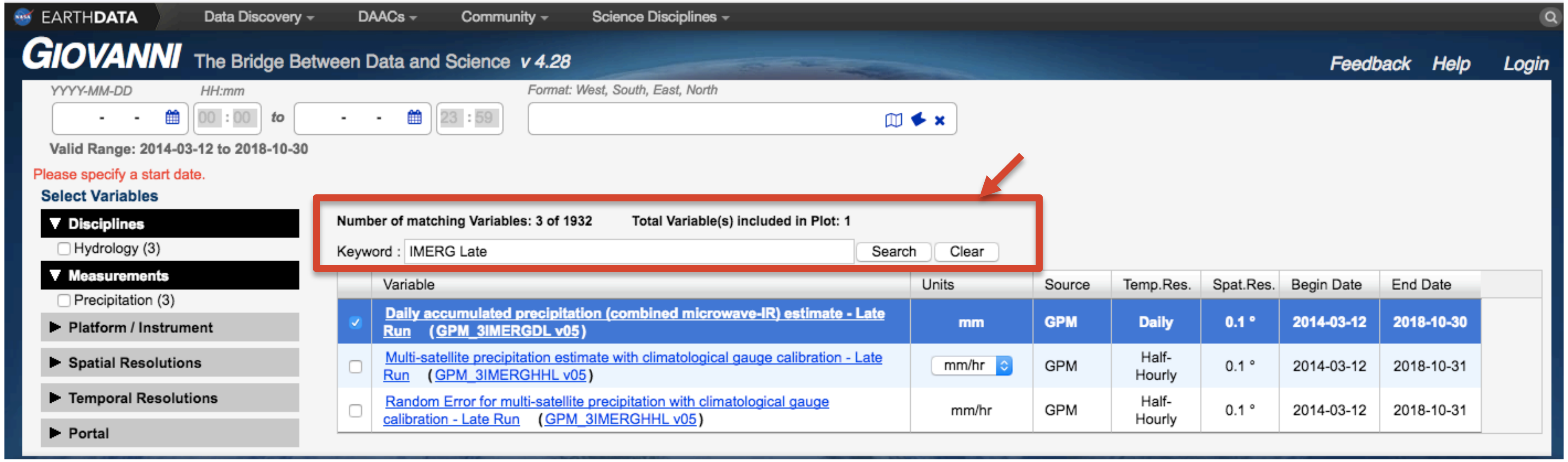
- Examine precipitation during August 2018 in Kerala
- Subset and make time series of GPM IMERG precipitation data using Giovanni
  - Giovanni is an online environment created by NASA for the display and analysis of geophysical parameters to access data
  - With Giovanni, you can find and display data in different types of plots
  - Giovanni also allows you to download the plot source files in NetCDF format (along with other formats)
- Examine and download a map of GPM IMERG precipitation using Giovanni

Part 1: Giovanni for GPM-IMERG Data Access and Analysis

1. Go to Giovanni: http://giovanni.gsfc.nasa.gov/giovanni
2. On the Giovanni page you will see the following options:
   - **Select Plot:** allows selection of analysis options
   - **Select Data Range (UTC):** allows selection of a time period
   - **Select Region (Bounding Box or Shape):** allows selection of a geographic region by latitude-longitude, map, or shapefile
   - **Keyword:** allows search of data parameters by keyword
   - **Plot Data:** (located on the bottom right of the page) begins the action to make a desired plot

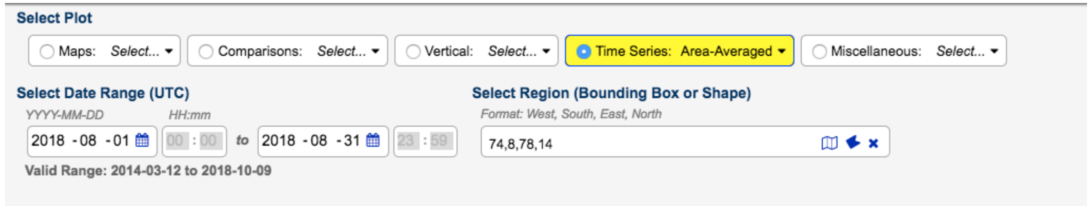
Part 1: Subset GPM IMERG Rainfall and Plot Time Series

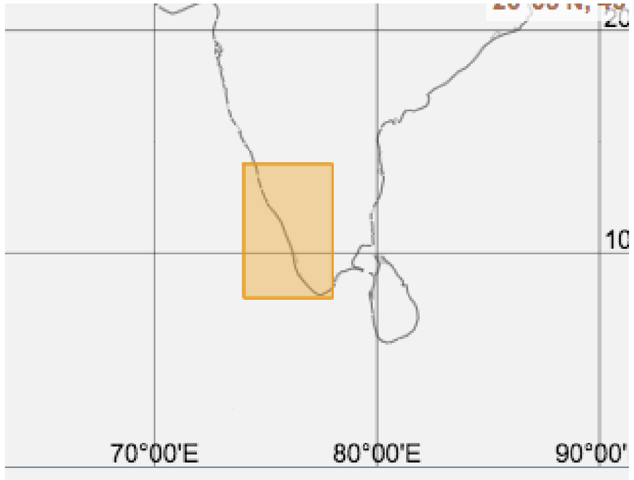
3. Enter the following options:
   - Next to **Keyword**
     - Enter IMERG Late. Click **Search**
     - Select **Daily accumulated precipitation (combined microwave-IR) estimate – Late Run (GPM_3IMERGDL_v05)**



