TECHNICAL WORKSHOP

BIHAR STATE POLLUTION CONTROL BOARD

CENTRE FOR SSTUDIES ON ENVIRONMENT AND CLIMATE

Step-by-Step Instruction Guide

For assessing fire events associated to agriculture using Remote Sensing and Geographical Information System (GIS) technique

The document provides step-by-step instruction to visualize and retrieve fire events from satellite retrievals using NASA-FIRMS platforms. The guide also demonstrates step-by-step procedure to analyse the satellite retrieved information using QGIS software.

on

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Time : 11.30 Am onwards

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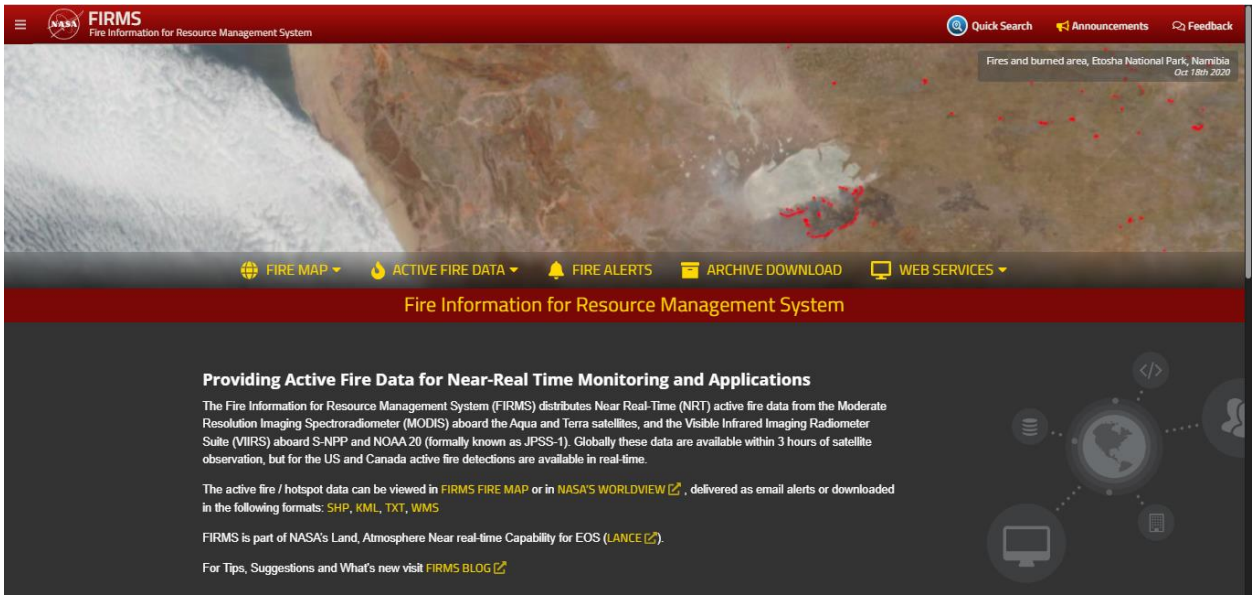
Step by Step guide to access NASA- Fire Information and Resource Management System (FIRMS)

Step 1: Access to NASA- Fire Information and Resource Management System (FIRMS)

The FIRMS platform can be accessed via (https://firms.modaps.eosdis.nasa.gov/)

Or

Search for '**NASA FIRMS**' in Google search box and click on the first link that appears



You must have now landed on the above shown page. Go through the entire page so to develop a basic understanding about the monitoring instruments, products and the overall focus cum rationale of FIRMS.

Let us now see the important tabs/section in this page

1. **Fire Map:** This tab provides access to global fire events for quick visualization. The tab provided additional features for customization such as date filter, monitoring instrument filter, time delineated occurrence, and

gridded visualization facility, etc for more focused interpretations and decision making.

2. **Active Fire Data:** This provides option to access the fire events occurred at 24Hrs/48Hrs/7 days. The data should be downloaded individually for all 3 satellites (namely MODIS*, VIIRS-SUOMI-NPP* and VIIRS-NOAA-20*) based on region of interest. The retrieved data is useful in terms of keeping the track of daily fire occurrences and subsequent ground level interventions.

   *MODIS – Moderate Resolution Imaging Spectroradiometer
   *VIIRS – Visible Infrared Imaging Radiometric Suite
   *NPP – National Polar orbiting Partnership
   *NOAA - National Oceanic and Atmospheric Administration

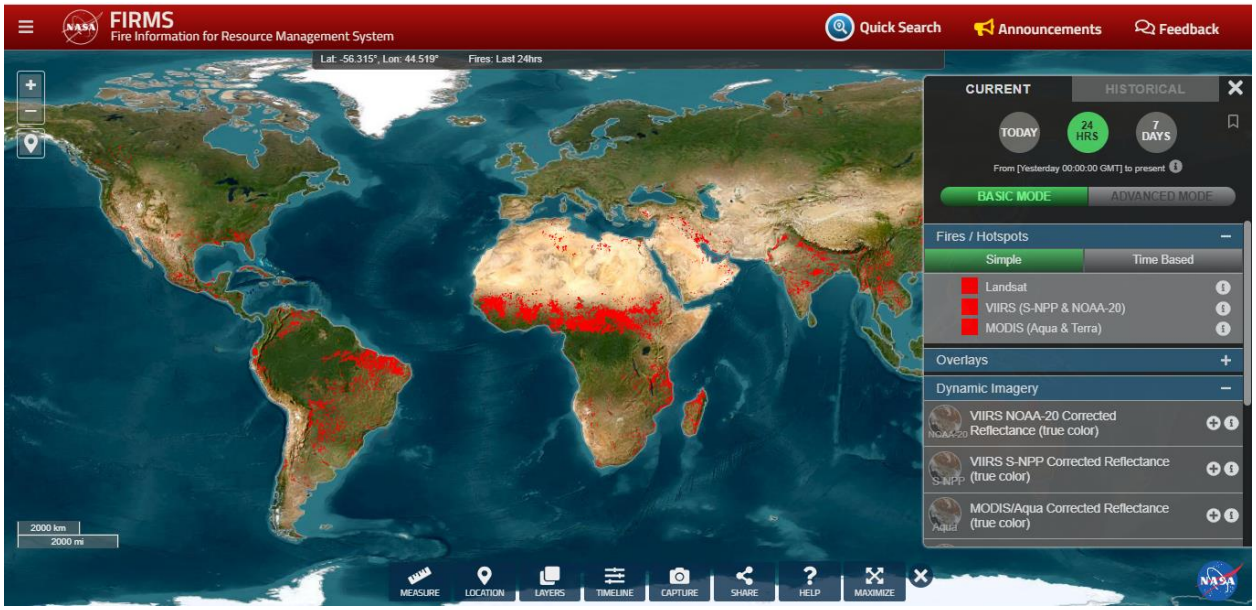
3. **Fire Alerts:** Fire alerts are provided via email on Near Real Time (NRT) basis for immediate ground level actions. The alerts frequency can also be adjusted to daily or weekly depending upon the requirement. The information shared via mail by the service providers are in Comma Separated Value (CSV) format.

4. **Archive Download**: Provides access for downloading long term information pertaining to fire events. These information are useful for analyzing the long term trend in fire event occurrences for policy level decisions and impact of policy level intervention on crop residue burning.

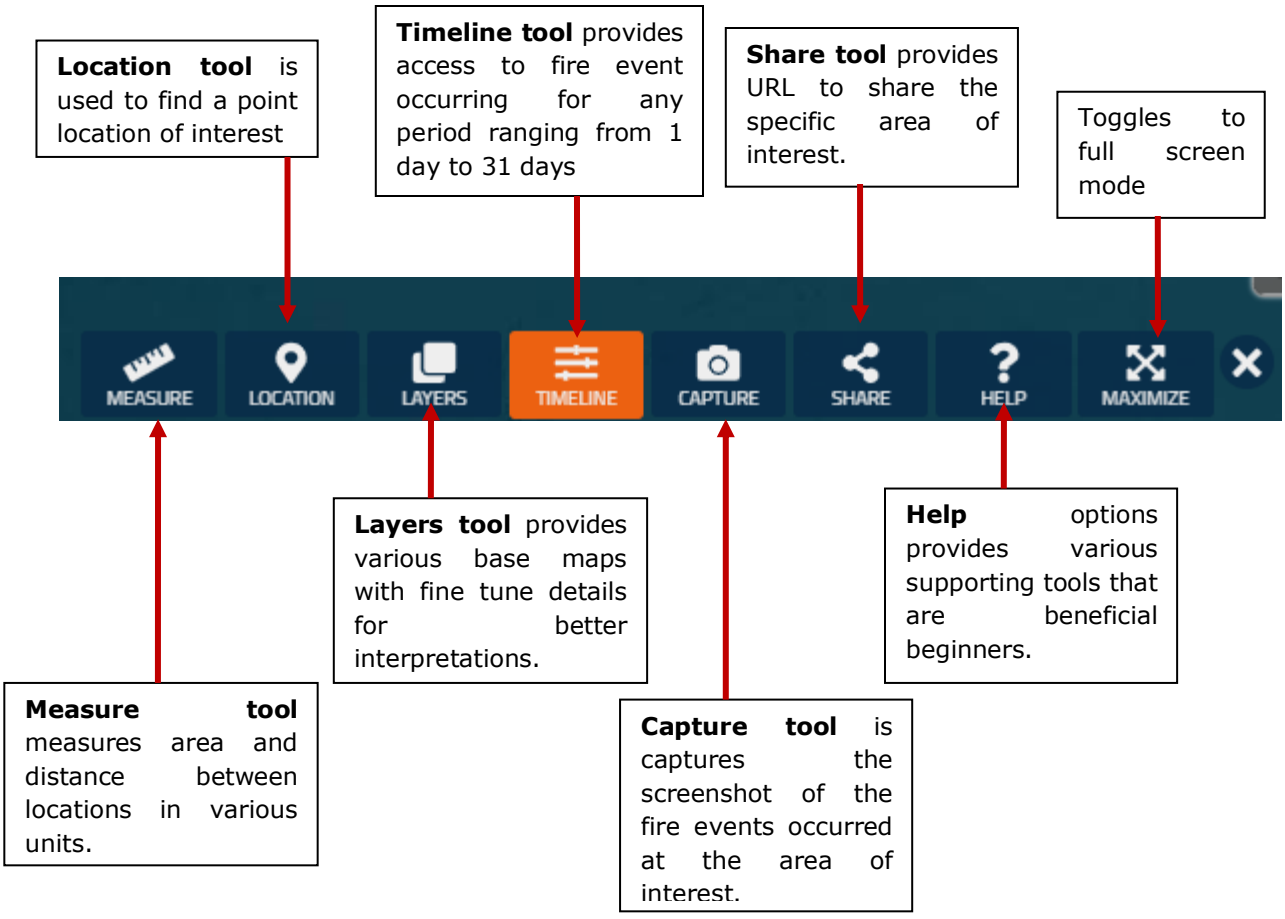
5. **Web Services**: provides Application Programming Interface (API) option to retrieve NRT fire occurrences for the area of interest. Thus retrieved data can be further analyzed for immediate ground level interventions.

