NDVI to Variable Nitrogen Application Map – QGIS plugin

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- Satellite images download – Copernicus Browser
  - Copernicus Data Space Ecosystem (CDSE), Modified Copernicus Sentinel data 2024 processed in Copernicus Browser. https://browser.dataspace.copernicus.eu/
- QGIS-based NDVI analysis and N prescription map processing
  - QGIS 2024. QGIS.org, Geographic Information System. QGIS Association. http://www.qgis.org

1. Conceptual framework (Precision Agriculture)

To enable site-specific variable management of nitrogen fertilizer (production input) site-specific variability hast to be ***quantifiable*** and ***manageable***. Quantifiable refers to specific means and methods for quantifying site-specific biomass variability (e.g. satellite image based NDVI and/or EVI etc.). Manageable in a sense being able practically via fertilizer spreader to reduce/increase fertilizer application amounts on a site-specific level.

With this open-source plugin the user can use NDVI (EVI) to identify in-field variability based on index value on site-specific level. There are two methods to utilize the index-based indication about site-specific level-based biomass variability. If its ***hypothesized*** that higher NDVI index value indicates better plant growth conditions a user can aim at: 1) agronomic yield maximizing or 2) agronomic yield equalizing site-specific variable nitrogen application.

In developed countries maximum nitrogen application amount per hectare in one season is limited due to environmental pollution concerns. This implies that if farmer wants to manage field nitrogen application on a site-specific level, it can be done only by reducing nitrogen applied in some areas of the field and increasing it in others.

Agronomic yield maximization would prescribe more fertilizer to be applied in the areas where plants “grow better” and less in the areas where index “indicates” less favourable conditions for plant growth.

Agronomic yield equalizing (homogenizing) variable N application would prescribe more fertilizer to be applied in the areas of the field with lower index values, under the assumption that plant need more nutrients in order to “catch up” with the rest of the field. It is assumed that this would lead to more equal biomass spread in the field at the end-of-season.

2. Required inputs

Two important geospatial input layers are required for running the plugin:

1) site-specific units delineating Input Layer (shape file delineating sub-field units – polygons) (***should be unzipped before adding to QGIS layer legend, in case if shape file is in zipped directory!***),

2) georeferenced NDVI input raster (.TIFF) that can be downloaded for specific dates via Copernicus Browser. In addition, via Copernicus Browser raw data (e.g. B02, B04 and B08) can be downloaded and NDVI can be calculated with QGIS Raster Calculator or experimental plugin “NDVI and EVI Index Calculator”.

3. Running plugin

Sample files for testing QGIS plugin can be found in GitHub:

https://github.com/memicemir/ndvi_to_variable_N_application/tree/main/SampleImage-TestPlugin