Part 1: Subset GPM IMERG Precipitation and Plot Time Series

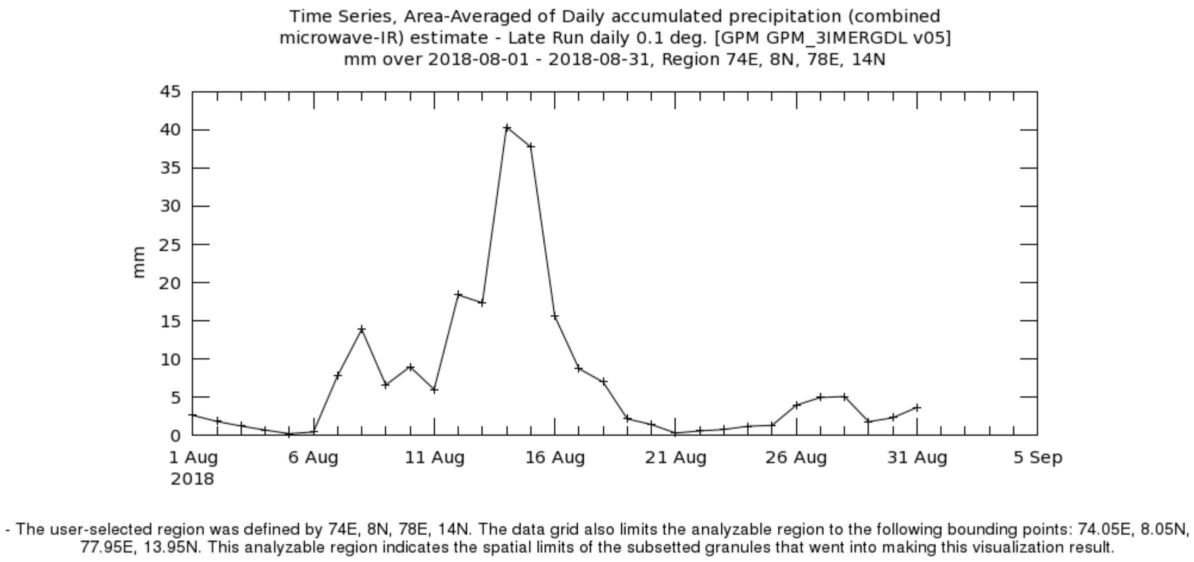
- Under Select Plot select **Time Series: Area-Averaged**
- Under Select Region (Bounding Box or Shape)
  - Enter the longitude-latitude around Kerala: 74.0,8.0,78.0,14.0
  - Note: east longitudes and north latitudes are positive. West longitudes and south latitudes are negative.
  - Click on the map icon to see the region
- Under Select Date Range (UTC)
  - In the **YYYY-MM-DD** windows, enter **2018-08-1** for the start date and **2018-08-31** for the end date



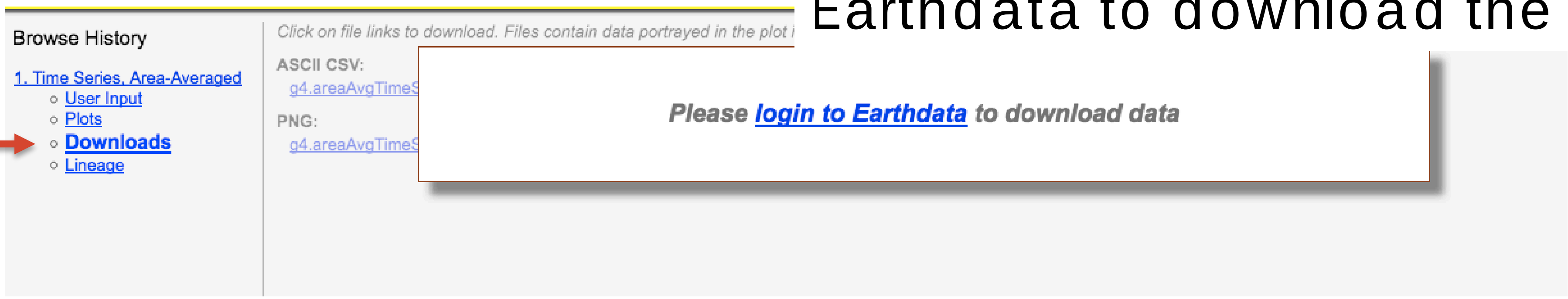


Part 1: Plot Time Series and Download

- Click on **Plot Data** (on the bottom right)
- You will get the time series of daily accumulated rainfall for August 2018, averaged over the selected domain
- Click on **Download** (on the left menu bar) to save the time series image and also the csv file on your computer



Note: you will have to login to NASA Earthdata to download the data

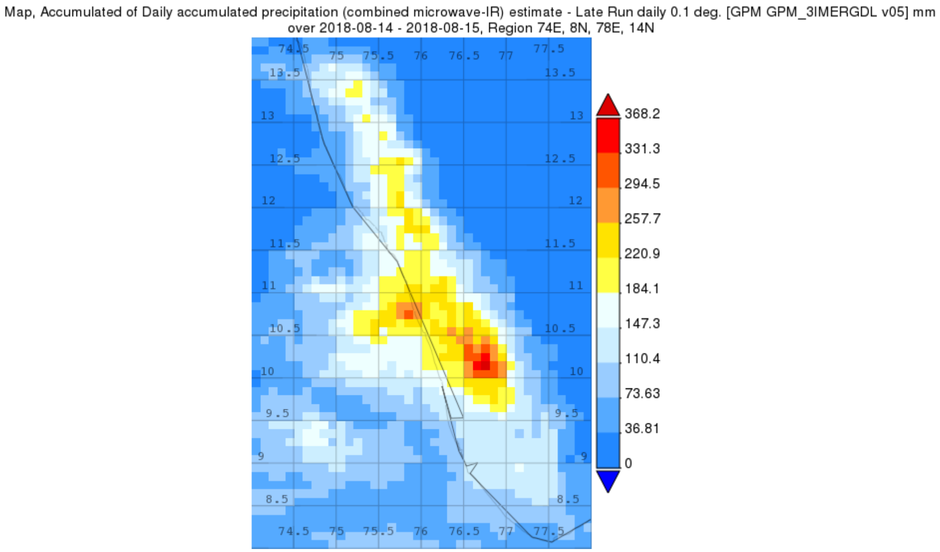


Part 1: Questions

1. Which day had the maximum precipitation? How much?

2. Which period of the month experienced daily precipitation > 15 mm?

Part 1: Plot IMERG Rainfall Maps



3. Click on **Back to Data Selection** (bottom right)
   – Under Select Plot, select **Map: Accumulated**
   – Under Select Date Range (UTC)
      • In the **YYYY-MM-DD** windows, enter **2018-08-14** to start and **2018-08-15** for the end date
   - Click on **Plot Data** (on the bottom right)
   - You will get the map of accumulated rainfall
   - Click on the **Downloads** link on the left, and you will see multiple file options. Choose the NetCDF (.nc) file by clicking on the link to save the file to your computer for later use in QGIS

