UTILIZING GIS TOOLS FOR ECOSYSTEM RELATED MAPPING

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Geographic information system (GIS) is a tool for making and using spatial information and it is mainly concerned with location of the features as well as properties/attributes of those features. It helps us gather, analyse and visualize spatial data for different purposes. A GIS quantifies the locations of features by recording their coordinates which are the numbers that describe the position of these features on Earth. The uniqueness of GIS is its ability to do spatial analysis. GIS helps us analyse the spatial relationships and interactions. Sometimes, GIS proves to be the only way to solve spatially-related problems and it is one of the most important tools that aid in decision making process. GIS basically helps to answer three questions; How much of what is where? What is the shape and extent of it? Has it changed over time?

Globally, on an average, GIS tools save billions of dollars annually in the delivery of goods and services through proper route planning. GIS regularly help in the day-to-day management of many natural and man-made resources, including sewer, water, power, and transportation networks. GIS help us identify and address environmental problems by providing crucial information on where problems occur and who are affected by them. It also helps us identify the source, location and extent of adverse environmental impacts. GIS enable us to devise practical plans for monitoring, managing, and mitigating environmental damage. Human impacts on the environment, conflicts in resource use, concerns about pollution, and precautions to protect public health have spurred a strong societal push for the adoption of GIS.

GIS is composed of hardware, software, data, humans and a set of organizational protocols. The selection and purchase of hardware and software is often the easiest and quickest step in the development of a GIS. Data collection and organization, personnel development and the establishment of protocols for GIS use are often more difficult and time consuming endeavours. A fast computer, large data storage capacities and a high quality, large display form the hardware foundation of most GIS. GIS software provides the tools to manage, analyse, and effectively display and disseminate spatial information. GIS as a technology is based on geographic information science and is supported by the

disciplines like geography, surveying, engineering, space science, computer science, cartography, statistics *etc.*

In GIS, we handle the spatial and attribute data sets. Spatial data describes the absolute and relative location of geographic features while the attribute data describes characteristics of the spatial features. These characteristics can be quantitative and/or qualitative in nature. Attribute data is also referred to as tabular data. Vector and raster are two different ways of representing spatial data. Raster data is made up of pixels (or cells), and each pixel has an associated value. A digital photograph is a simple example of a raster dataset where each pixel value corresponds to a particular colour. In GIS, the pixel values may represent elevation above/below sea level, or chemical concentrations, or rainfall *etc.* The key point is that all of this data is represented as a grid of (usually square) cells. Vector data consists of points, lines, and polygons. The individual points are stored as pairs of (x, y) co-ordinates. The points may be joined in a particular order to create lines, or joined into closed rings to create polygons, but all vector data fundamentally consists of lists of co-ordinates that define vertices, together with rules to determine whether and how those vertices are joined.

As with many other systems, GIS basically works on the principle of '*GIGO*' that is *garbage in garbage out*. Hence the quality of data that you feed into GIS is very important and it determines the quality of the end products. But, when used wisely, GIS can help us live healthier, wealthier, and safer lives.

Hands on: Mapping the Progress of El Nino/La Nina using ONI

El Niño and La Niña are the two phases of the El Niño-Southern Oscillation (ENSO) cycle. The ENSO cycle describes the fluctuations in temperature between the ocean and atmosphere in the east-central Equatorial Pacific. La Niña is referred to as the cold phase of ENSO and El Niño as the warm phase of ENSO. These deviations from normal sea surface temperatures can have large-scale impacts not only on ocean processes, but also on global weather and climate. El Niño and La Niña episodes typically last nine to 12 months, but some prolonged events may last for years. The frequency of El Niño and La Niña episodes can be quite irregular, but El Niño and La Niña events occur on average every two to seven years. Typically, El Niño occurs more frequently than La Niña.

El Niño

El Niño means The Little Boy, or Christ Child in Spanish. El Niño was originally recognized by fishermen off the coast of South America in the 1600s, with the appearance of unusually warm water in the Pacific Ocean around December. The term El Niño refers to the large-

scale ocean-atmosphere climate interaction linked to a periodic warming in sea surface temperatures across the central and east-central Equatorial Pacific. Typical El Niño effects are likely to develop over North America during the upcoming winter season. Those include warmer-than-average temperatures over western and central Canada and over the western and northern United States. Wetter-than-average conditions are likely over portions of the U.S. Gulf Coast and Florida, while drier-than-average conditions can be expected in the Ohio Valley and the Pacific Northwest. The presence of El Niño can significantly influence weather patterns, ocean conditions and marine fisheries across large portions of the globe for an extended period of time.