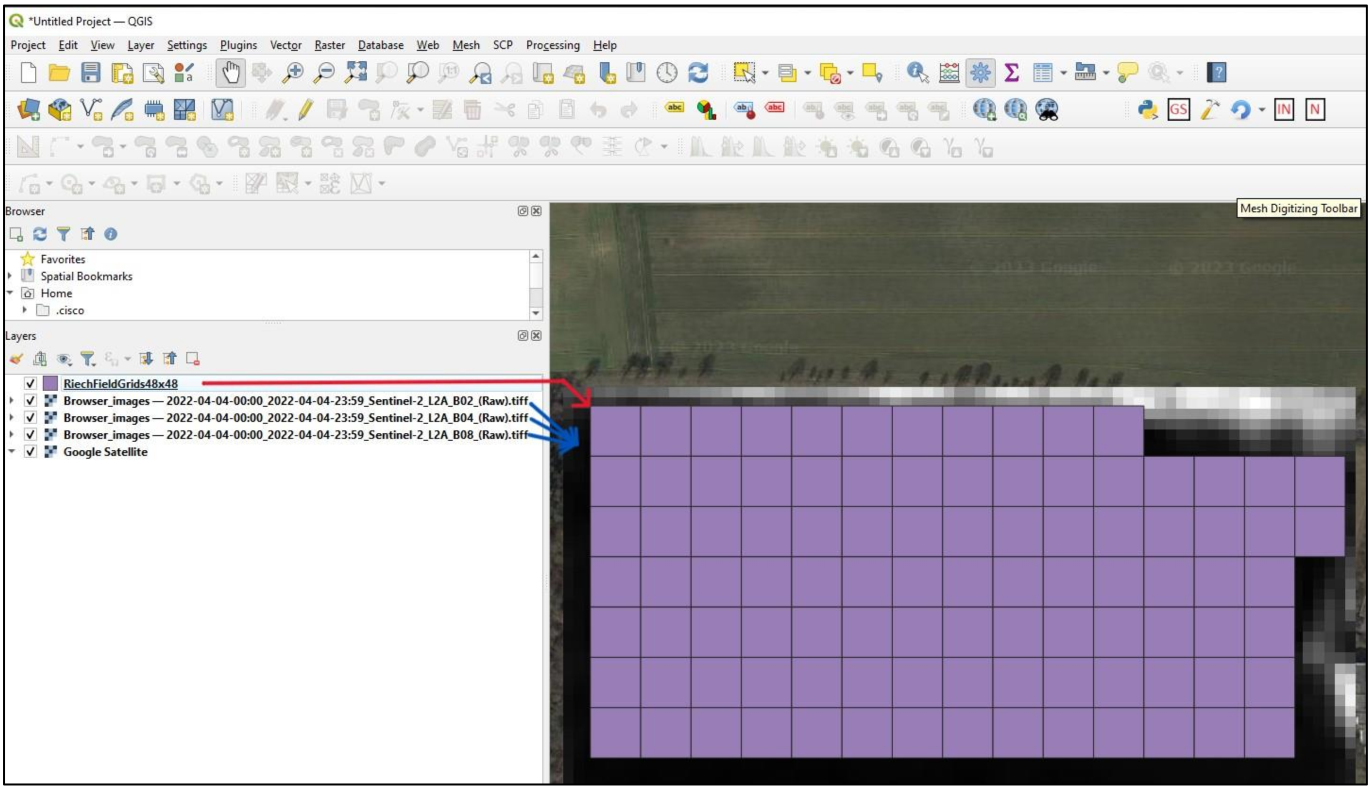

Figure 1. Input layers required for running plugin: geospatial grid (shape layer) and Sentinel 2 raw bands (in this case from Copernicus Browser)