Part 2: Outline

- Conduct precipitation, terrain, and SEDAC data analysis for the Kerala flood using QGIS
- Load IMERG precipitation raster saved in Part-1 into QGIS
- Copy and load SRTM terrain and SEDAC data (population, impermeable surface) – you have been given this data on a USB drive to copy on your computer
- Calculate slope using the SRTM data
- Analyze all the data sets to identify areas with high flood potential and impacted population

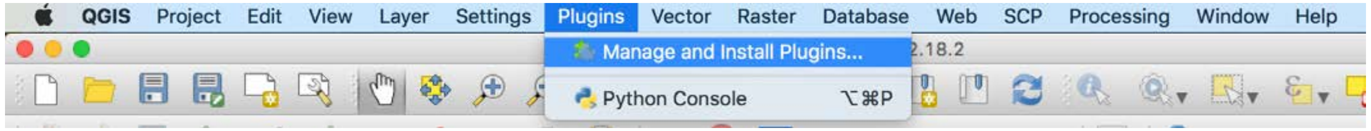
Note

- We will resample the precipitation data, which is at 0.1 degree (10 km) to 0.01 degree (1 km) resolution

- We will clip all the data to the state of Kerala using the shapefile

Precipitation Analysis in QGIS

1. Open QGIS and start a new project. Save the project to a working folder as Kerala
2. Set the Project → **Properties** → **CRS** → WGS84, EPSG:4326
3. On the top menu bar, click on **Web** to check if you have **OpenLayers plugin**



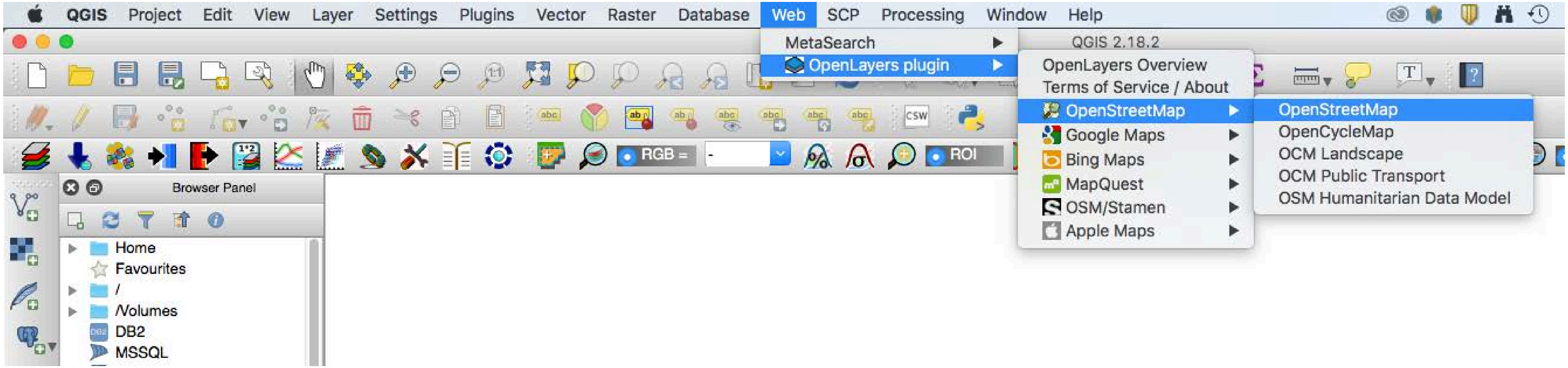
If you do not have the OpenLayers plugin:

- Select **Plugins** from the top menu, and choose **Manage and Install Plugins**
- You will get a window with options for Plugins
- Enter OpenLayers in the search window*
- Click on the **OpenLayers plugin** and press **Install plugin** in the bottom right

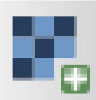
* If you do not see the OpenLayers plugin, click on **Settings** and check the box for **Show also experimental plugins**

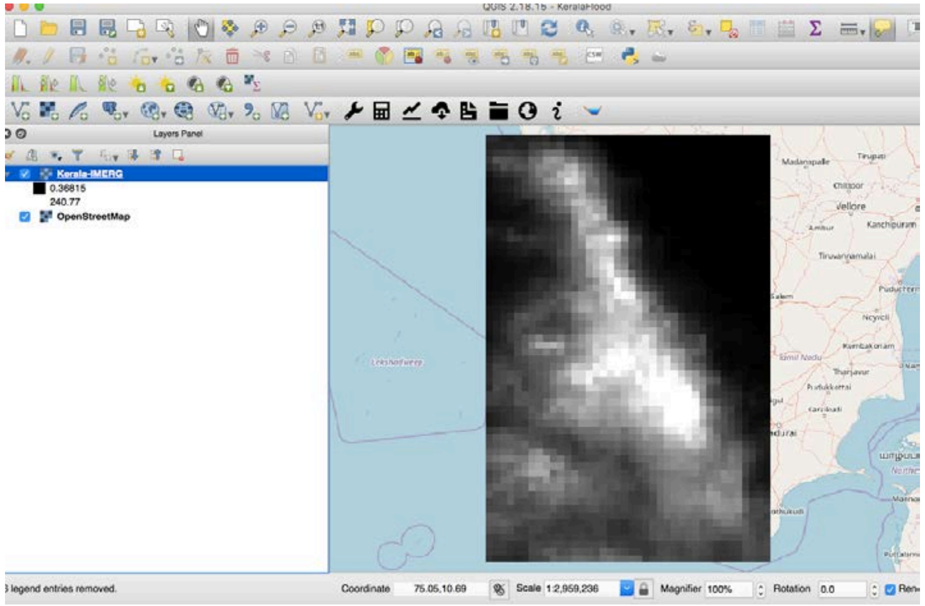
Precipitation Analysis in QGIS

3. From the top menu bar, click on **Web**, select **OpenLayers plugin** and select a background map
4. This exercise uses the plugin **OpenStreetMap**