Step 2: Let us access the global fire information.

Select '**Global**' option from the '**Fire Map**' dropdown→ A page as shown below must be have opened.



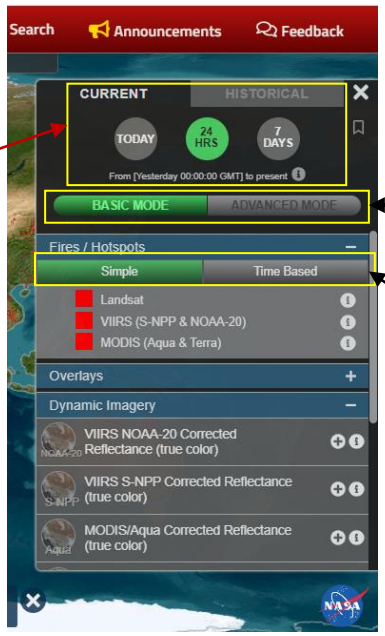
Step 2.1: Let us first get an understanding of the basic tools displayed at the bottom of the page



Step 2.2: Exploring through the options provided (click on bar key provided in extreme top right for black box to appear) to filter the data as per the requirement

Date Filtering

The '**CURRENT'** option provides more recent fire occurrences information (present upto 7 days). To view the fire occurrences up to 31 days/ 4 weeks toggle to '**HISOTRICAL**' option



Other advanced filtering

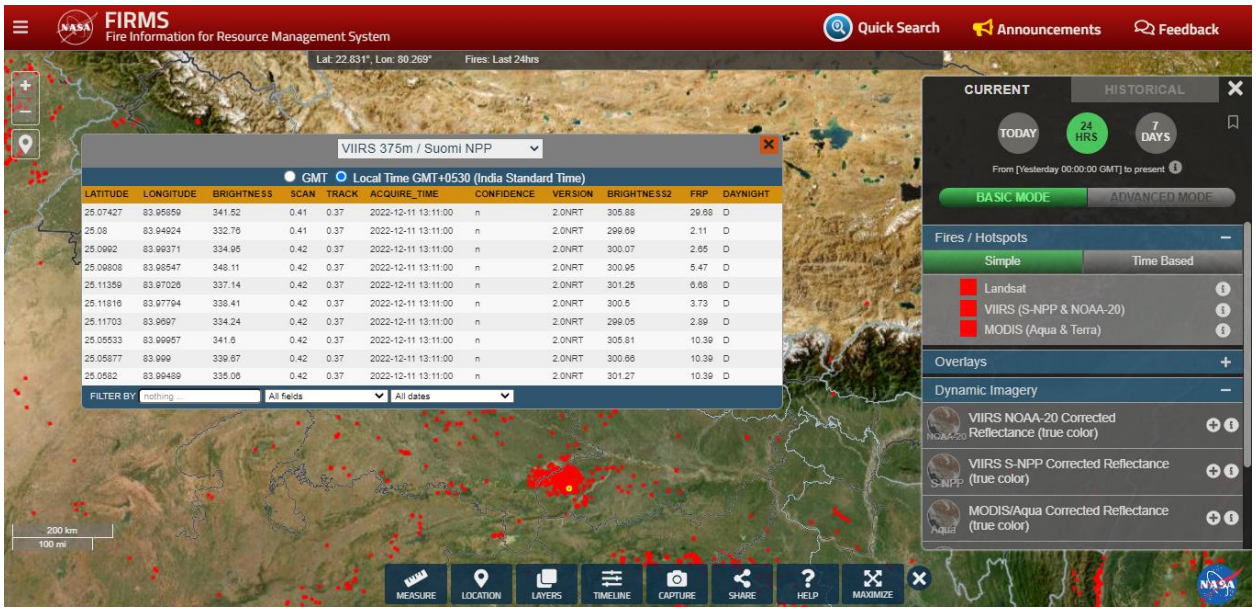
The '**BASIC MODE**' option provided access to fire events with no customisation facility.

Time Based filtering

However, it supports time based delineation upon switching to '**Time Based**' from '**Simple**' under Fires/Hotspots tab. The '**ADVANCED MODE'** customisation is detailed in further section.

Step 2.3: Quick glance through the information pertaining to the fire event

Click on any of the fire point to access the full information pertaining to the fire event. The major information includes Latitude, Longitude, Acquisition time, Confidence, Intensity of fire (Fire Radiative Power (FRP)), Occurrence (Day/Night).

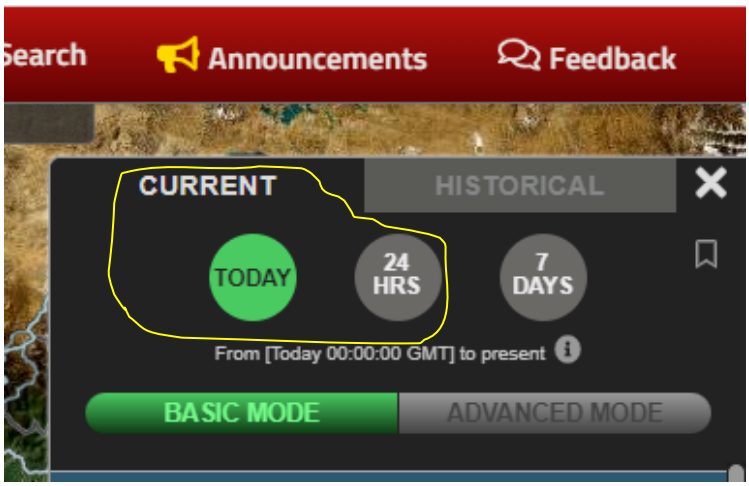


Step 2.4: Exploring the 'Time Based' option under 'BASIC MODE' option

CURRENT → Select either 'TODAY' or '24 HRS' → BASIC MODE → Toggle to 'Time Based' from 'Simple'.

A visualization similar as below must now be appearing on your screen. Each color depicts the interval of fire occurrences from the present. The option is best explored for fires up to lag of 1 day.

NOTE 1: The CURRENT option is limited to 'TODAY' and '24 HRS'. Choosing '7 DAYS' option will automatically toggle to 'HISTORICAL' from 'CURRENT'.



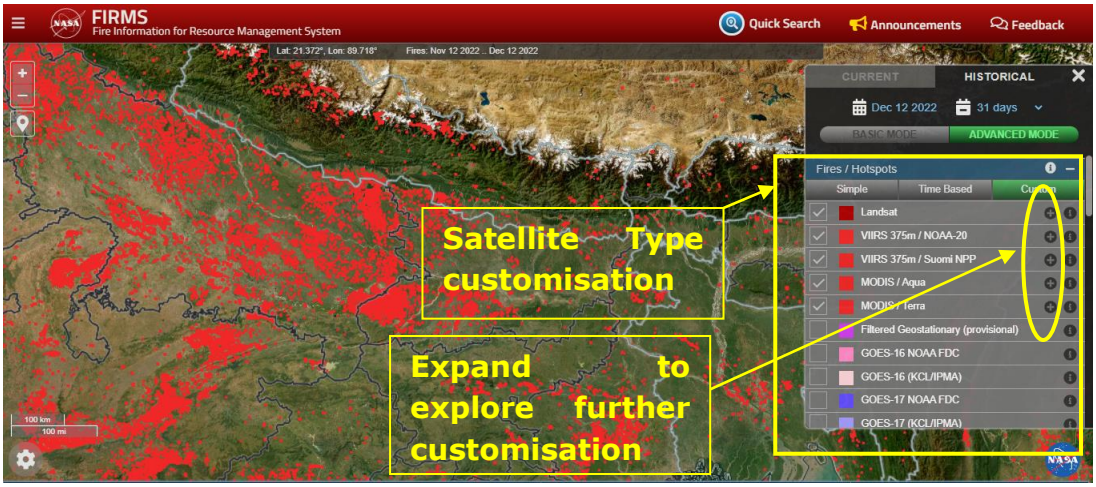
Step 2.5: Exploring the 'Time Based' option under 'ADVANCED MODE' option

Select HISTORICAL option → set the calendar option to week or more → click ADVANCED MODE option→ click on Fires/Hotspots → Toggle to 'Time Based' from 'Simple'.

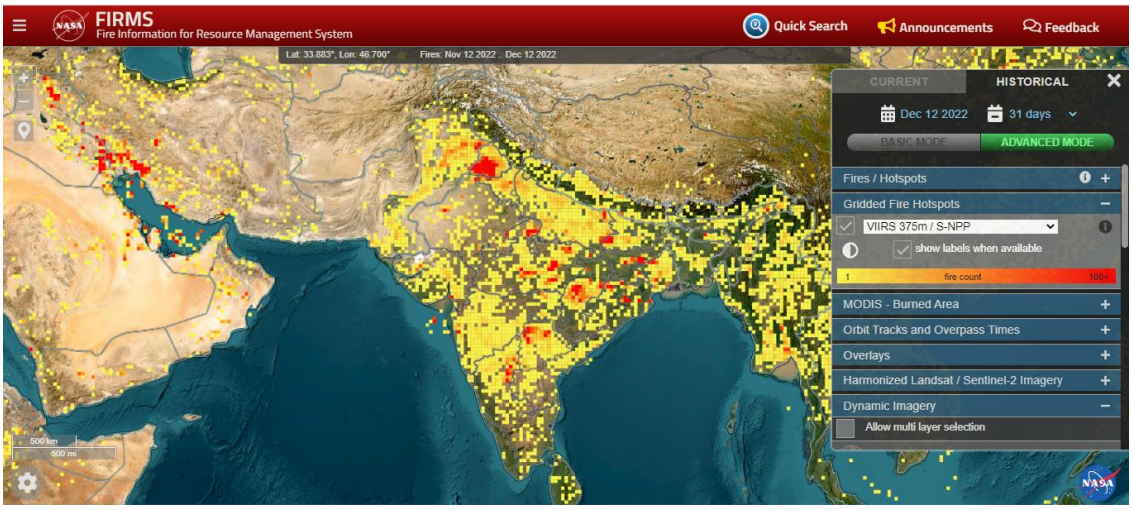
A visualization similar as above must now be appearing on your screen. Each color depicts the interval of fire occurrences from the present. The similar can be explored under the 'CURRENT' and 'BASIC MODE' option.