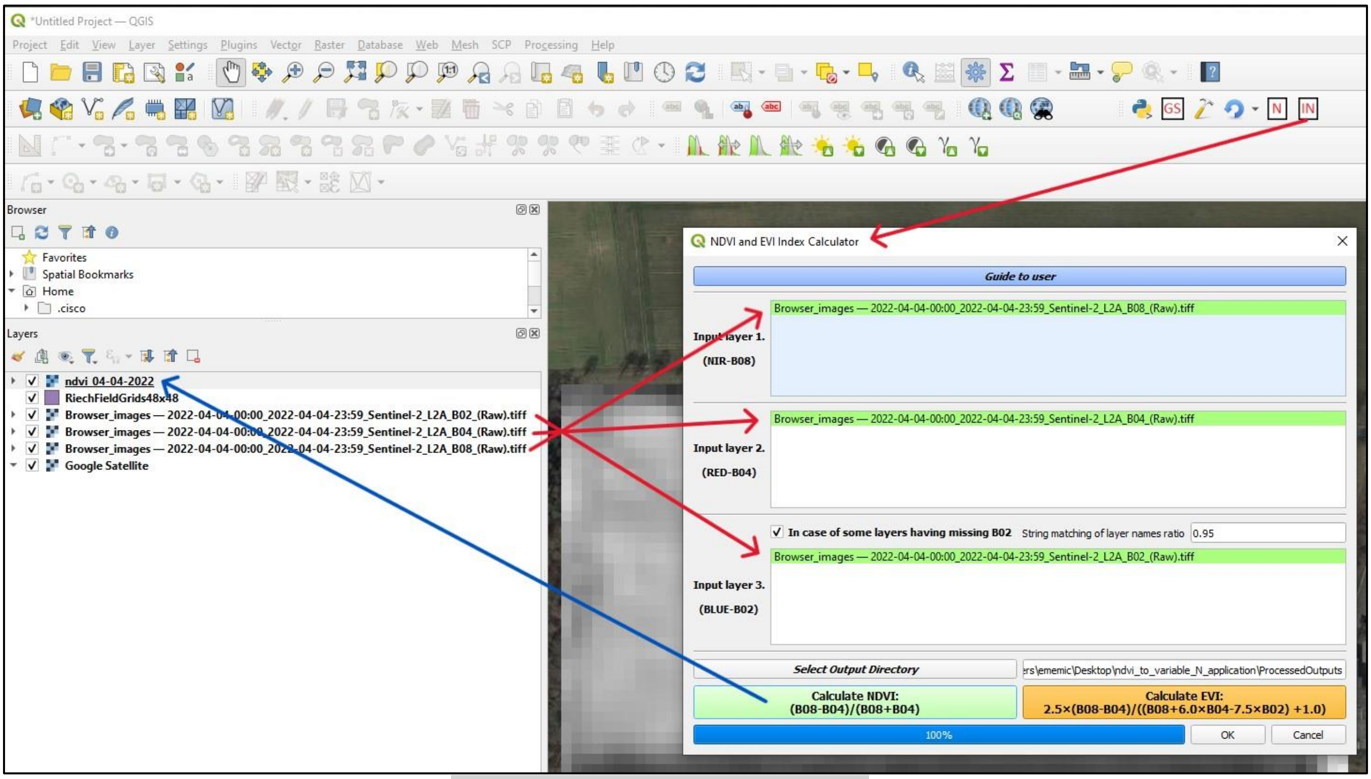

Figure 2. Using already published NDVI and EVI Index Calculator plugin a user can produce NDVI index layer.