La Niña

La Niña means The Little Girl in Spanish. La Niña is also sometimes called El Viejo, anti-El Niño, or simply "a cold event." La Niña episodes represent periods of below-average sea surface temperatures across the east-central Equatorial Pacific. Global climate La Niña impacts tend to be opposite those of El Niño impacts. In the tropics, ocean temperature variations in La Niña also tend to be opposite those of El Niño.

ENSO events are thought to have been occurring for thousands of years. Modern day research and reanalysis techniques have find that at least 26 El Niño events since 1900 with the 1982-83, 1997–98 and 2015–16 events among the strongest on record.

Different countries have different criteria to determine what constitutes an El Niño/ La Niña event, which is tailored to their specific interests. For example, the Australian Bureau of Meteorology looks at the trade winds, Southern Oscillation Index (SOI), weather models and sea surface temperatures in the Nino 3 and 3.4 regions, before declaring an El Niño. However, the Japan Meteorological Agency declares that an El Niño event has started when the average five-month sea surface temperature deviation for the NINO 3 region, is over 0.5 °C (0.90 °F) warmer for 6 consecutive months or longer. The Peruvian government declares that an El Nino is under way, if the sea surface temperatures in the Nino 1 and 2 regions, equal or exceed +0.4 °C for at least 3 months.

The Oceanic Niño Index (ONI) is the standard used by NOAA for identifying El Niño (warm) and La Niña (cool) events in the tropical Pacific. It is the running 3-month mean SST anomaly for the Niño 3.4 region (*i.e.*, 5°N-5°S, 120°-170°W). The events are defined as 5 consecutive overlapping 3-month periods at or above the +0.5°C anomaly for warm (El Niño) events and at or below the -0.5 °C anomaly for cold (La Niña) events. The threshold is further categorized as Weak (with a 0.5 to 0.9 SST anomaly), Moderate (1.0 to 1.4), Strong (1.5 to 1.9) and Very Strong (> 2.0) events.
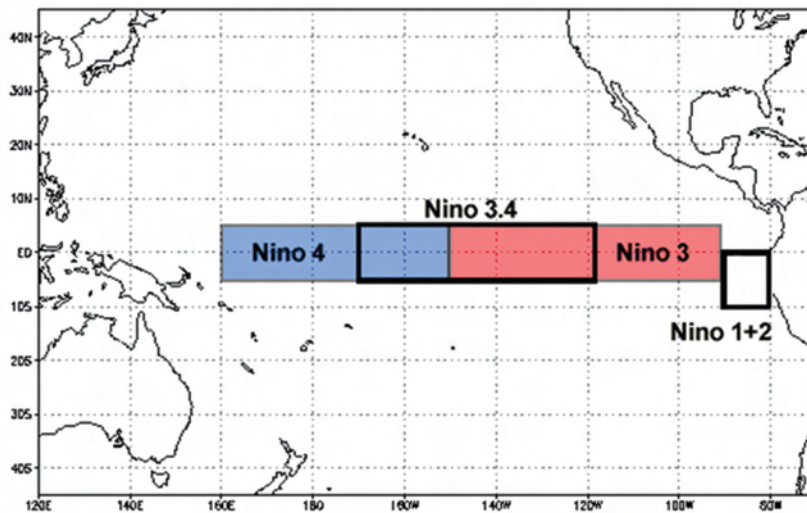
Spatial Extent of Nino regions

It has been found that necessary condition for the development and persistence of deep convection (enhanced cloudiness and precipitation) in the Tropics develops when the local SST is 28°C or greater. Once the pattern of deep convection has been altered due to anomalous SSTs, the tropical and subtropical atmospheric circulation adjusts to the new pattern of tropical heating, resulting in anomalous patterns of precipitation and temperature that extend well beyond the region of the equatorial Pacific. An SST anomaly of +0.5°C in the Niño 3.4 region is sufficient to reach this threshold from late March to mid-June. During the remainder of the year a larger SST anomaly, up to +1.5°C in November-December-January, is required in order to reach the threshold to support persistent deep convection in that region.

Task: Categorize the years into El Nino/ La Nina or normal year based on ONI.