Step 2.6: Exploring the 'Custom' option under 'ADVANCED MODE' option

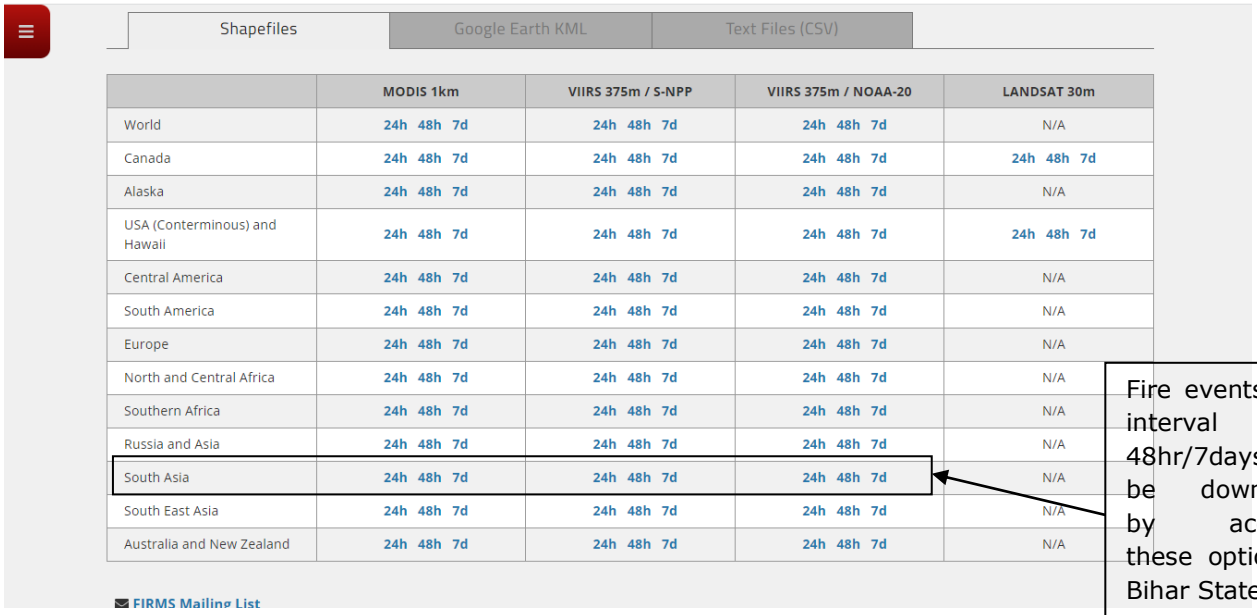
a) The 'Custom' option within the Fires/hotspots provides access to set of customizations for distinguishing fire events based on a) Type of sensor capture; b) Period of Burn (Day or Night); c) Confidence range; and d) Fire Radiative Power range for effective decision making.



a) Gridded Fire Hotspots options provides cumulative fire counts based on type of sensor capture in a gridded format of size 27.75Km * 27.75Km.

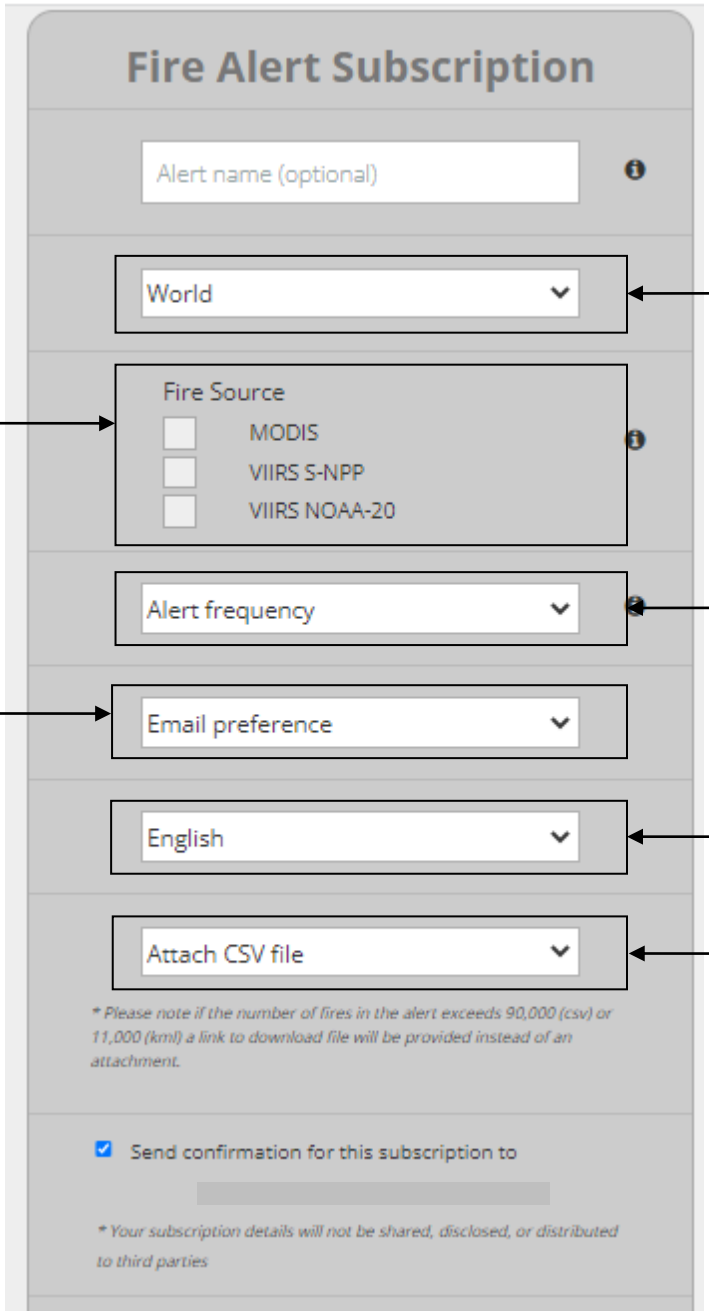


Step 3: Let us now check how to download retrospective data for the individual satellites (MODIS/SUOMI) at smaller intervals corresponding to 24 hours, 48 hours, and 07 days in the relevant formats against the area of interest or region (shapefile, KML and CSV). Toggle to the home page or click on the link provided in step 1 → Select '**GLOBAL**' option under '**ACTIVE FIRE DATA**' dropdown. Further scrolling reveals the page below. The information thus downloaded needs to be processed using Geographical Information System (GIS) software for drawing useful inferences.



Fire events at an interval 24hr/ 48hr/7days can be downloaded by accessing these options for Bihar State.

Step 4: Let us now create E-mail fire alerts for immediate attention and on-ground actions. Toggle to the home page or click on the link provided in step 1 → Fire Alerts → Enter the e-mail address and click on '**Proceed**' → Click on '**Send confirmation email**'. Enter the code received in the e-mail provided and click '**Validate**' → Now Enter the Email-ID and click '**Proceed**' → click on '**Create Fire Alerts**' → Fill the Fire Alert Subscription (Illustrated below) and click on '**Submit**'.



Select all 03 fire sources

Enter the 'Email-ID' to which the information will be shared

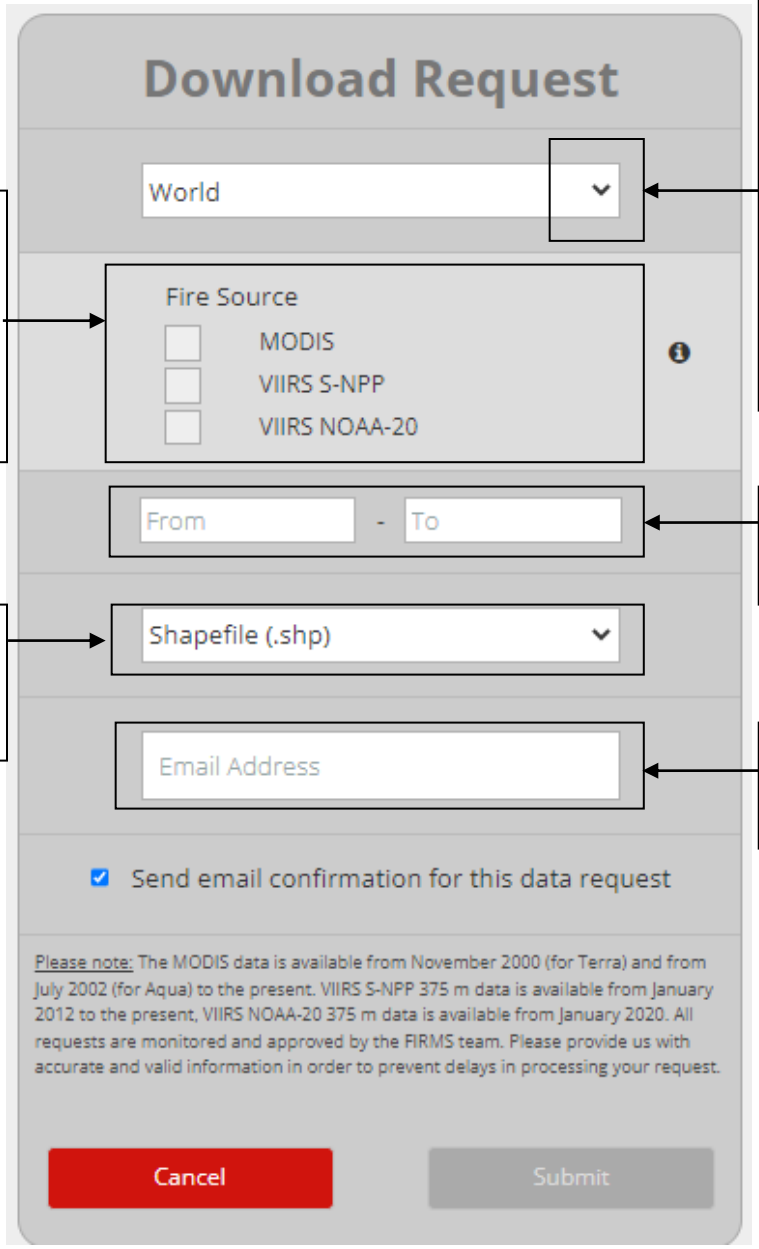
Select '**Custom Region**' from the drop down → click on '**Use Map**' → click on '**Draw Custom Box (Classic)**' → Click and drag the custom box covering your area of interest.

Select either '**Daily**' or '**Rapid**' option depending upon requirement

Leave it as default

Select '**CSV file**' option

Step 5: Let us now check how to download retrospective data with wider time horizon for comparative assessments and effective policy level decisions. Click on homepage or the link provided in step 1 → click on '**Archive Download**' → click on '**Create New Request**' → complete the download request (illustrated below) and click on '**Submit**'.



Select the satellite for which the data needs to be retrieved.