Add IMERG NetCDF Data

5. In your QGIS map, click on the **Add Raster**  function on the left
6. Navigate to your accumulated precipitation (.nc) data file saved from Giovanni analysis and click on **Open** to add
   – A **Coordinate Reference System Selector** box may pop up. Select WGS84, EPSG:4326
   – From the top Menu Bar, use the **Zoom In** tool to zoom in and out on the layer

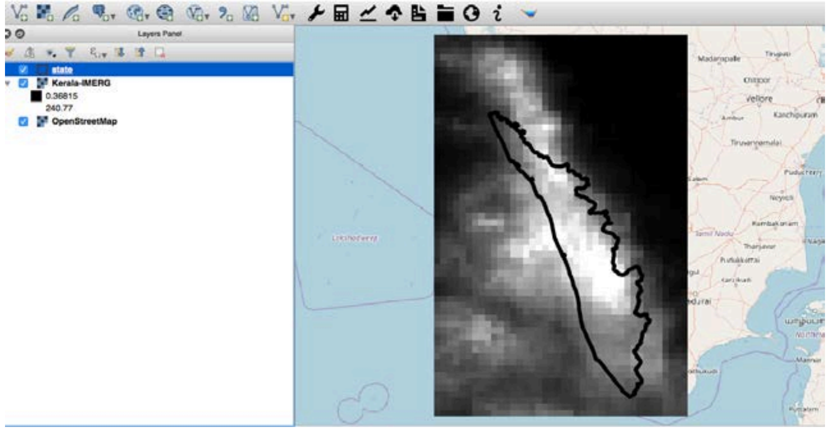


Note: These NetCDF images have to be converted to GeoTIFF images for you to perform raster calculations on the data

Convert NetCDF Data to GeoTiff

7. Right-click (or control-click on Mac) on the IMERG (.nc) raster layer
8. From the drop-down menu, select **Export → Save As**
   – Note that the **Format** in the opened window is **GeoTIFF**
   – Make sure the **Add save file to map** option is checked
   – Click on **File name** and enter the folder name where all the data are and enter a file name (Suggestion: Kerala-Rain) and click **OK**
   – You will see the GeoTIFF layer displayed on the map and the file will be saved to the data folder
9. Now you can remove the NetCDF raster layers by right-clicking on each layer and choosing **Remove Layer**

Add Kerala State Shapefile



10. Click on the menu on the left bar and click **Add Vector** to add the Kerala shapefile (state.shp). Click Add
11. To make the shapefile transparent with only the border outlined, right click on the layer file and go to **Properties → Symbology**
12. Click on the down arrow in the Fill window and select **Simple line**
13. Click on the down arrow in the **Outline** window and choose a color of the shapefile boundary (This example uses black)
14. Set the **Stroke width** to be 1.5 Millimeter
15. Click **OK** to get the following result in the QGIS window

Resample IMERG Rainfall Data

16. In the top menu, select Processing → Toolbox. A search window will appear to the right of the map. Type “warp”
    – You should see r.resample.interp from the list
17. Double click on r.resample.interp – this will open a new window