Software Required: QGIS 2.18.14 and Microsoft Excel

Data sets required:

Climatic (1981-2010) monthly mean SST (1_JAN.tif, 2_FEB.tif, 3_MAR.tif, 4_APR.tif, ... 12_DEC.tif)

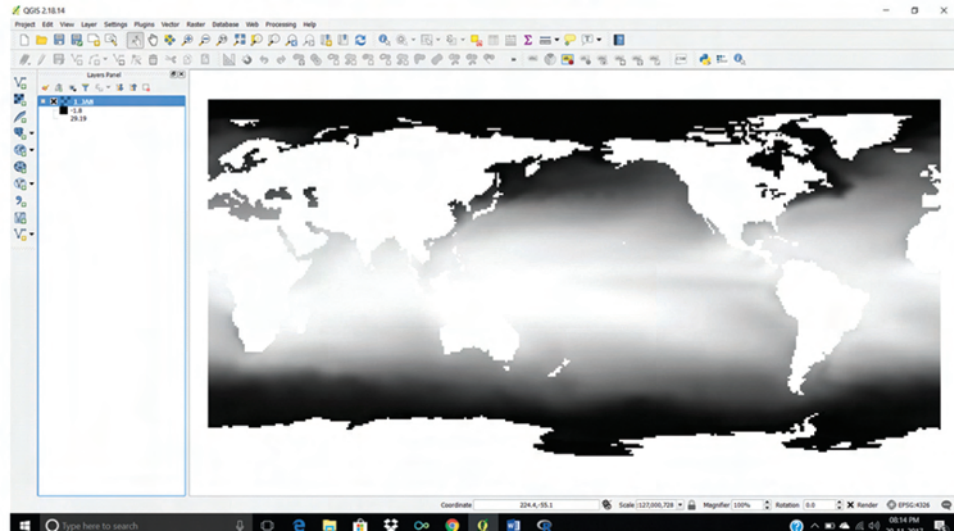Actual monthly mean SST (2015_JUN.tif, 2015_JUL.tif, 2015_AUG.tif, ... 2017_OCT.tif)

Shape file for Nino 3.4 region: NiNo_3.4_Poly.shp

Loading SST data into QGIS:

Open QGIS -> Go to Layer menu -> Add raster layer -> Browse to the folder location -> Select the file -> 1_JAN.tif and load the file into the map view.
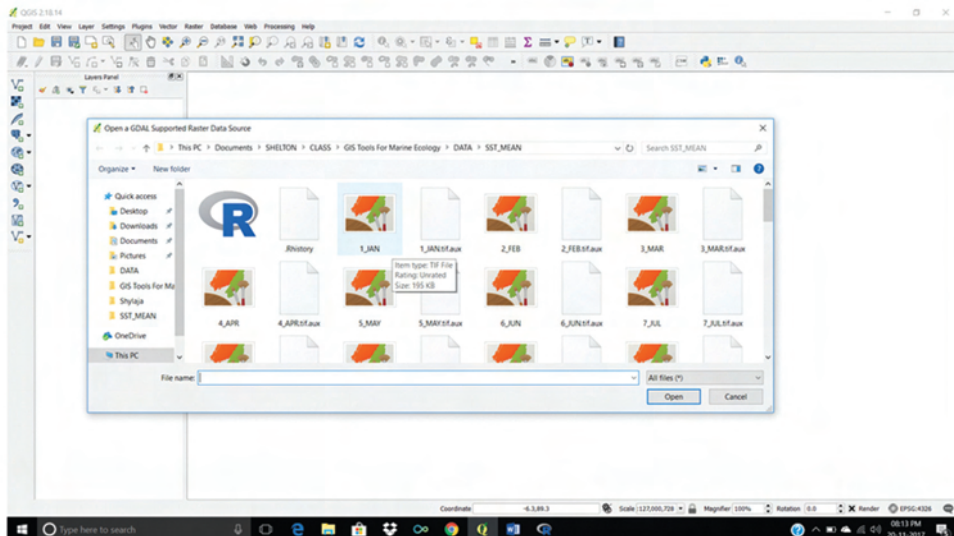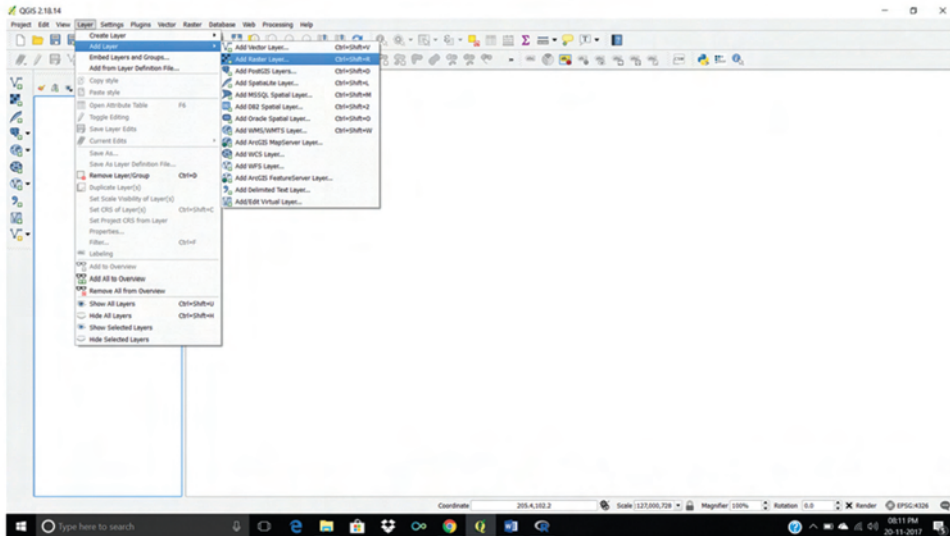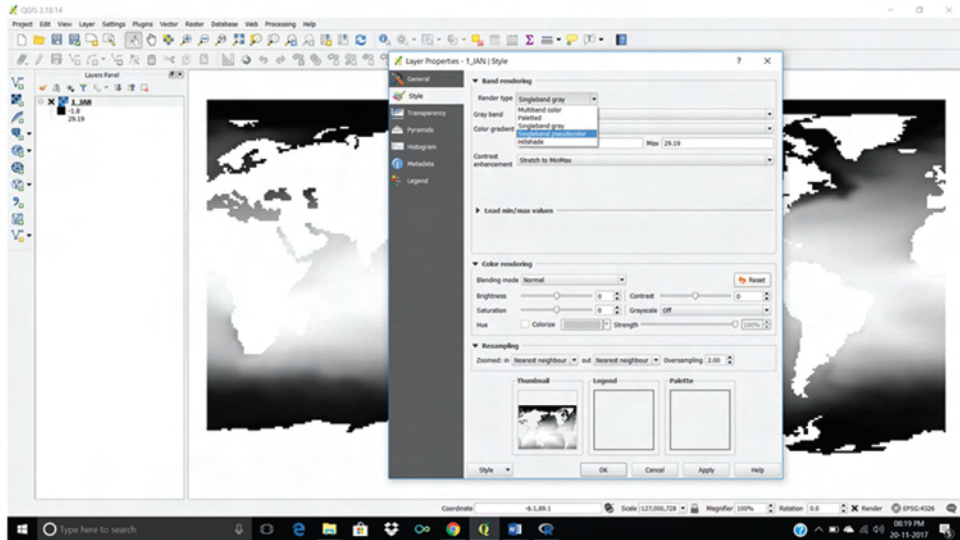