Generally all 03 sources are selected for effective analysis

Select 'Custom Region' from the drop down → click on 'Use Map' → click on 'Draw Custom Box (Classic)' → Click and drag the custom box covering your area of interest.

Alternate drop down options can be

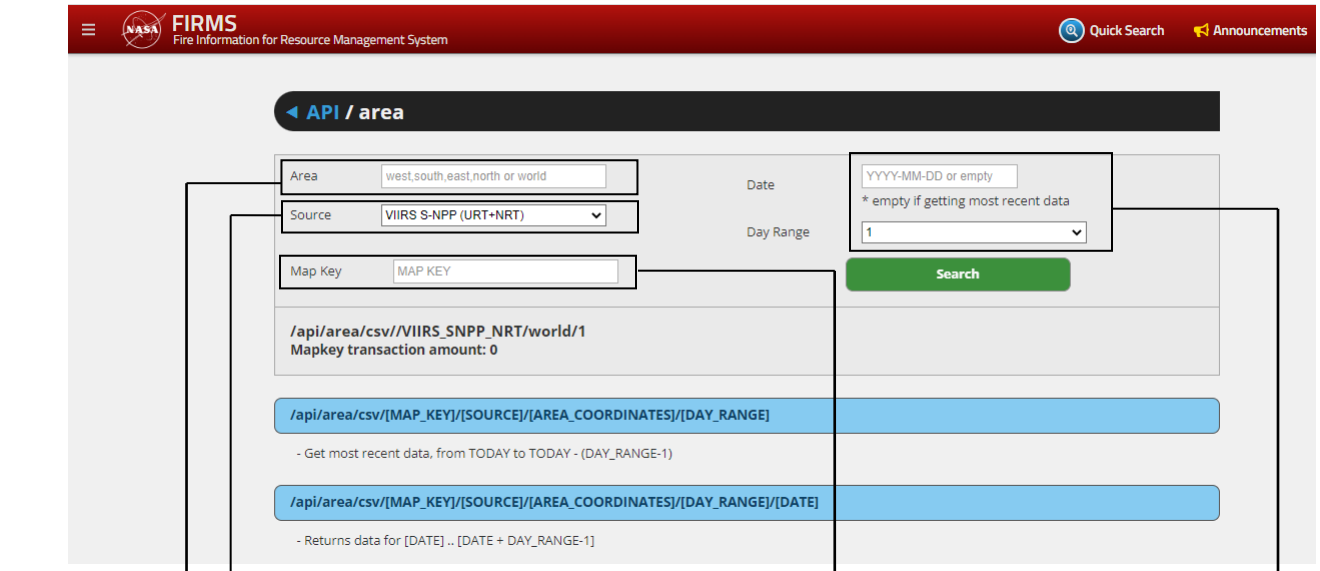
Provide the duration for which the data needs to be retrieved

Provide the format (.shp or .csv is chosen) in which data needs to be retrieved.

Enter the 'Email-ID' in which an access to data shall be shared

You will now receive a confirmation mail in the e-Mail ID provided in the 'Download Request' page. A link to download the requested data will be sent through email once the service provider has processed the data.

Step 6: Let us now access the near real time fire information. Click on homepage or the link provided in step 1 → Select '**Global**' option from the '**WEB SERVICES**' dropdown → Select '**API - Application Programming Interface**' option → Select '**area**' option under 'Service' column → scroll down to the '**Map Key**' tab and click on '**Get MAP_KEY**' option → Enter the email address and click '**Get MAP Key'** option → A page shown below will now appear. Fill the information as demonstrated and click '**Search**'.



Enter the co-ordinates

For Bihar:
West = '82.54688'
South ='22.96283'
East = '89.29688'
North = '28.06316'

Select following sources individually

a) MODIS (URT +NRT)
b) VIIRS NOAA-20 (URT +NRT)
c) VIIRS S-NPP (URT +NRT)

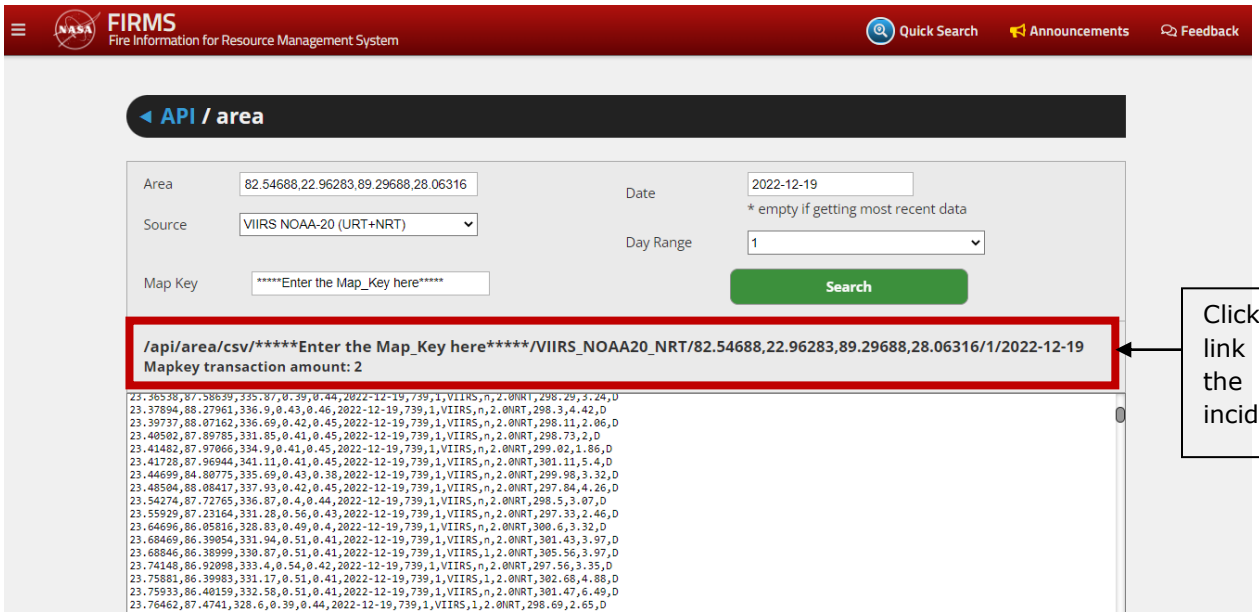
Enter the '**Map Key**' received in the mail

Leave the tabs '**Empty**' to access NRT information

A panel as shown in the next page now be appearing on your screen. Click on the link as highlighted in red to access the NRT information → A new page will now open consisting of NRT information pertaining to fire incidence → Right click → Save.

The information shall be shared in text format which needs to be further processed for effective ground level interventions. The further processing includes clipping out the fires falling out of area of interest, filtering of non-agriculture fires, identification of panchayats and blocks pertaining to fire incidents. The same shall be done using

Quantum-Geographical Information System (Q-GIS) software. The step by step process is deliberated in the further sections.



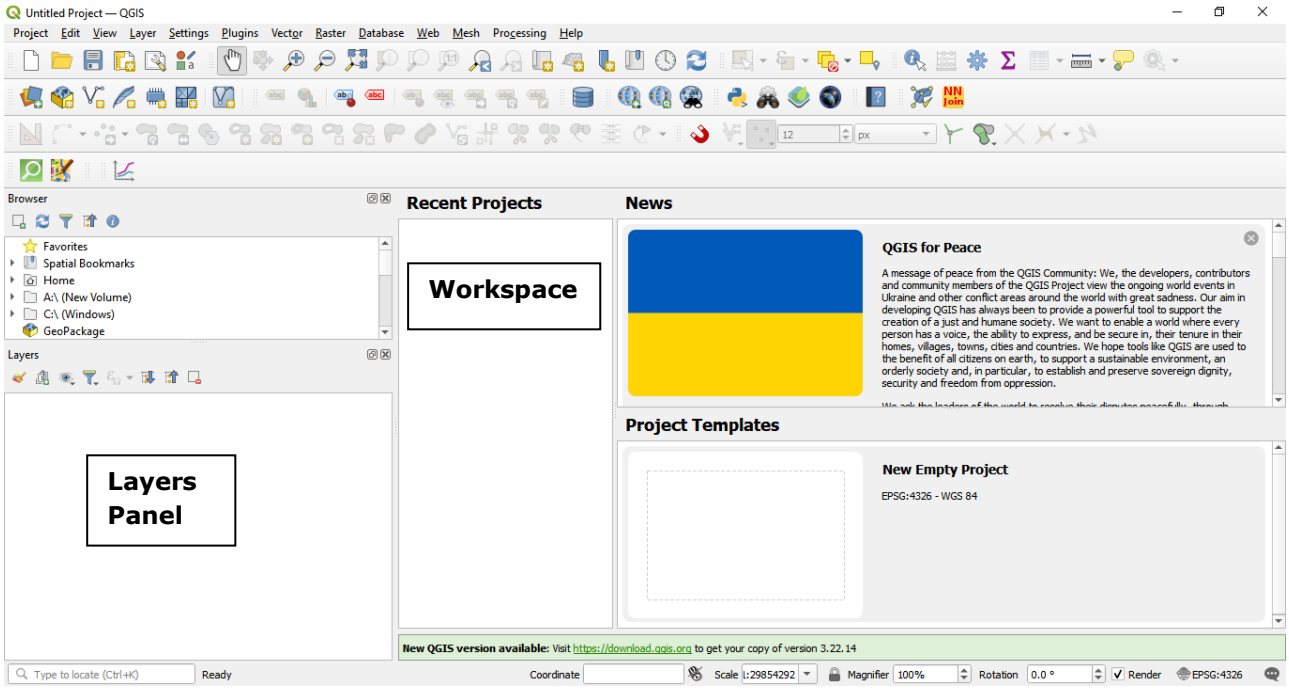
Click on the link to access the NRT fire incidences

Introduction to Q-GIS

Step 1: Download Q-GIS software. Click on the link https://www.qgis.org/en/site/ → click on 'Download Now' option → click on '**Download Q-GIS 3.28**' option from '**Download for Windows**' dropdown.

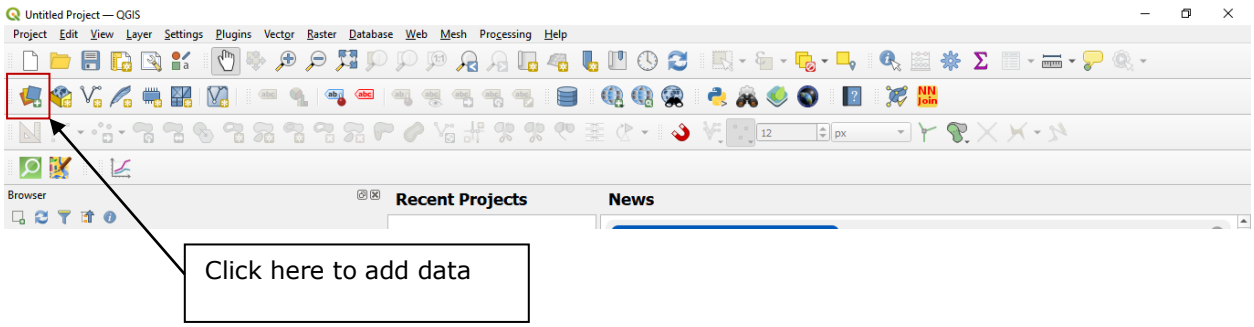
Install the downloaded '**QGIS-OSGeo4W-****.msi**' extension file to initiate the software.