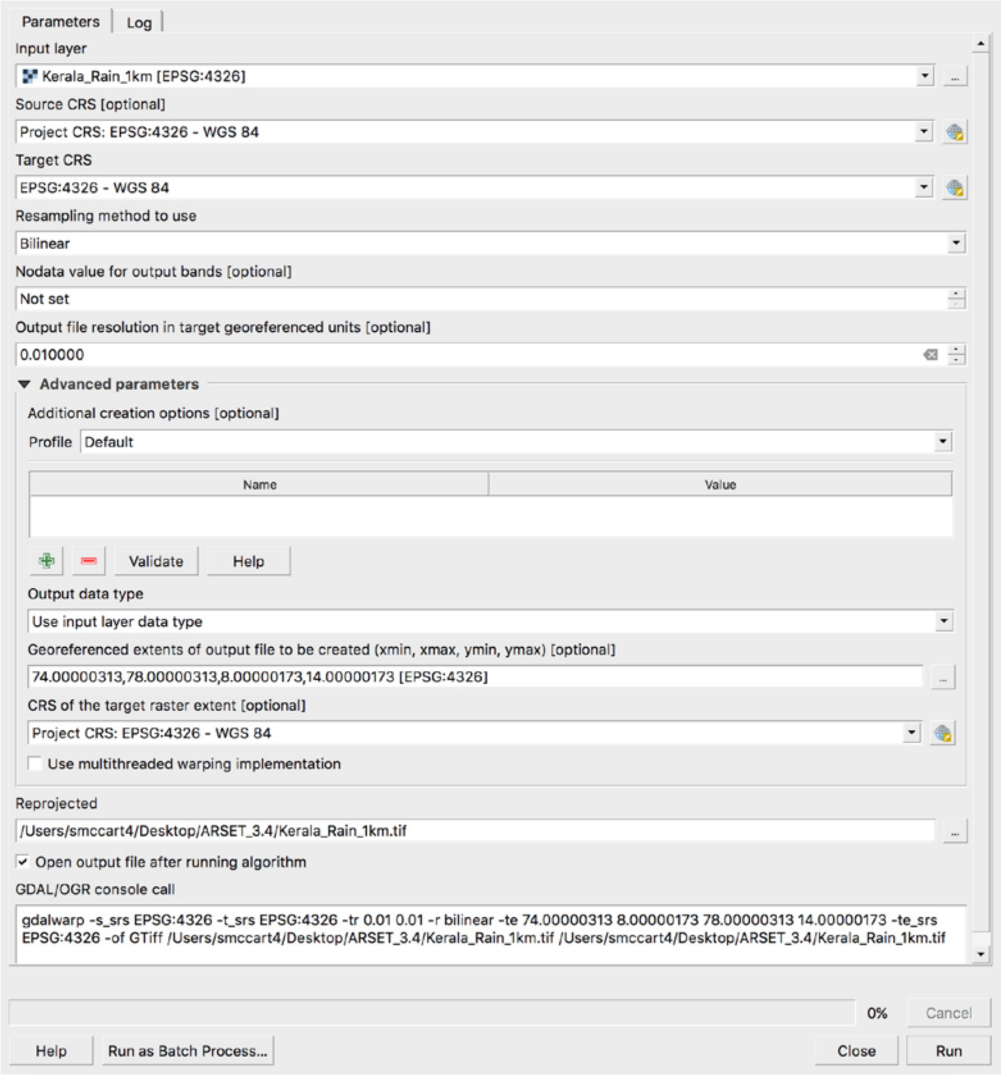
Resample IMERG Rainfall Data

18. In the **Input raster layer** window use the dropdown menu to select Kerala-Rain
    - In the Source CRS dropdown menu select EPSG:4326 – WGS 84
    - In the **Sampling Interpolation method**, choose **bilinear**
    - In the **GRASS GIS 7 region extent (xmin,xmax,ymin,ymax)**, choose **Use layer extent → Kerala-Rain**
    - In the **GRASS GIS 7 region cell size** enter: **0.01**
    - Click on **Resampled Interpolated → Save to file →** project folder → Kerala_Rain_1km
    - Make sure to check the box **Open output file after running algorithm**
    - Click **Run**

Resample IMERG Rainfall Data

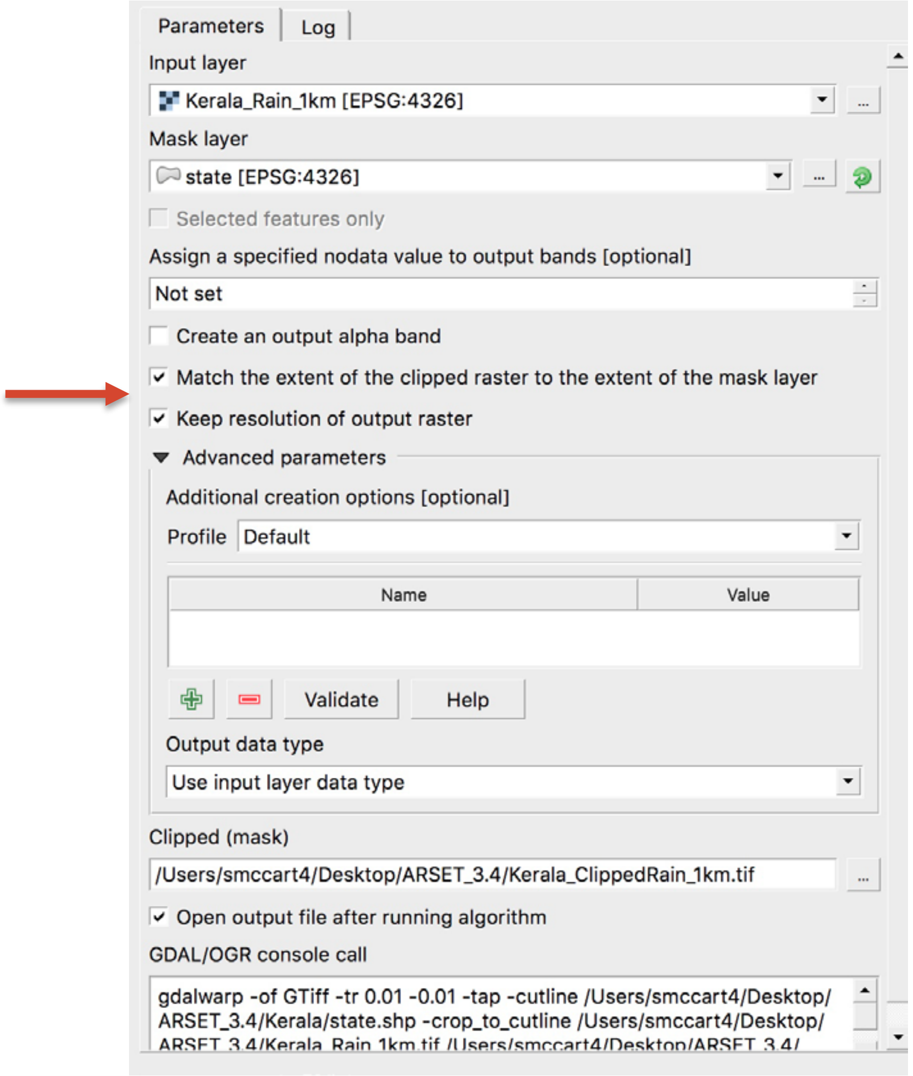
- You will see a new layer in your Layers Panel: **Resampled Interpolated**
- Rename this layer (right click) → **Rename Layer → Kerala_Rain_1km**

[Note: we are not creating any new information – just interpolating precipitation at a higher resolution for spatial analysis]