Now, to get a clear visual effect of the temperature variation, change the grey scale of the map to pseudo colour rendering. For that, right click the file name on the Layers panel (left side of the main view panel) and select the properties.
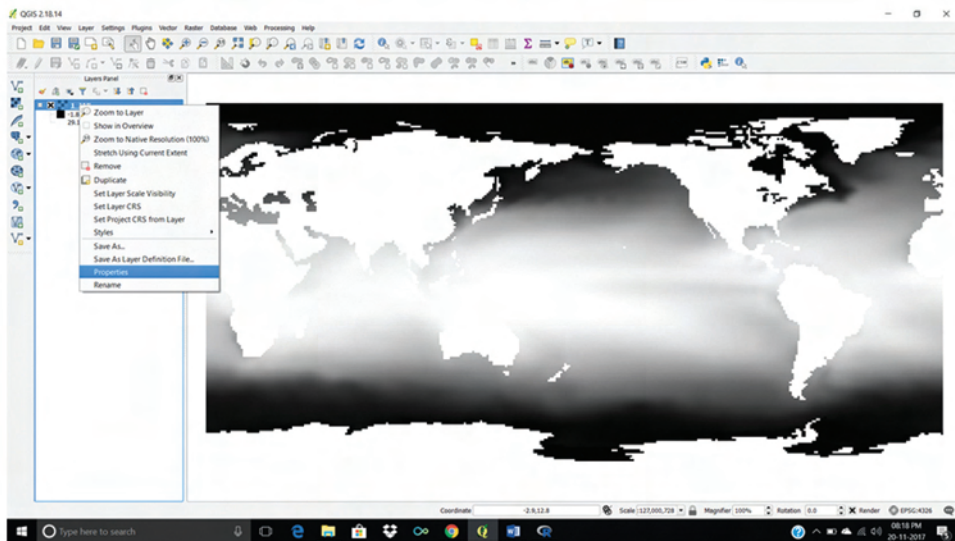