Double click on QGIS Desktop app → Page as shown below will now appear.



Step 2: Let us now add fire events retrieved from NASA FIRMS platforms. The data can be retrieved in 2 formats namely .shp, .csv and .text. Let us explore individually how to add these data to QGIS.

Step 2.1: Click on '**Open Data Source Manager**' option from the Homepage



Step 2.2: Let us first see how add vector data/information (.shp format). Click on '**Vector**' option -> Select the file from the directory → click on '**Add**'

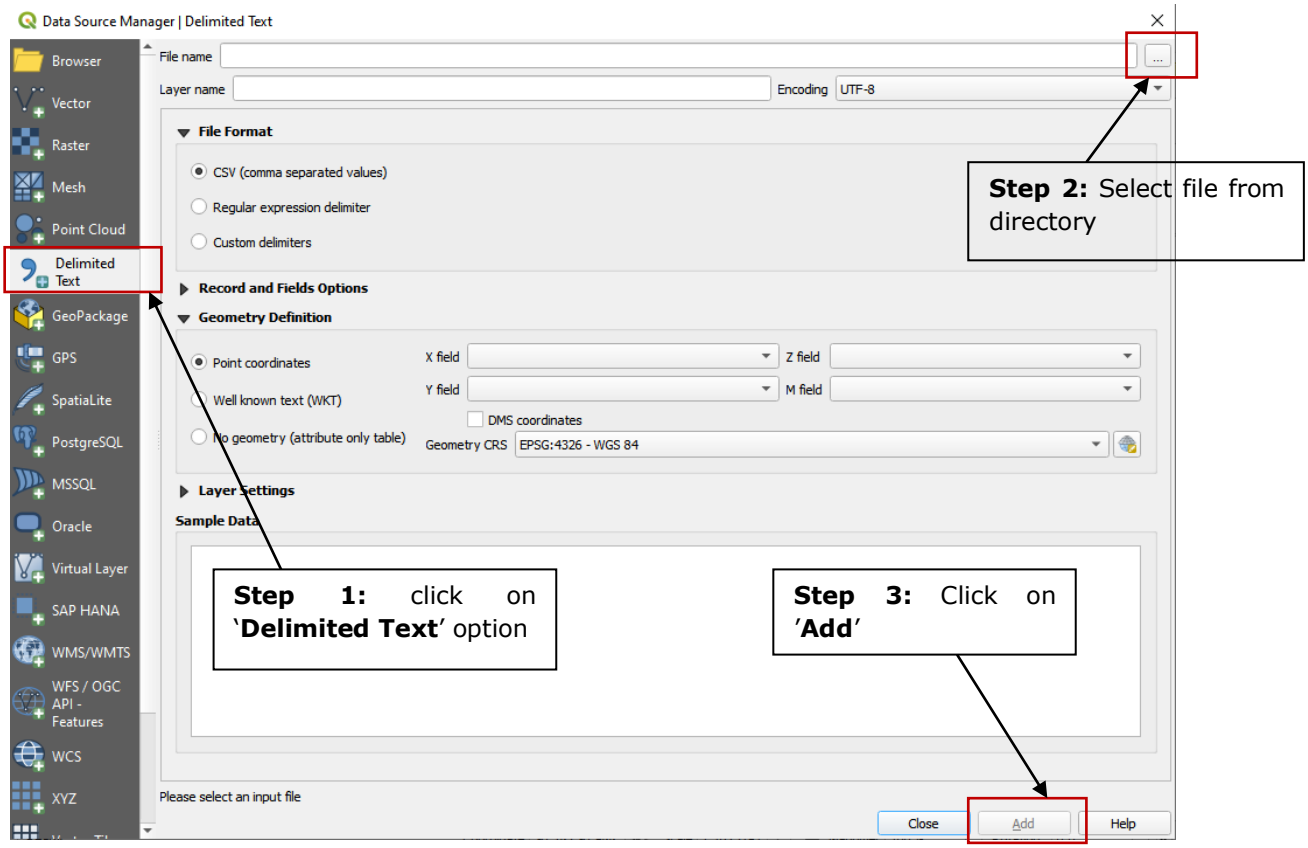
Similar to above, now add other vector files shared via google drive. The following vector files are shared.

a) State boundaries (Shared as state_bihar.shp)
b) District boundaries (Shared as dist_bihar.shp)
c) Panchayat and Block boundaries (Shared as PANCHAYAT_BOUND_WITH_FOREST_ATTRIBUTES.shp)
d) Forest boundaries (Shared as PF_BOUNDARY_2019.shp)

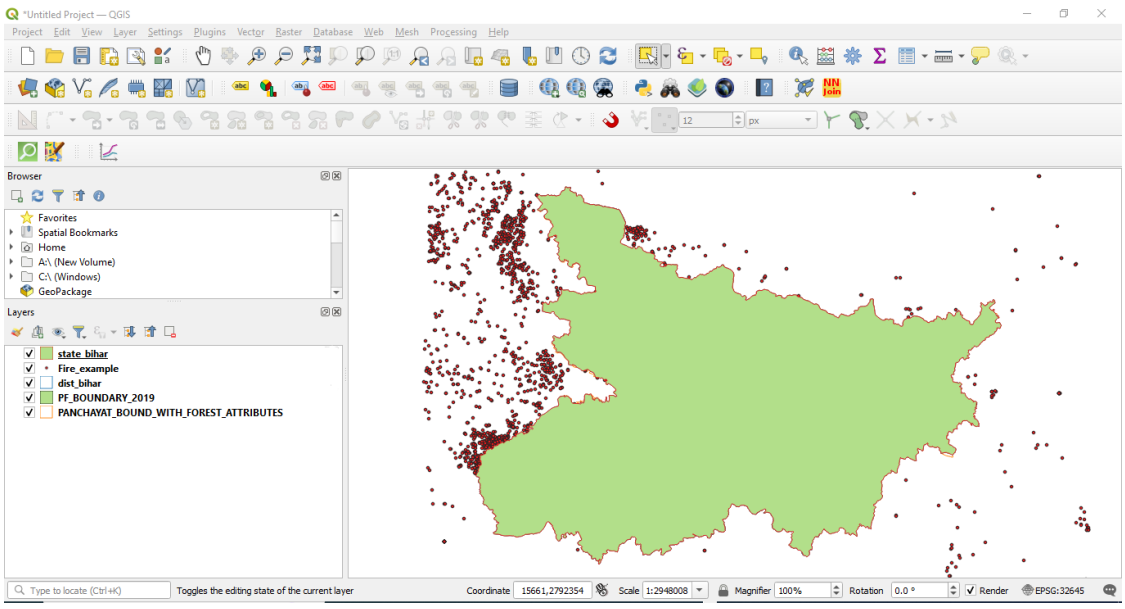
Note 2: Vector data is the most common type of GIS data. Most data loaded into a GIS software program tends to be in vector data. Vector data represents geographic data symbolized as points, lines, or polygons.

Raster data represents geographic data as a matrix of cells that each contains an attribute value. While the area of different polygon shapes in a data set can differ, each cell in a raster data set is the same cell. The size of the area in the real world that each cell represents is known as the spatial resolution. Source: https://www.gislounge.com/geodatabases-explored-vector-and-raster-data/

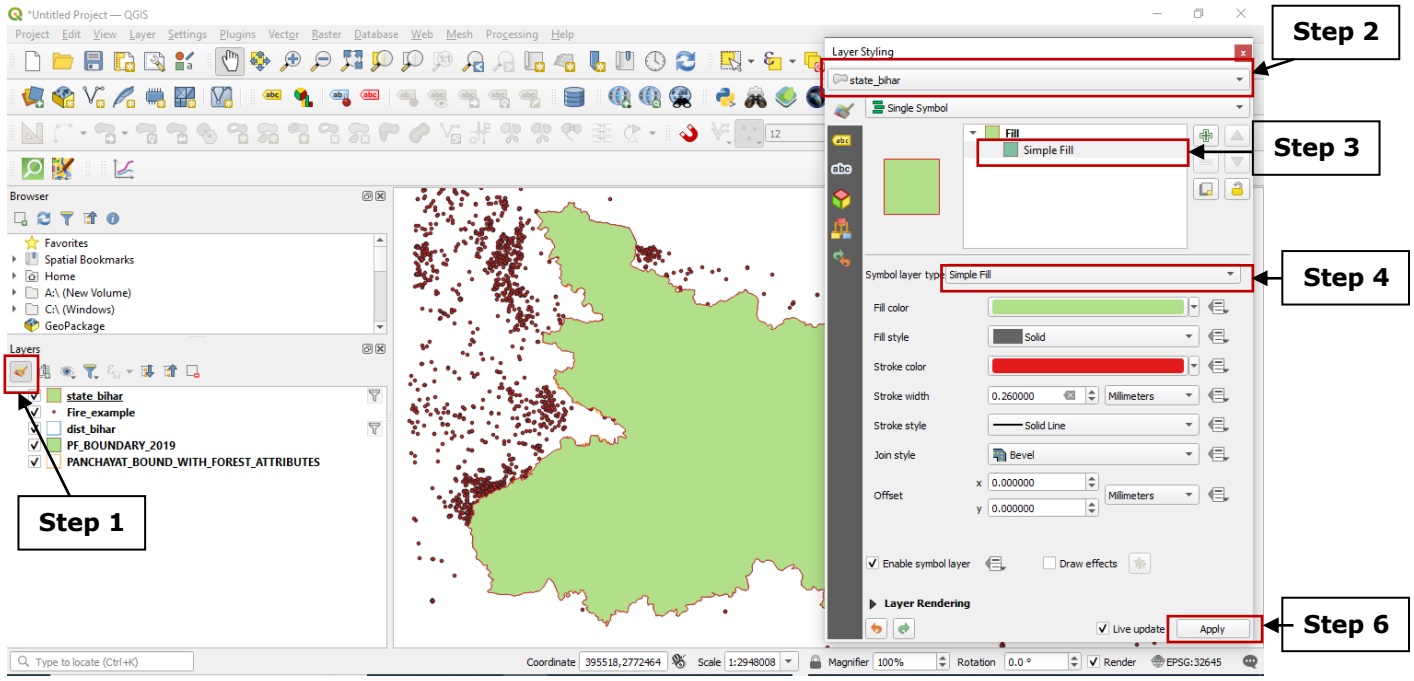
Step 2.3: Let us now explore how add delimited text data (.csv or .txt format). Click on '**Delimited Text**' option -> Select the file from the directory → click on '**Add**'