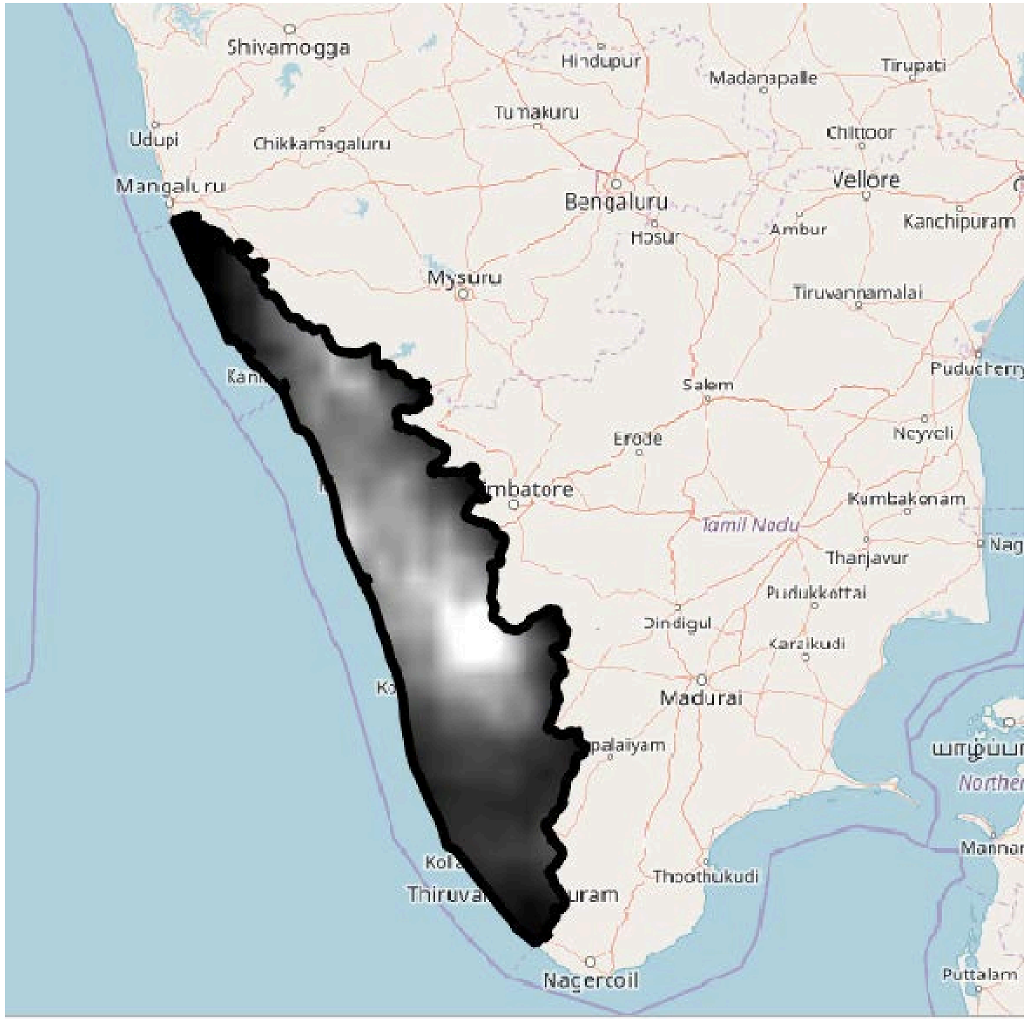
Clip IMERG Rain Data to the Kerala Shapefile

19. Now clip the interpolated rain layers to the Kerala state shapefile
    - On the top bar go to **Raster → Extraction → Clip Raster by Mask Layer**
    - In the Input File (raster) window select **Kerala_Rain_1km**
    - In the **Mask Layer** window select the shapefile state
    - Check the boxes for **Match the extent of the clipped raster to the extent of the mask layer** and **Keep resolution of output raster**



Clip IMERG Rain Data to the Kerala Shapefile

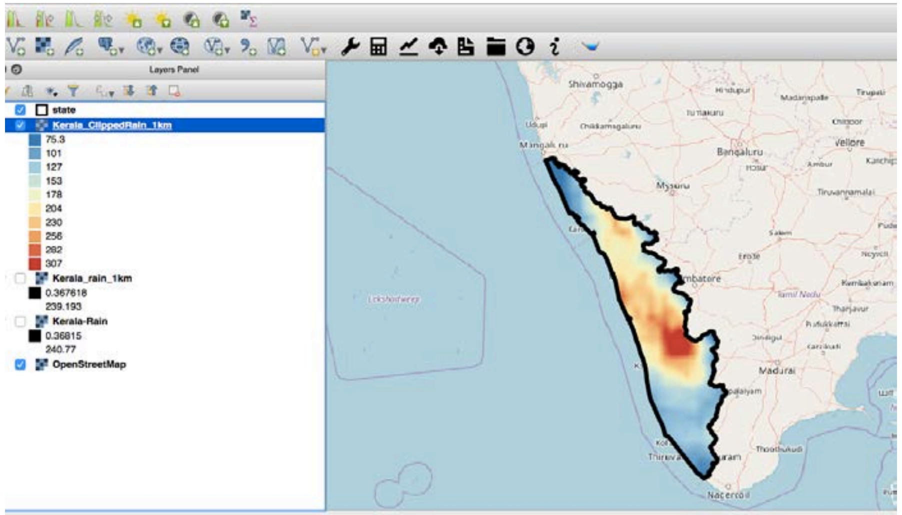
- Enter **Clipped (mask) → Save to file → Working folder → Kerala_ClippedRain_1km**
- Click **OK** on at the bottom right. Now right-click and remove Kerala_Rain_1km from the layers panel



Add Color to the Clipped Rain Layer

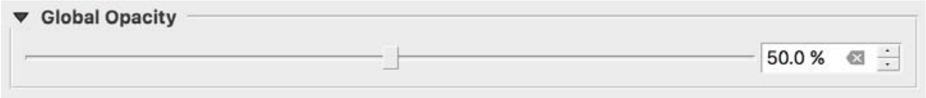
20. Right click on the clipped file Kerala_ClippedRain_1km and go to **Properties → Symbology**
    - Select the **Render Type** as **Singleband Pseudocolor**
    - In **Color ramp**, make sure the Red-Yellow-Blue (RdYlBu) color palette is selected
    - Right-click on color ramp and click **Invert color ramp** so that low runoff values are shown in blue and high in red
    - Keep the default **Min** and **Max** values
    - Below the color display, change the **Mode** to **Equal Interval** and **Classes** to 10. Click **Classify**
    - Click **Apply** then **OK**