From the Layer Properties pane, go to style tab and change the band render type to 'Single band pseudo colour'.
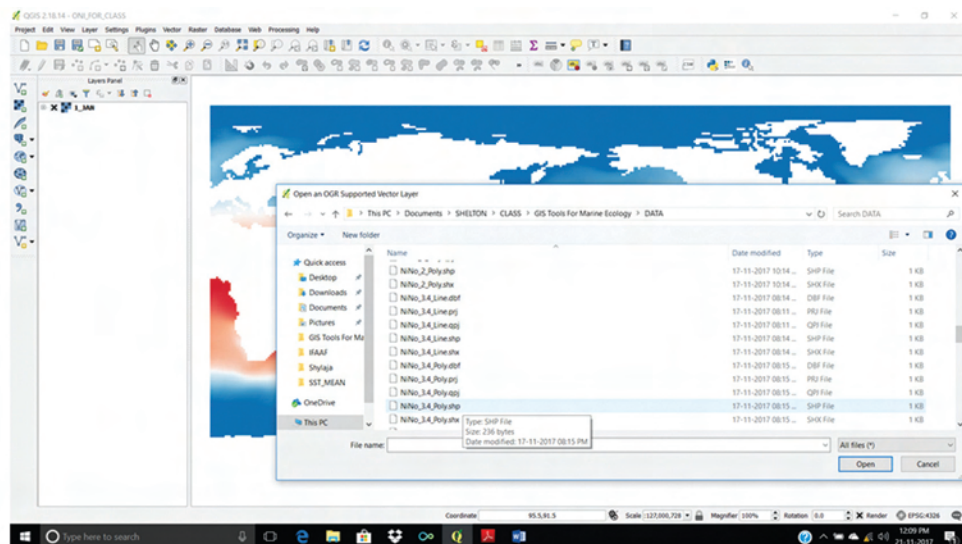
Then choose a 'Colour' band. Change the 'Mode' to 'Equal interval', set 'Classes' to '30' and press the 'Classify' button. The display will change to pseudo colour gradient as per the SST variations. Likewise, load all the SST layers.
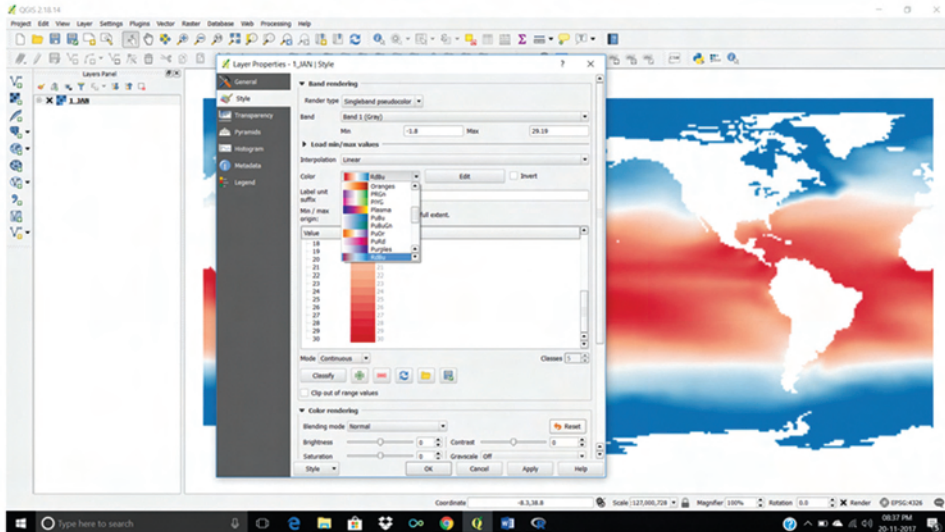
Now, we have to load the shape file for Nino 3.4 region. Go to Layers menu -> Add Layers -> Add Vector Layer.
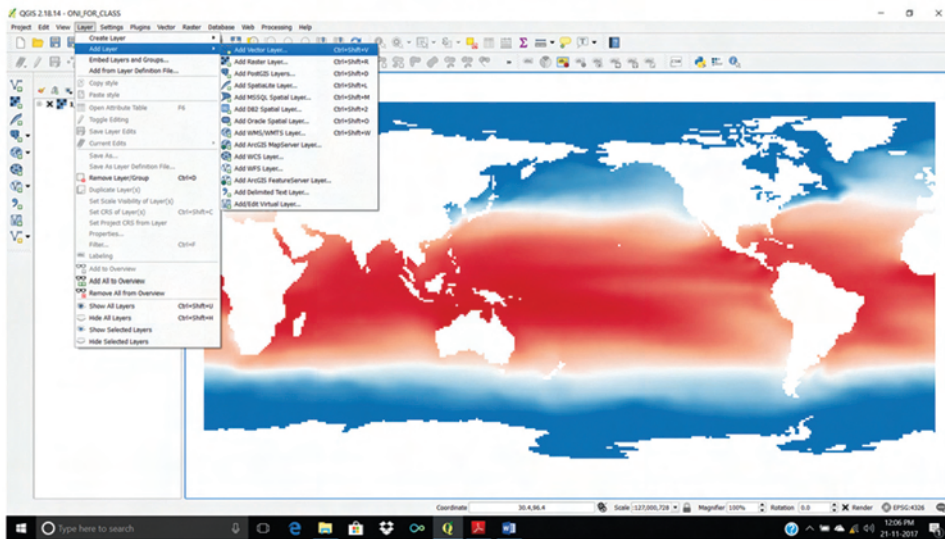
Browse to the file 'NiNo_3.4_Poly.shp' and open it.