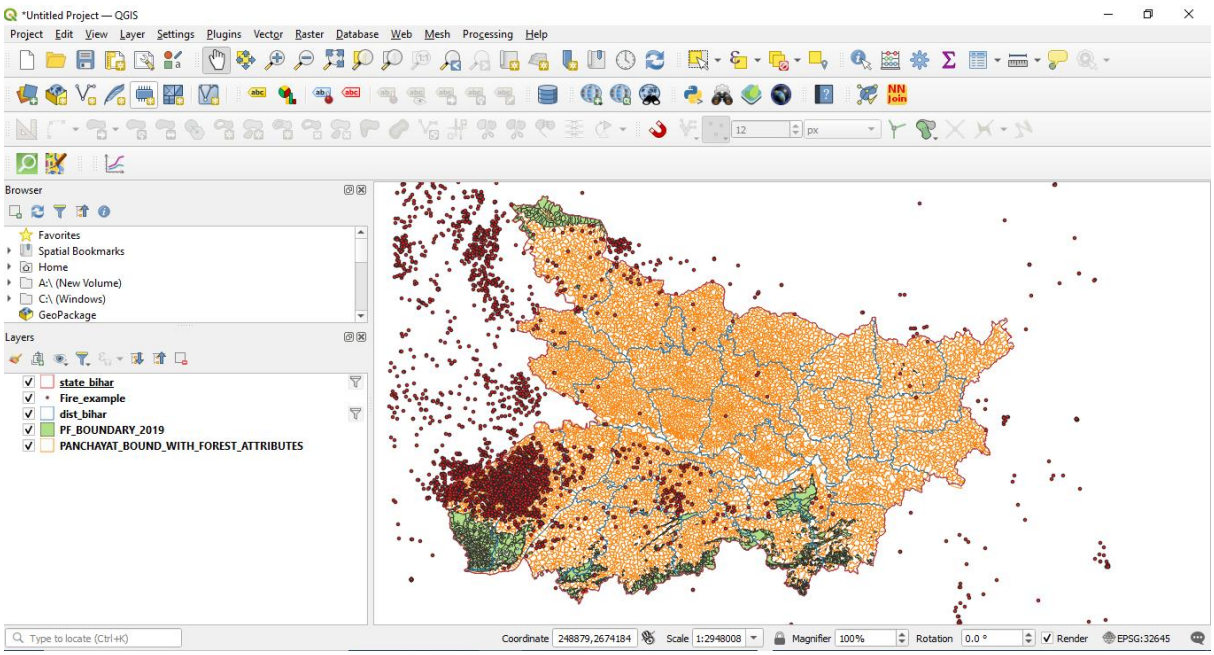
The vector/delimited text data must now been added to the QGIS work space. The work space should appear as illustrated below



Step 3: Let us change the symbology for better visualization.
Select '**Symbology**' option from the Layer tab. A new tab called '**Layer Styling**' now opens → Select the vector layer to be edited from the drop down → click on '**Simple Fill**' → Select '**Simple Fill**' from the '**Symbol Layer Type**' dropdown → **Select the color** from '**Color**' option → Click '**Apply**'→ close the '**Layer Styling**' tab

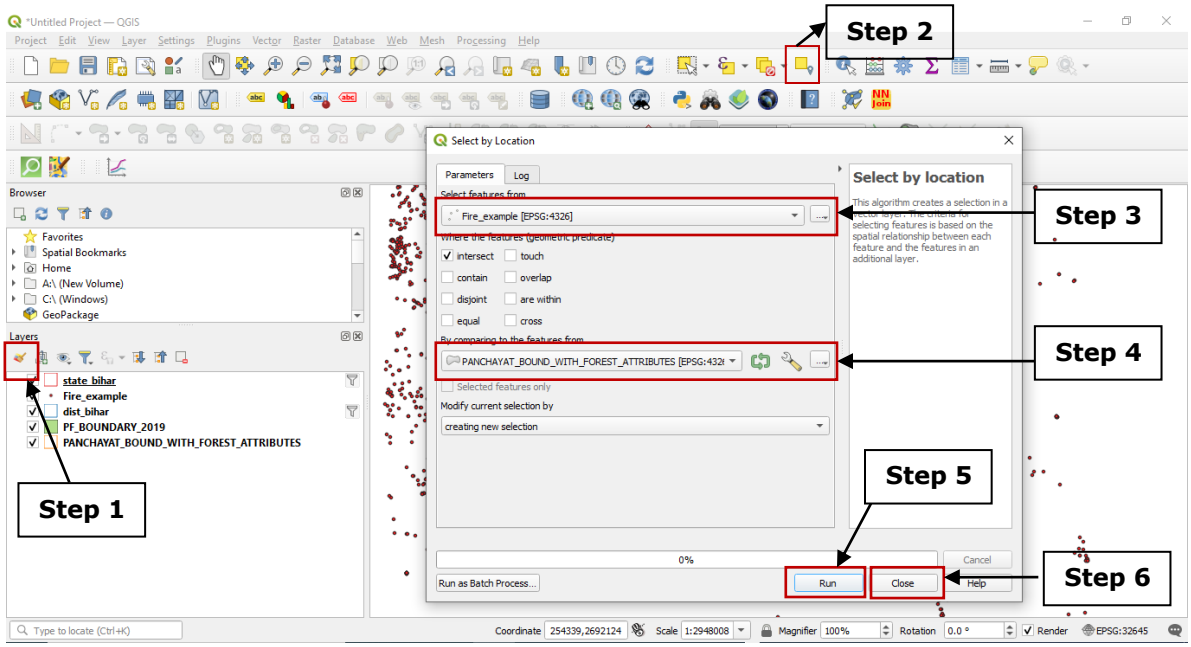


Similarly, you can now edit all the other vector layers by exploring '**Sybmology**' option. The final output after adjusting symbology is as illustrated below.



Step 4: Let us now initiate fine-tuning of the data. First, let us clip the fire events occurred out of the area of interest.

Step 4.1: Select '**Select by Location**' Option. A new tab opens → Select the '**Fire_example**' vector file from the '**Select features from**' dropdown → Select '**PANCHAYAT_BOUND_WITH_FOREST_ATTRIBUTES**' vector file from '**By comparing to the features from**' dropdown → click '**Run**' → close the tab.

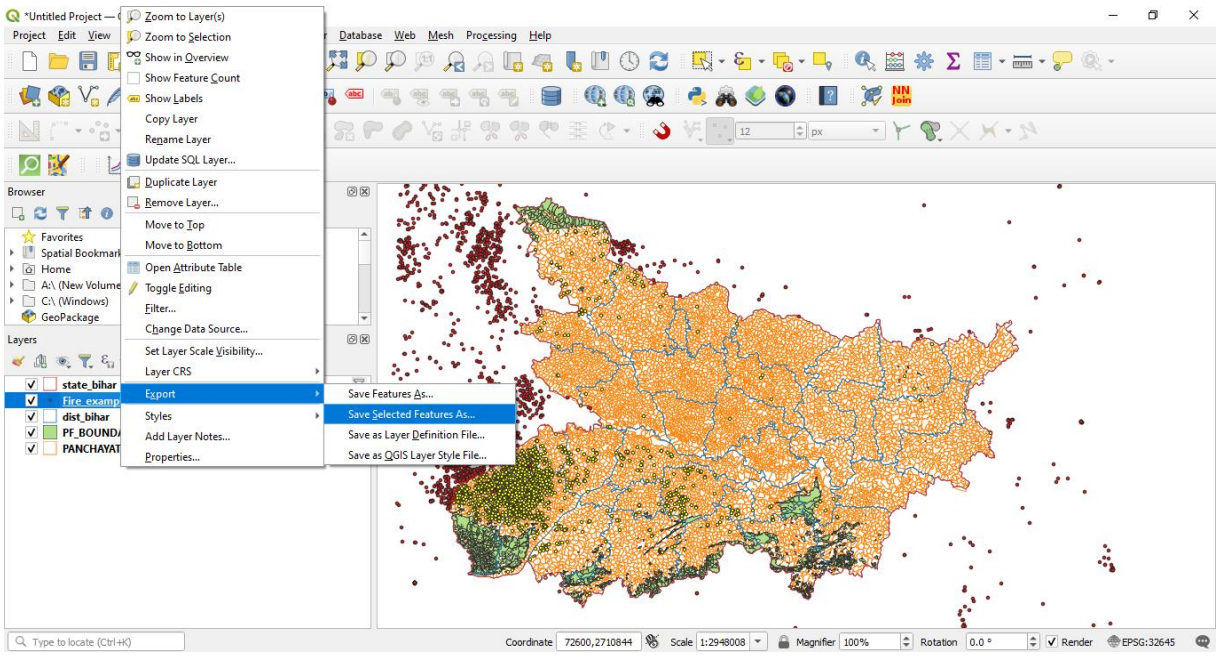


Step 4.2: Now you can observe all the fire points intersecting with the PANCHAYAT_BOUND_WITH_FOREST_ATTRIBUTES vector file are selected in **'yellow'** color. Let us now save this filtered information as a separate vector file.

Right click on '**Fire_example**' vector file from the layers panel → Select '**Export**' → Select '**Save Selected Features as**'. A new tab opens-> Select '**ESRI Shape file**' from the '**Format**' dropdown → provide '**File Name**' (Fires_Bihar_clipped) → click '**OK**'.

Note 3: In generally, fire points/data are retrieved from 4 satellites at various overpasses. MODIS provides information retrieved from 'AQUA' and 'TERRA' and SUOMI provides information retrieved from 'NPP' and 'NOAA-20'.

In this session, we follow the conventional technique of applying the filter procedure individually for all the satellite retrieved information. Whereas, there existing advanced options such as merge to integrate all the satellite retrieved data to a single vector file which requires preliminary processing to homogeneous the data types.