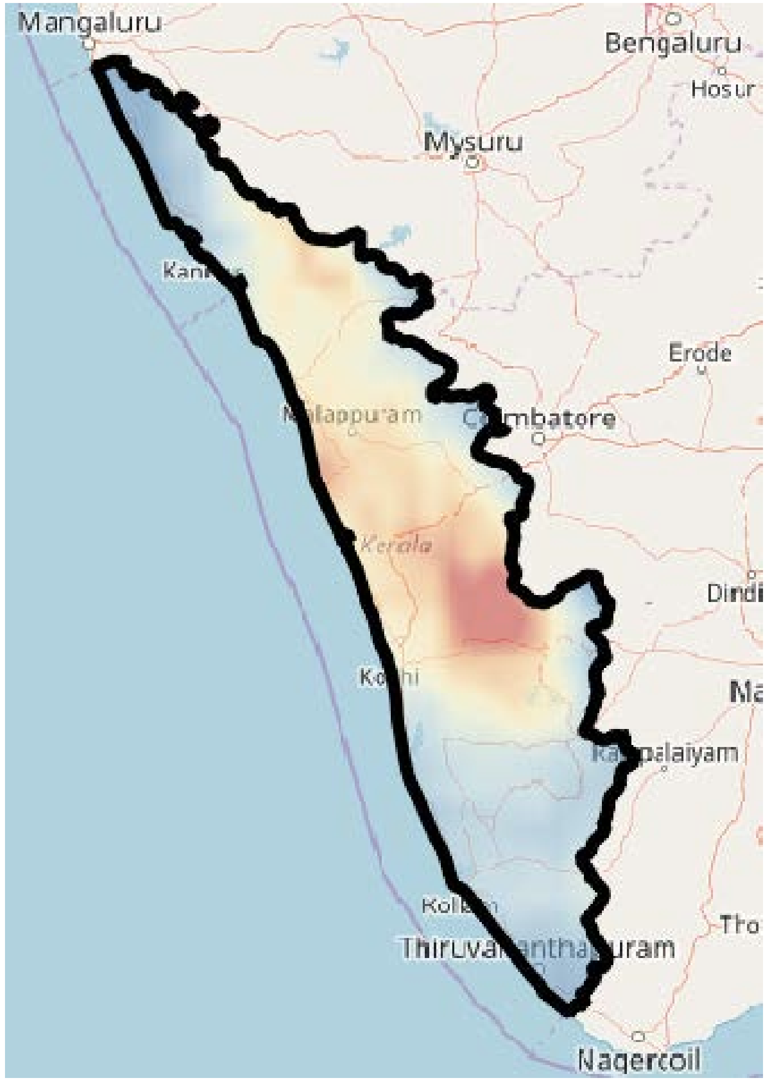
Precipitation



Make the Rain Layer Partially Transparent

21. Right click on the clipped file Kerala_ClippedRain_1km and go to **Properties → Transparency**
22. Make the **Global Opacity** to ~50%
23. Click Apply and OK and you will get the rain layer that is partially transparent and you will see the map on the right





Add SMAP Soil Moisture Data

24. Right-click anywhere in the tool bar and add the **Browser Panel**
25. Using the Browser Panel, select all 16 **SMAP_L3_SM_P_E_xxxxxxxx_Clip.tif** files you copied to your computer and add them to the canvas
    - Using the steps 22-23, add RdYlBu colors to the **first layer** and also make it 50% transparent. Invert the color ramp so red symbolizes higher values
    - Right-click on the first layer → **Styles** → **Copy Style**
    - Select all other SMAP layers → right-click → **Paste Style**

- Where are the highest soil moisture values located?

Add SMAP Soil Moisture Data

- At the top of the screen click on **Plugins → Manage and Install Plugins → Install Value Tool**
- In the Layers Panel select all SMAP layers → right-click → **Group Selected**
- Right-click in the tool bar and open the Value Tool Panel
- In the Value Tool Panel, click on the **Table** tab and explore the values as you move your cursor over the SMAP images
- Next, click on the Graph tab and enter 0 for Y min and 0.75 for Y max
- Move your cursor over the SMAP images again for a time series of the 16 images

Add SRTM Terrain Data

26. Click on the **Add Raster** icon
27. Navigate to the file **Kerala_ClippedSRTM.tif** that you copied to your computer
28. Using steps 22-23, add colors to the SRTM terrain layer and also make it 50% transparent

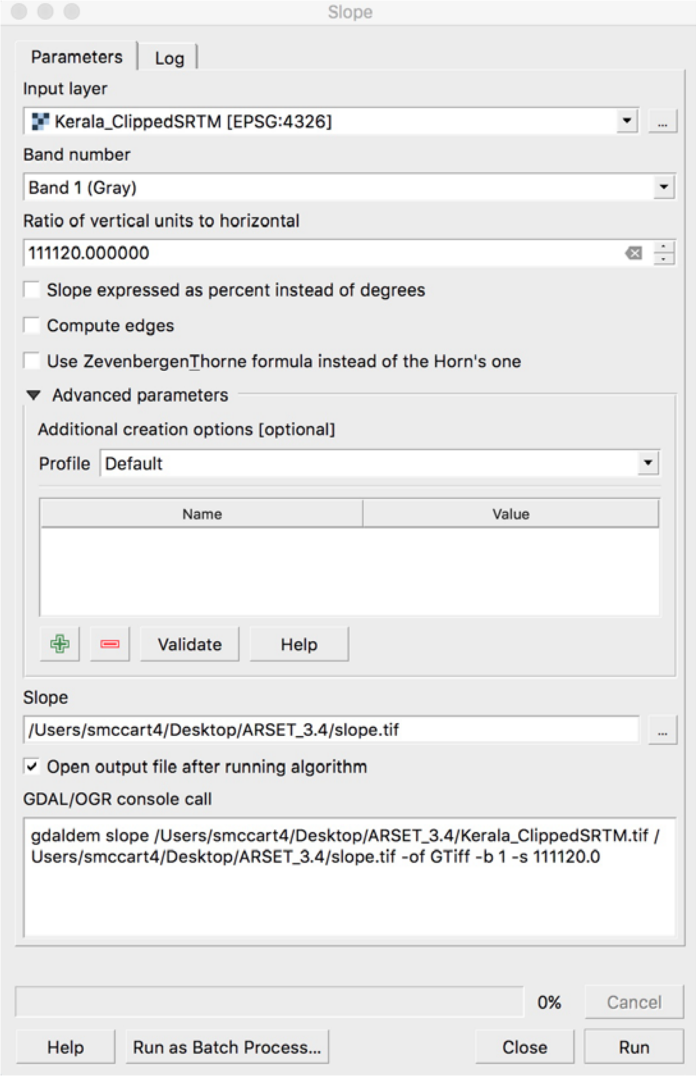
[Note: the color PRGn are used for the terrain layer]