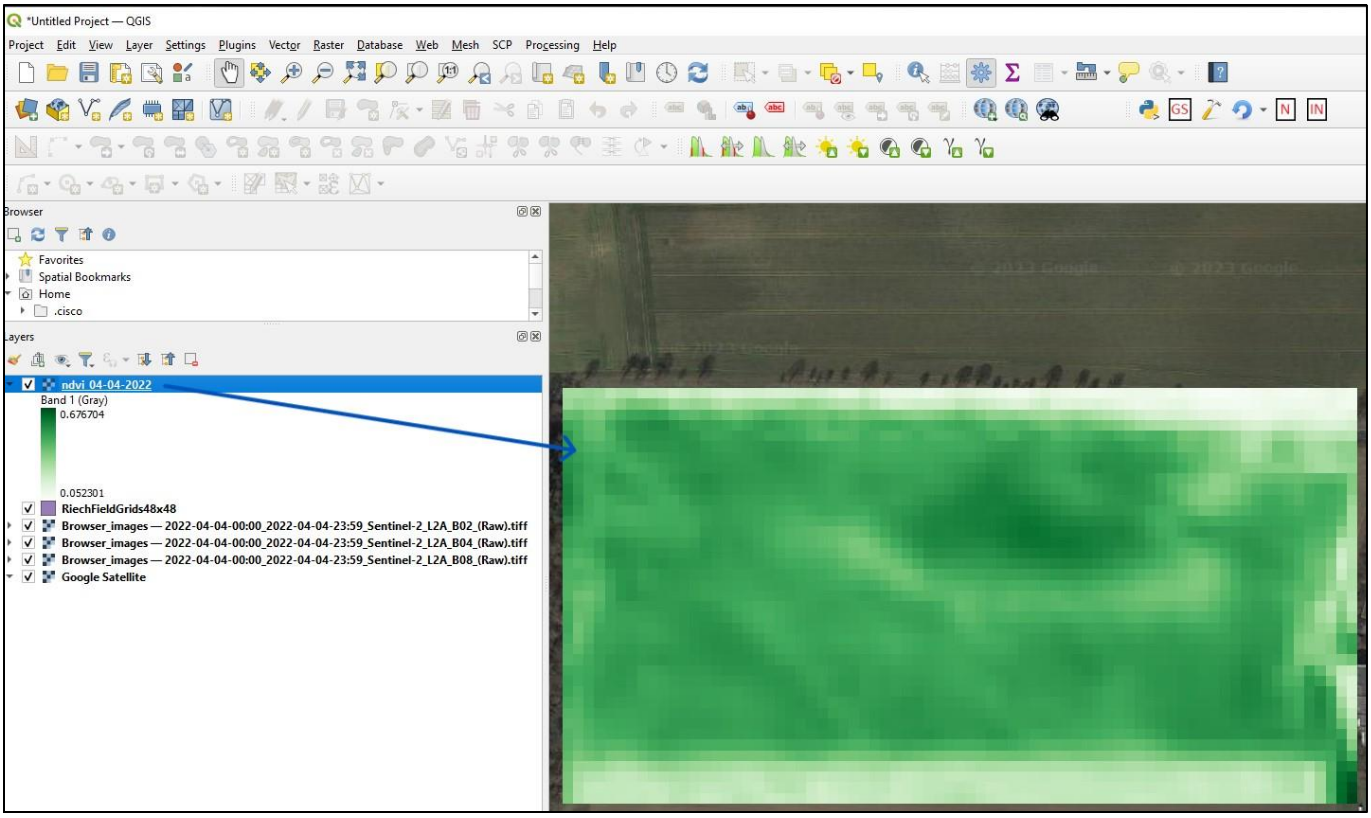

Figure 3. The NDVI index layer in QGIS

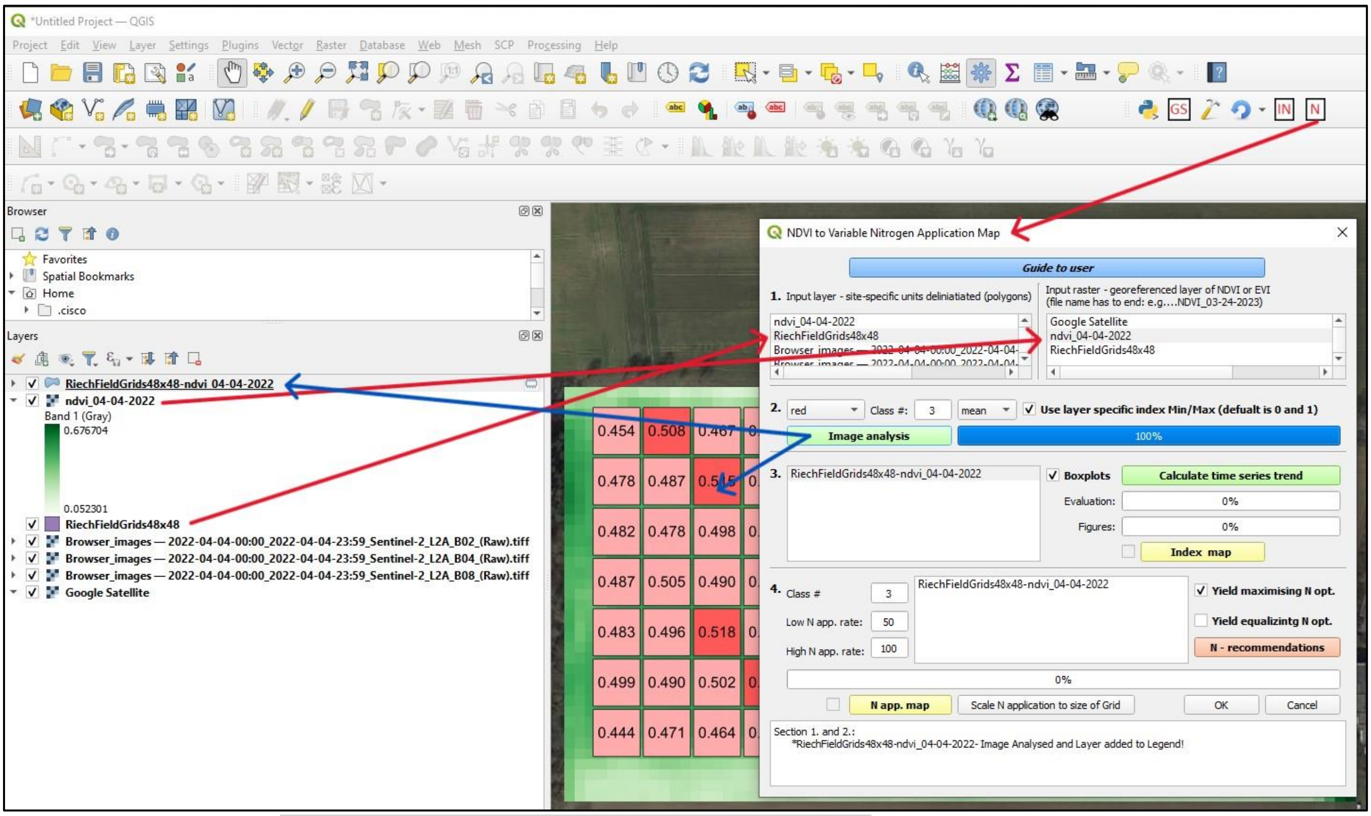

Figure 4. Initializing NDVI to Variable Nitrogen Application Maps plugin will open interface. In the interface section 1 in Input layer the user selects grid shape file and in Input raster the user selects NDVI index layer. Once Image analysis push button in section 2 in the interface is pressed, it will produce a new layer with grid (polygon) based index values. In Figure 5 the options from interface section 2 are described.