Now, we have to extract the mean value of SST from the Nino 3.4 region. For that we have to use the 'SAGA' tool 'Raster Statistics for Polygons'.

Go to 'Processing' menu -> select 'Toolbox'. On right side of the Main window, tools panel will get displayed. In the tool box, under SAGA tools, go to Vector<->Raster sub group and select the tool 'Raster Statistics for Polygons'.
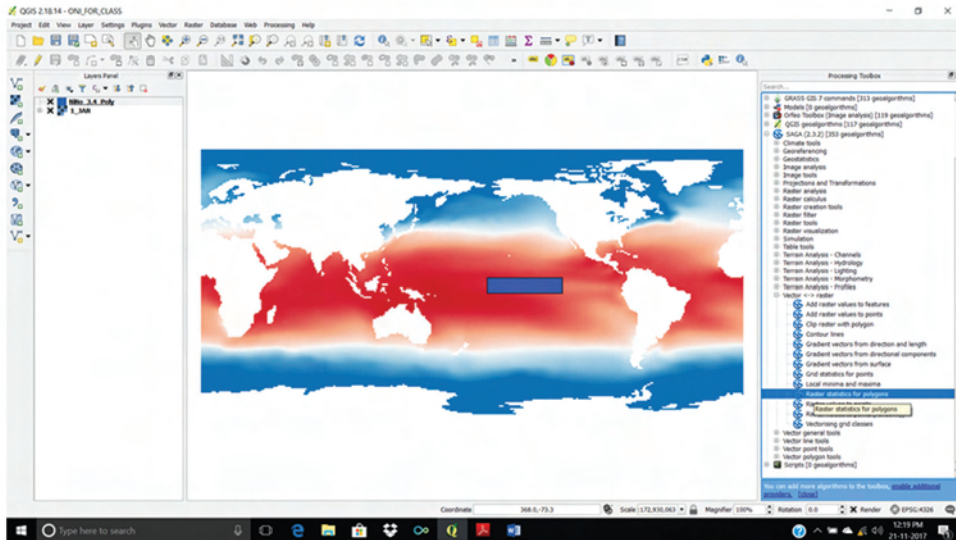
In the 'Raster Statistics for Polygons' tool panel, in the Grids option, select the SST datasets. For 'Polygons' select NiNo_3.4_Poly.shp', Method-> Standard, Grid Naming -> Grid Name, tick mark 'Mean' and press 'Run'.
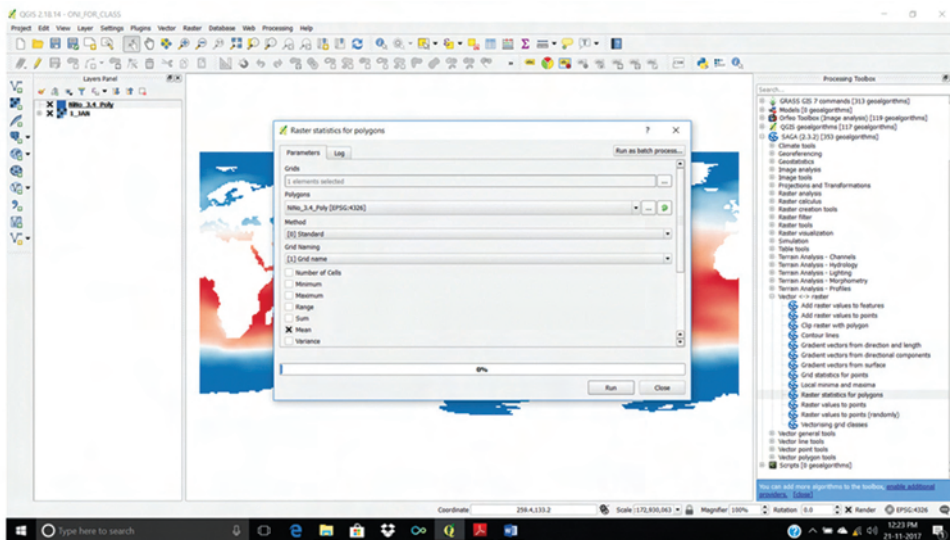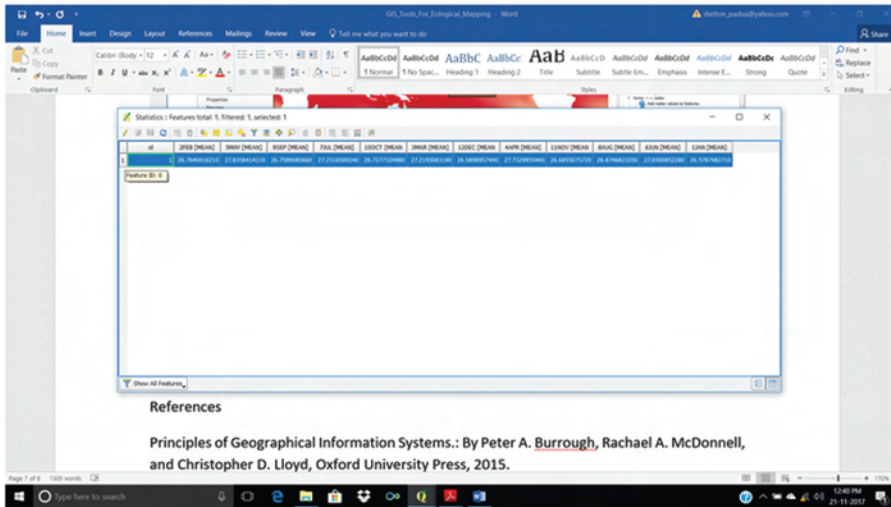