Terrain

Derive Slope from the SRTM Digital Elevation Model

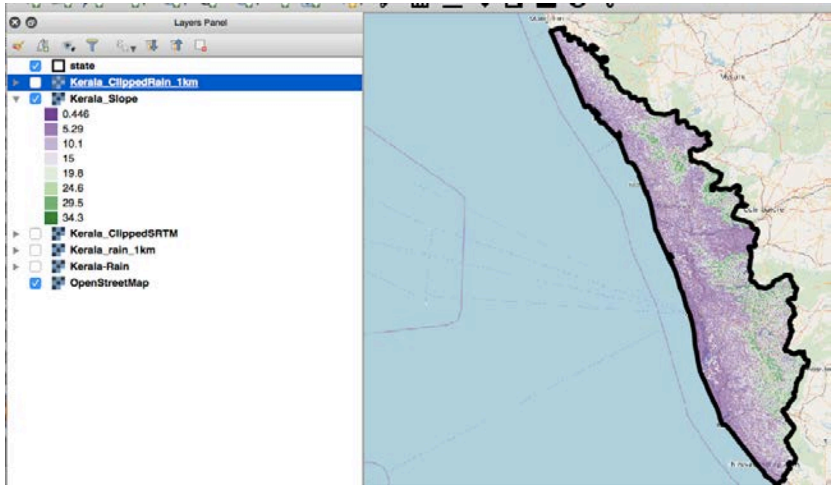
Using the SRTM elevation in QGIS, we can create a slope product using the DEM (Terrain Models) Tool

29. In the top menu, select: **Raster → Analysis → Slope**
30. In the dialog that appears, ensure the Input file is the Kerala_ClippedSRTM.tif file we just visualized

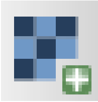


Derive Slope from the SRTM Digital Elevation Model

31. In the **scale (ratio of vert. units to horiz)** box, enter 111120.00 to convert the units to meters
32. **Do not check the Slope expressed as percent box** – the slope will be in degree
33. Set the Output file to your working folder and name ending in .tif (Suggestion: slope.tif)
34. Click **OK**
35. The resulting image displays the slope in degrees
36. Using steps 22-23, change the color and transparency of the slope layer (use PrGn colors)

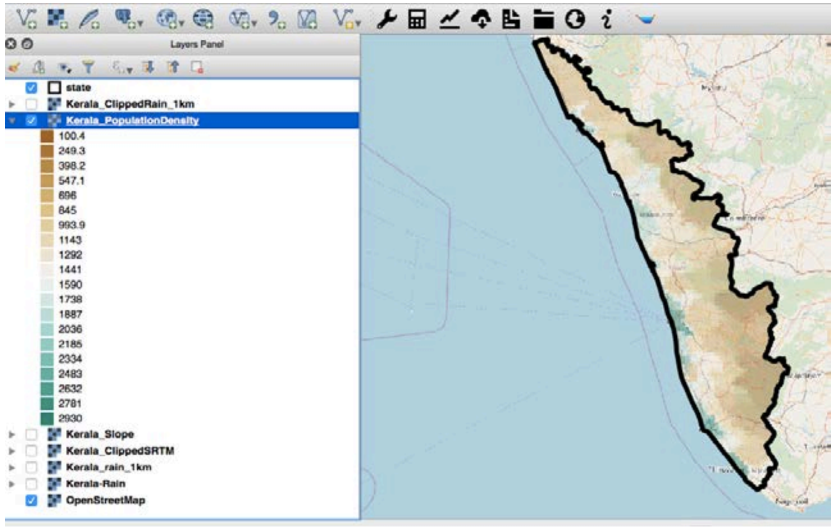


Add Population Density Data

37. Click on the **Add Raster** icon 
38. Navigate to file Kerala_PopulationDensity.tif that you copied to your computer
39. Using the steps 22-23 add colors to the population density layer and make the layers 50% transparent

Note: the color BrBG and 20 intervals are used for the population density layer

39. Examine each layer by turning other layers off
40. Also examine precipitation with slope, population density, and urban areas

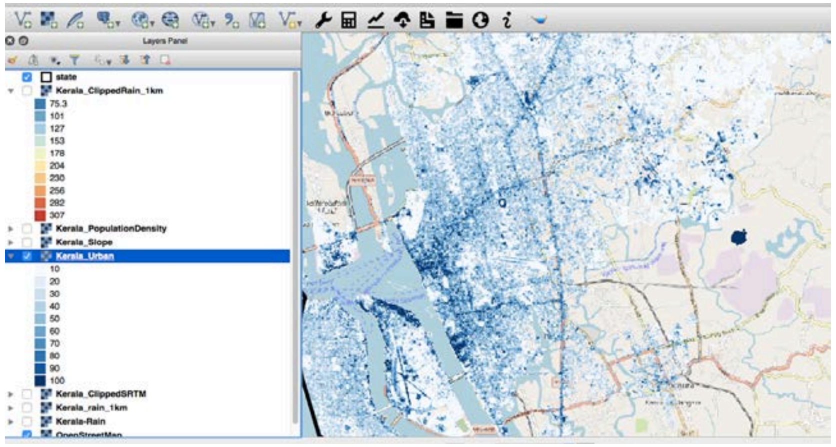


Add Impermeable Surface Data

41. Click on the **Add Raster** icon

42. Navigate to file Kerala_Urban.tif you copied on your computer

43. Using the steps 22-23 add colors to the population density layer and make the layers 50% transparent



Note: the color Blues and 10 intervals are used to highlight the impermeable areas between 10 to 100%

44. Examine each layer by turning other layers off

45. Also examine precipitation with slope, population density, and urban areas

Questions

1. Using the map, write down what the maximum accumulated rain was for August 14-15.
2. What is the terrain height range where the rainfall was maximum?
3. Which city received more rain: Kochi or Alapuza?
4. Examine the slope by zooming in and see where low slope areas are surrounded by high slope ridges.
5. Based on the rainfall and impermeable surface layers, list at least two cities, towns, or urban areas that received >250 mm rainfall.
6. What is the population density range in the areas you listed above in question 5?

Discussion

1. Can the slope information, impermeable surface information, and rainfall help in identifying regions where flooding/water logging may occur?

2. Based on the rainfall, slope, and population density, in which areas might the most number of people have been affected by flooding? Can you confirm this based on in situ reports from news or other sources?