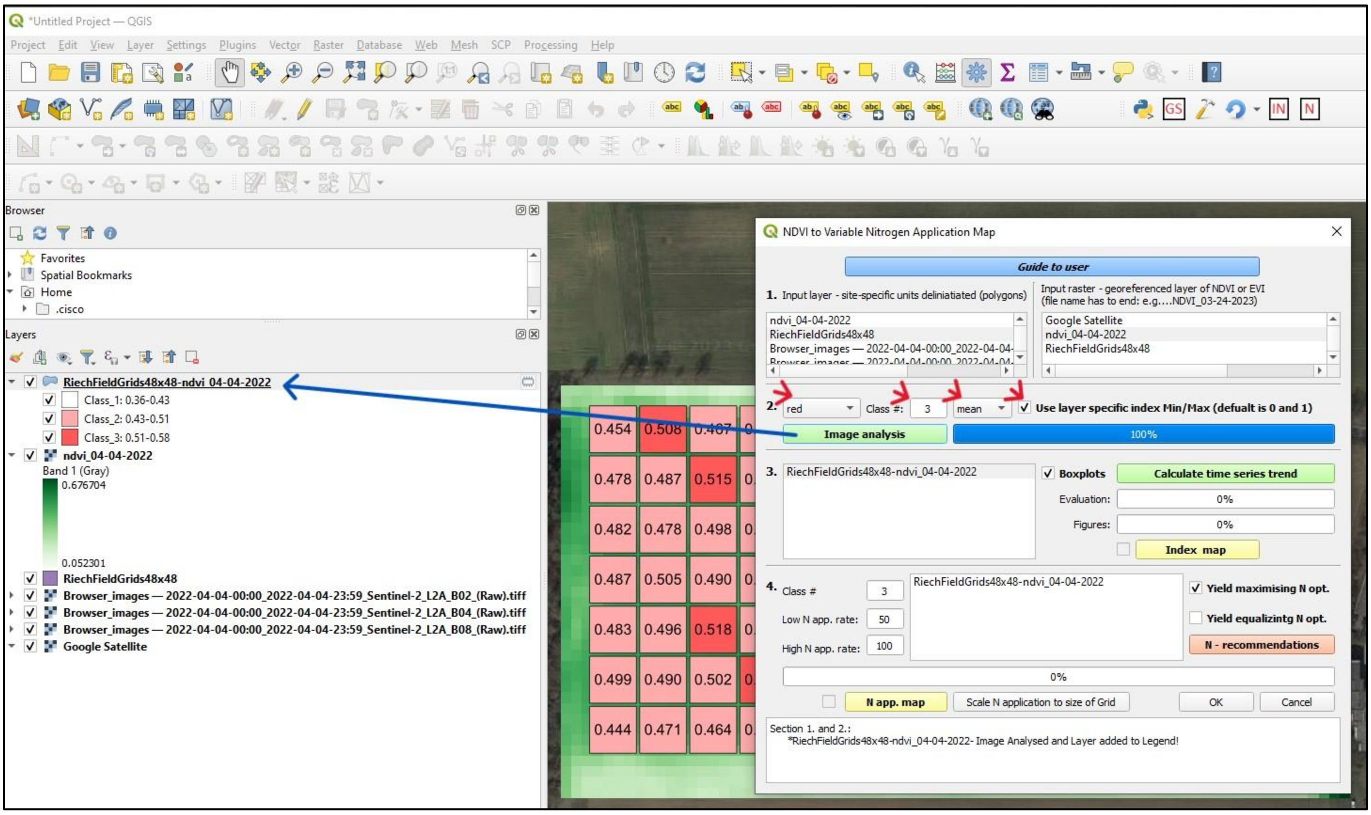

Figure 5. In section 2 in the interface the user can initialize the color of the heat map that will be used (e.g. red, green, blue) and number of index classes (categories). With in the interface Class #: 3 the plugin will assign all index values to three classes based on index min/max by splitting it in three equal interval categories. The option **mean** is the targeted field in the Attribute table used for analysis. *There are other options which are not yet tested!* Categories are based on the mean values from Attribute table.