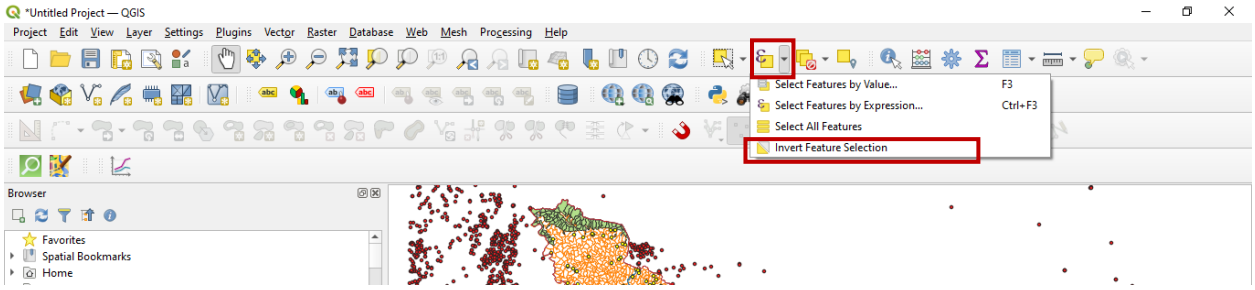
Step 5: Further lets us clip the fire points falling within the forest region. It is assumed that the fire incidents captured within the forest region correspond to forest burning.

Step 5.1: The steps are similar to Step 4.1 except that the output from step 4.2 will be compared against forest shape files.

Select '**Select by Location**' Option. A new tab opens → Select the '**Fires_Bihar_clipped'** vector file from the '**Select features from**' dropdown → Select '**PF_BOUNDARY_2019**' vector file from '**By comparing to the features from**' dropdown → click '**Run**' → close the tab.

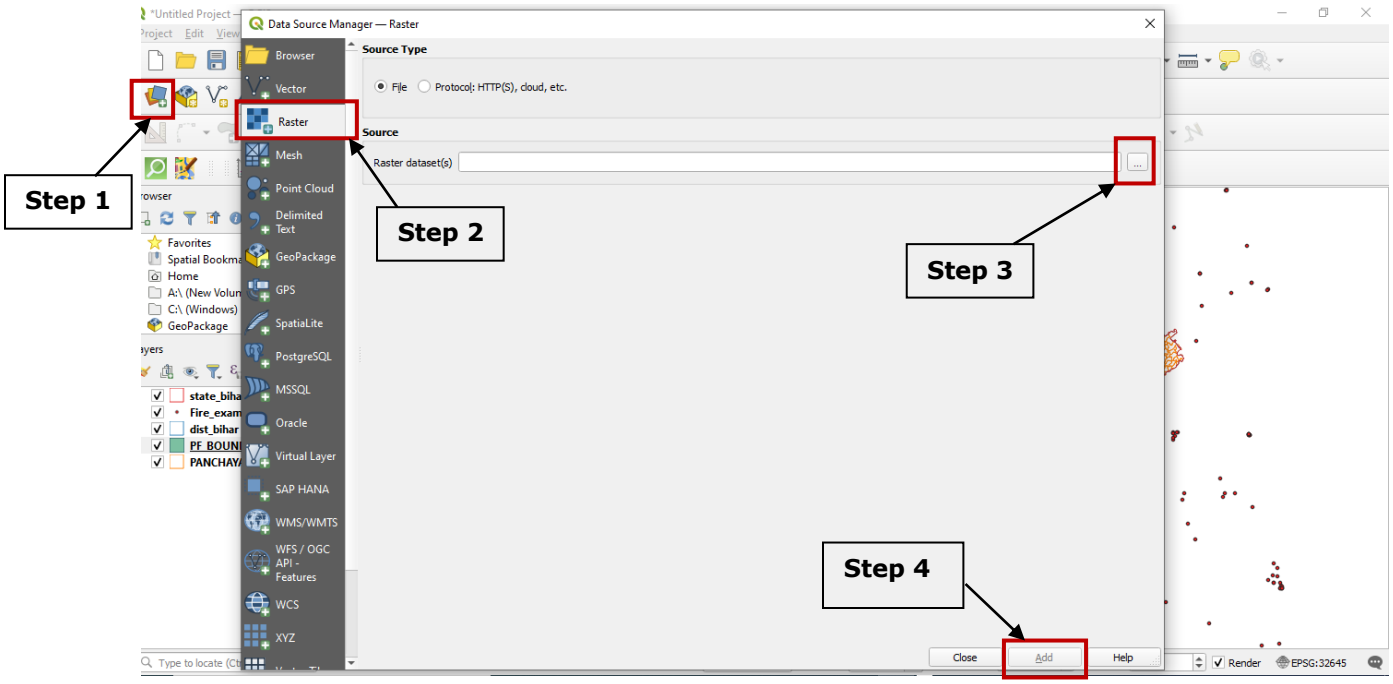
Step 5.2: Now you can observe all the fire points intersecting with the PF_BOUNDARY_2019 vector file are selected in **'yellow'** color. Let us now inverse the clipping to filter non-forest fires.

Select '**Invert selection**' from the '**Select Features using an Expression**' dropdown. Save the selected fire points by following Step 4.2.



Step 6: Let us now proceed towards the last step of fine-tuning. Here were compare individual fires against the Landuse-Landcover raster data classified by 'Annual International Geosphere-Biosphere Programme (IGBP) classification' at 500m spatial resolution. The raster data has been shared through google drive

Step 6.1: Let us first input the raster data to the workspace. Start by following step 2.1. A new tab called '**Data Source Manager**' opens→ Select '**Raster**' option → select the raster file → click '**Add**'.

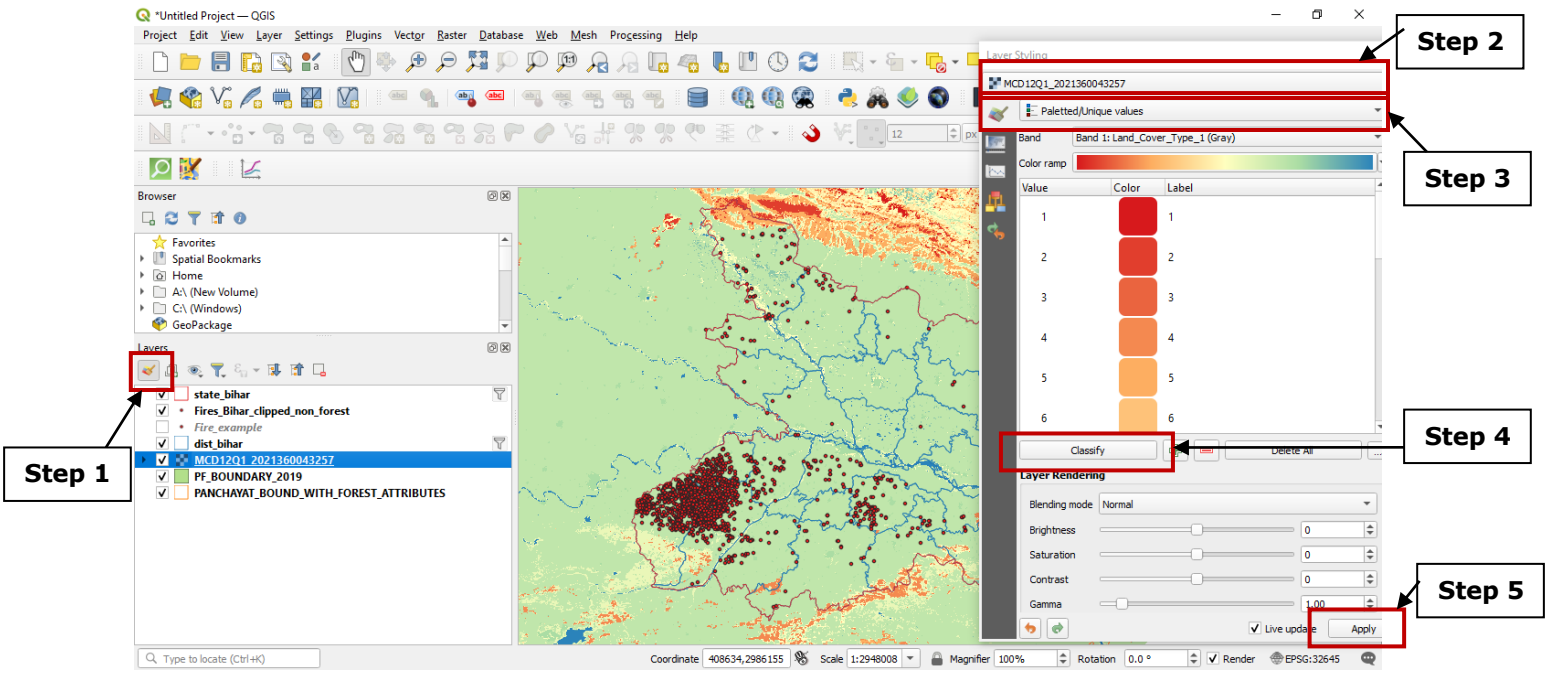


Step 6.2: Edit the 'Symbology' for better visualization. Select '**Symbology**' → Select '**MCD12Q1_2021360043257**' from the dropdown → select '**Paletted/Unique values**' from the drop down → Select the '**color ramp**' of the choice → Click '**Classify**' → click '**Apply**'. The illustration is shown in the next page.

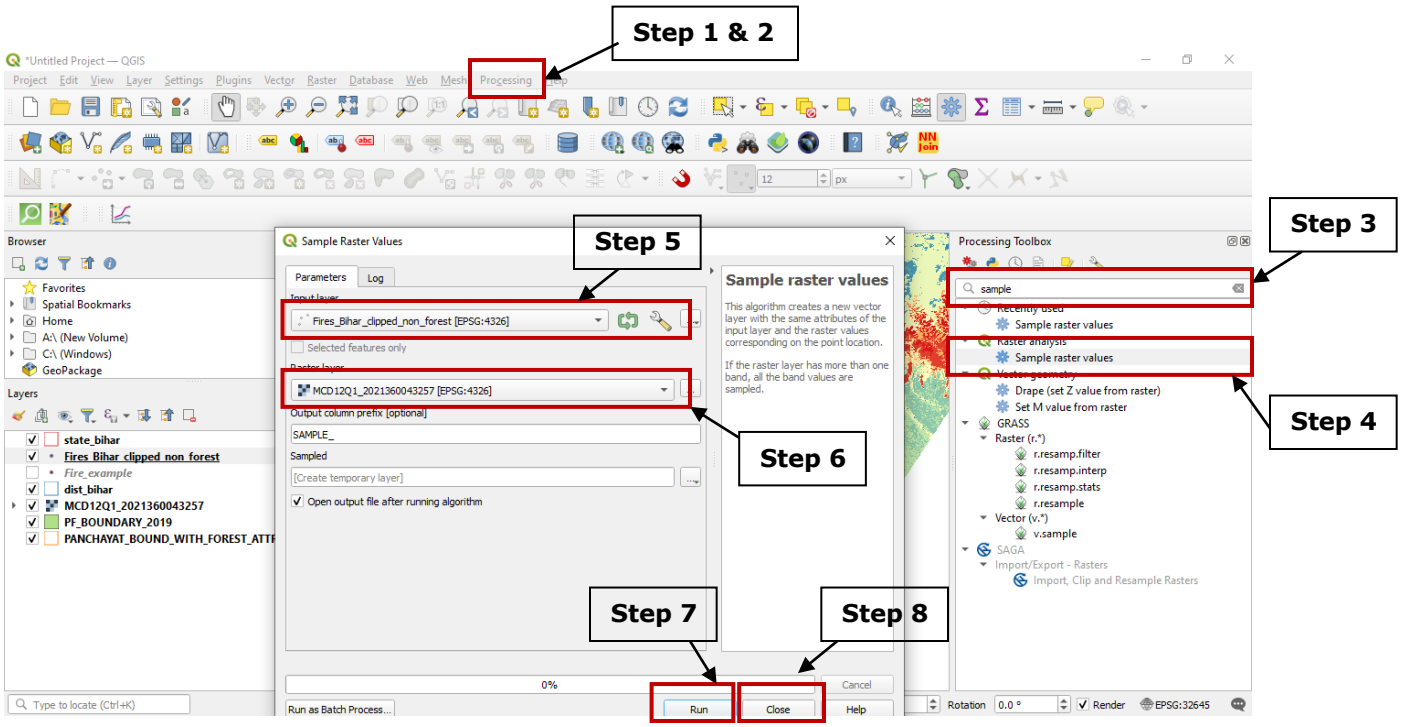
Let use now sees what does different classes of the raster indicates.