Now, you will get a 'Statistics' vector layer in the 'Layers Panel'.
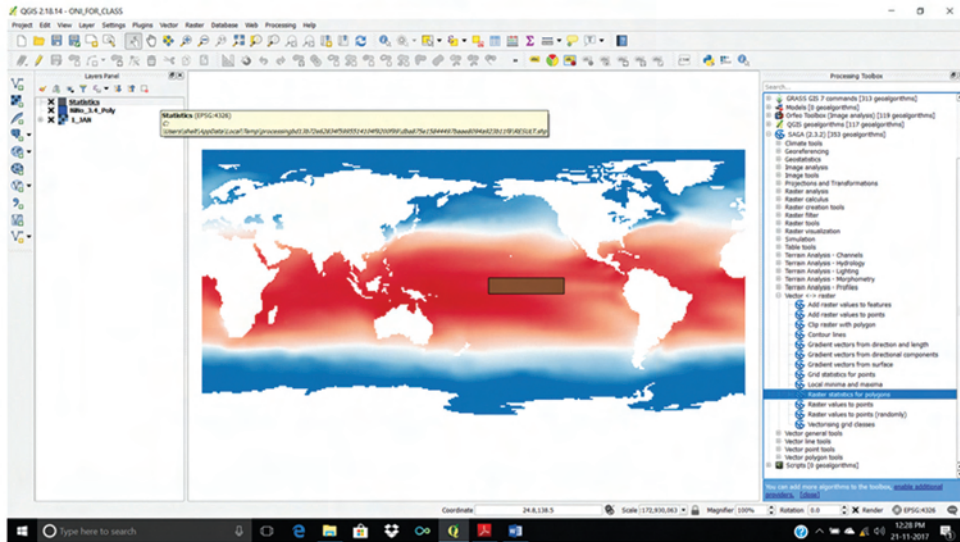
Right click on the layers panel and open the 'Open Attribute Table' button. This will open up the attribute table.
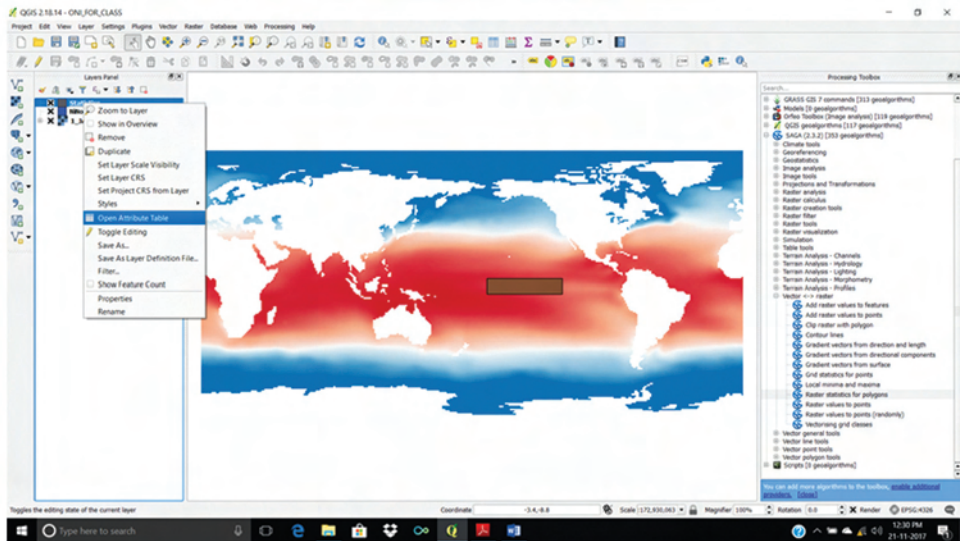

From the attribute table, select the row of attributes by 'left clicking' the corresponding row number.

Once the row is highlighted, copy the records to clipboard by clicking the 'Copy' button or using the keys 'ctrl+c'. Now open a Microsoft Excel sheet and paste the copied values. Do the procedure for both climatic monthly mean SST data (1_JAN to 12_DEC) and actual monthly mean SST data (2015_JUN to 2017_OCT).

Calculate the three months running mean from 2015_JUN to 2017_OCT and three months climatic running means. Now, find the SST anomaly (difference between these two sets of running means).
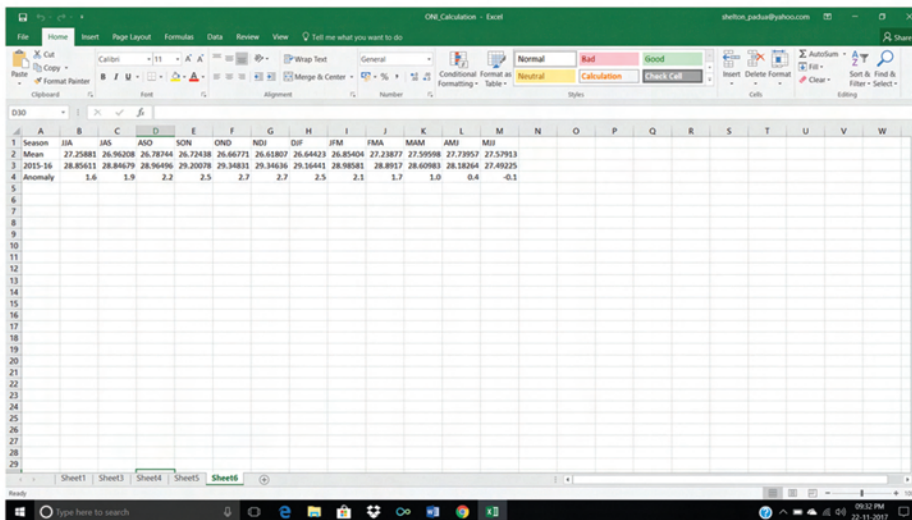
Now, see if the SST anomaly qualifies for El Nino/ La Nina or normal year as per the criteria and report accordingly.

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