Classes	Landuse-Landcover type
1	Evergreen Needleleaf Forests: dominated by evergreen conifer trees (canopy >2m). Tree cover >60%.
2	Evergreen Broadleaf Forests: dominated by evergreen broadleaf and palmate trees (canopy >2m). Tree cover >60%.
3	Deciduous Needleleaf Forests: dominated by deciduous needleleaf (larch) trees (canopy >2m). Tree cover >60%.
4	Deciduous Broadleaf Forests: dominated by deciduous broadleaf trees (canopy >2m). Tree cover >60%.
5	Mixed Forests: dominated by neither deciduous nor evergreen (40
6	Closed Shrublands: dominated by woody perennials (1

7	Open Shrublands: dominated by woody perennials (1
8	Woody Savannas: tree cover 30
9	Savannas: tree cover 10
10	Grasslands: dominated by herbaceous annuals (<2m).
11	Permanent Wetlands: permanently inundated lands with 30
12	**Croplands: at least 60% of area is cultivated cropland.**
13	Urban and Built
14	Cropland/Natural Vegetation Mosaics: mosaics of small
15	Permanent Snow and Ice: at least 60% of area is covered by snow and ice for at least 10 months of the year.
16	Barren: at least 60% of area is non
17	Water Bodies: at least 60% of area is covered by permanent water bodies.

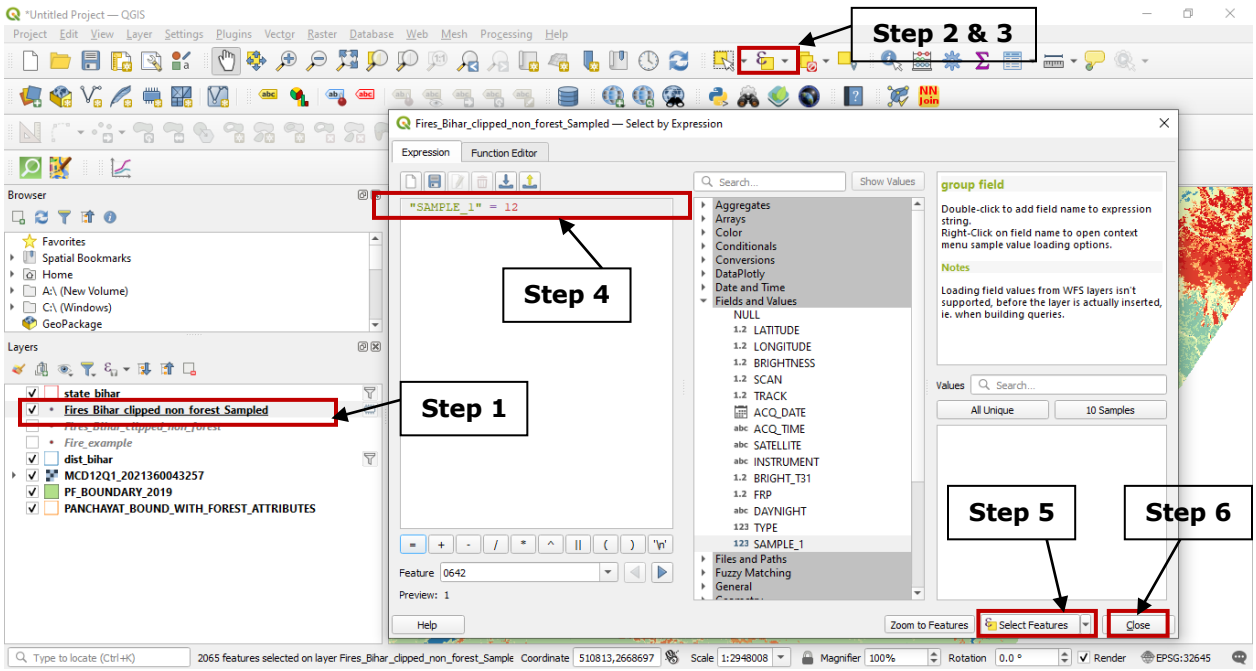


Step 6.3: Let us assign the landuse landcover class for each fire type. Select **'Processing'** from the tool bar above → select **'Toolbox'**. A new tab called '**Processing Toolbox**' appears → Search for **'Sample Raster Values'** in the search bar and select the same. A new tab opens → Provide the '**output from step 5.2**' as input layer → Select '**MCD12Q1_2021360043257**' from the Raster Layer dropdown → Click '**Run**' → close the tab → Rename the newly created vector file (from '**Sampled**' to '**Fires_Bihar_clipped_non_forest_sampled**'). The illustration is provided in the next page.



Step 6.4: Now that we know that the fire points falling within the Landuse Landover class 12 corresponds to agriculture/crop residue related fires, let us filter these fire points from rest.

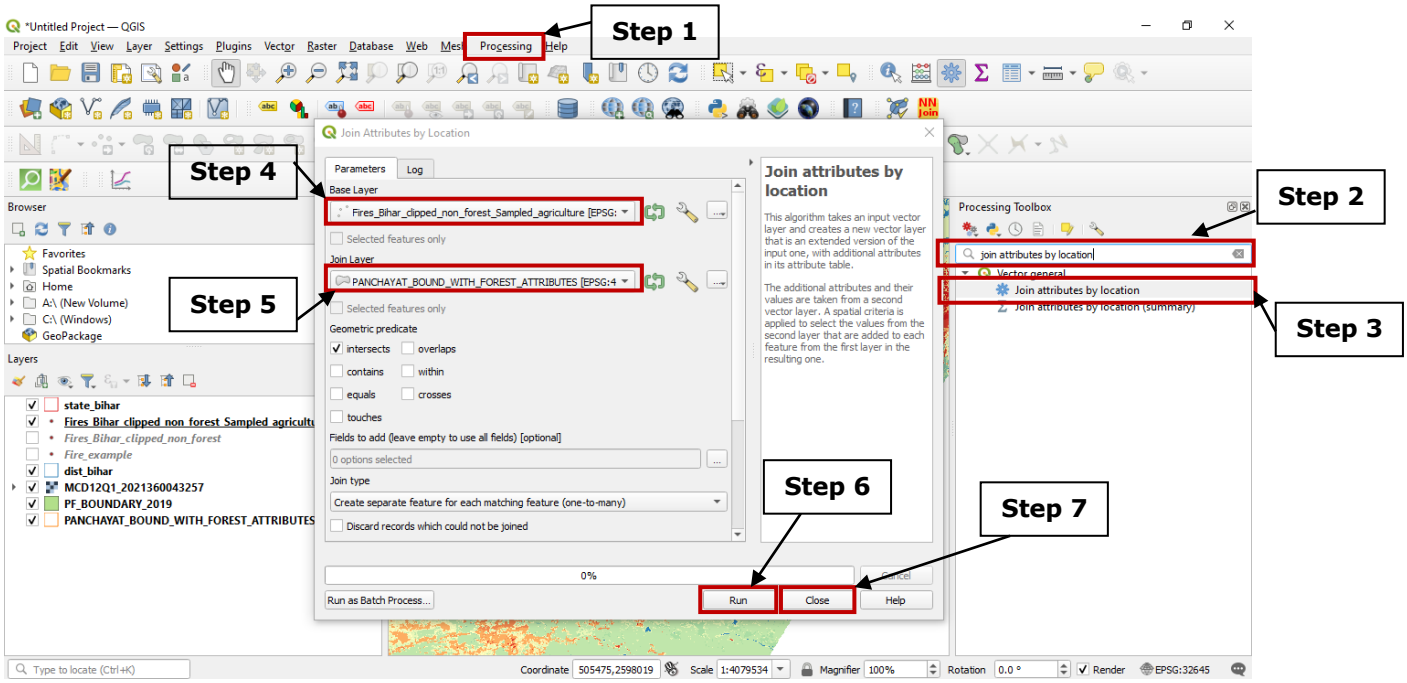
Select '**Fires_Bihar_clipped_non_forest_sampled'** from the layers panel → Select '**Select Features By Expression**' from '**Select Features using an Expression**' dropdown. A new tab opens → in the expression panel type **"SAMPLE_1" = 12 ->** Click on '**Select Features'** → click on '**Close**'.



The illustration is shown as above. Save the selected fire points by following Step 4.2. Here we save the vector layer as '**Fires_Bihar_clipped_non_forest_Sampled_agriculture**'.

Step 7: Now that we have completed the major fine tuning, let us assign the panchayat, block and district name against each of the fire points identified for effective ground level intervention. Select **'Processing'** from the tool bar above → select **'Toolbox'**. A new tab called '**Processing Toolbox**' appears → Search for **'join Attributes by Location'** in the search bar and select the same. A new tab opens → Select '**Fires_Bihar_clipped_non_forest_Sampled_agriculture'** from Base Layer dropdown → Select '**PANCHAYAT_BOUND_WITH_FOREST_ATTRIBUTES**' from Join Layer dropdown → Click on '**Run**' → Click on '**Close**'.

Now save the vector layer as '**Agriculture_fires_analysed_data'**.



Step 8: Now let us export the analyzed data in csv format. The exported data can further be shared to respective agriculture officials for effective ground level interventions.

Right click on '**Agriculture_fires_analysed_data'** vector file from layers panel → Select '**Export**' → Select '**Save Selected Features as**'. A new tab opens-> Select '**Comma Separated Value [CSV]'** from the '**Format**' dropdown → provide '**File location & Name**' → click '**OK**'.