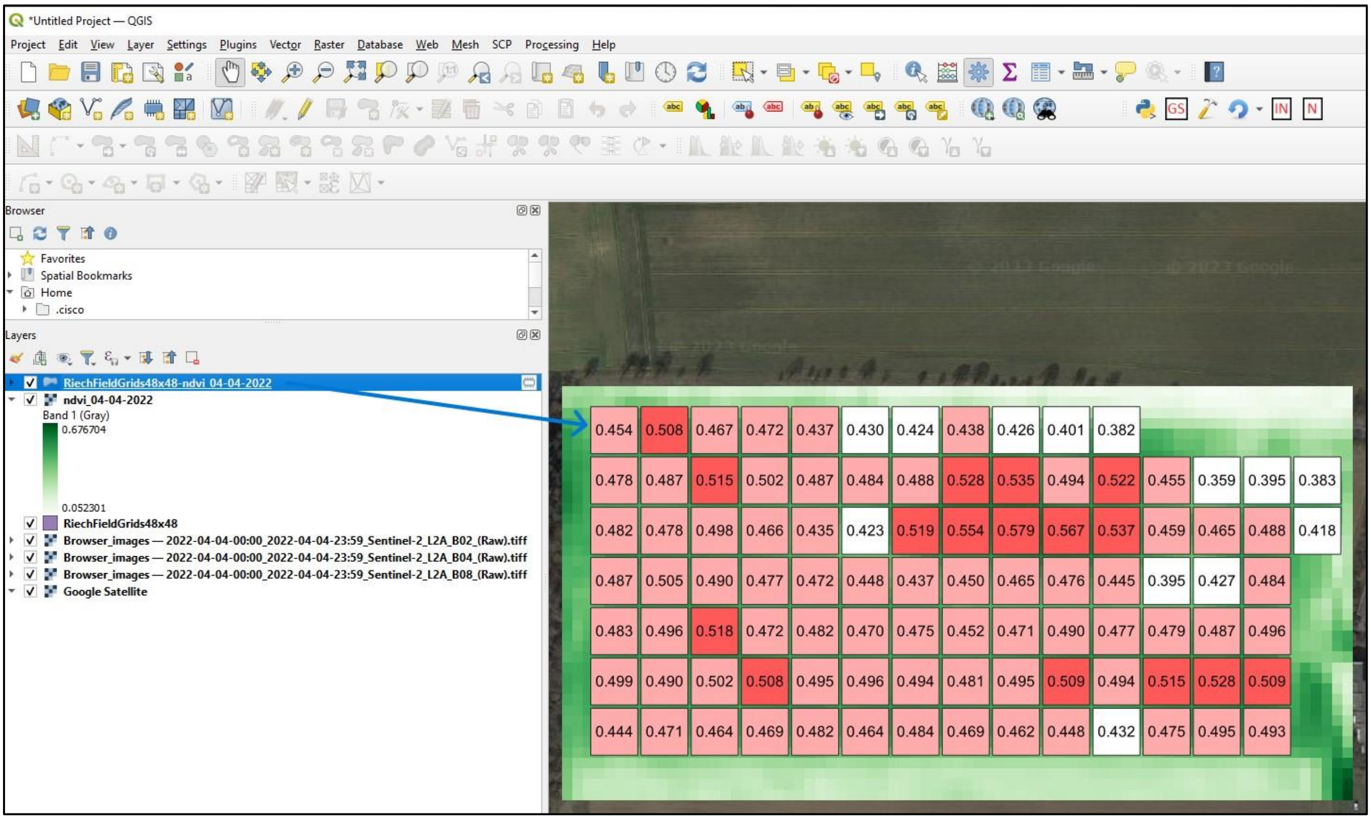

Figure 6. The output heat map is based on three categories of newly produced layer (in this example).

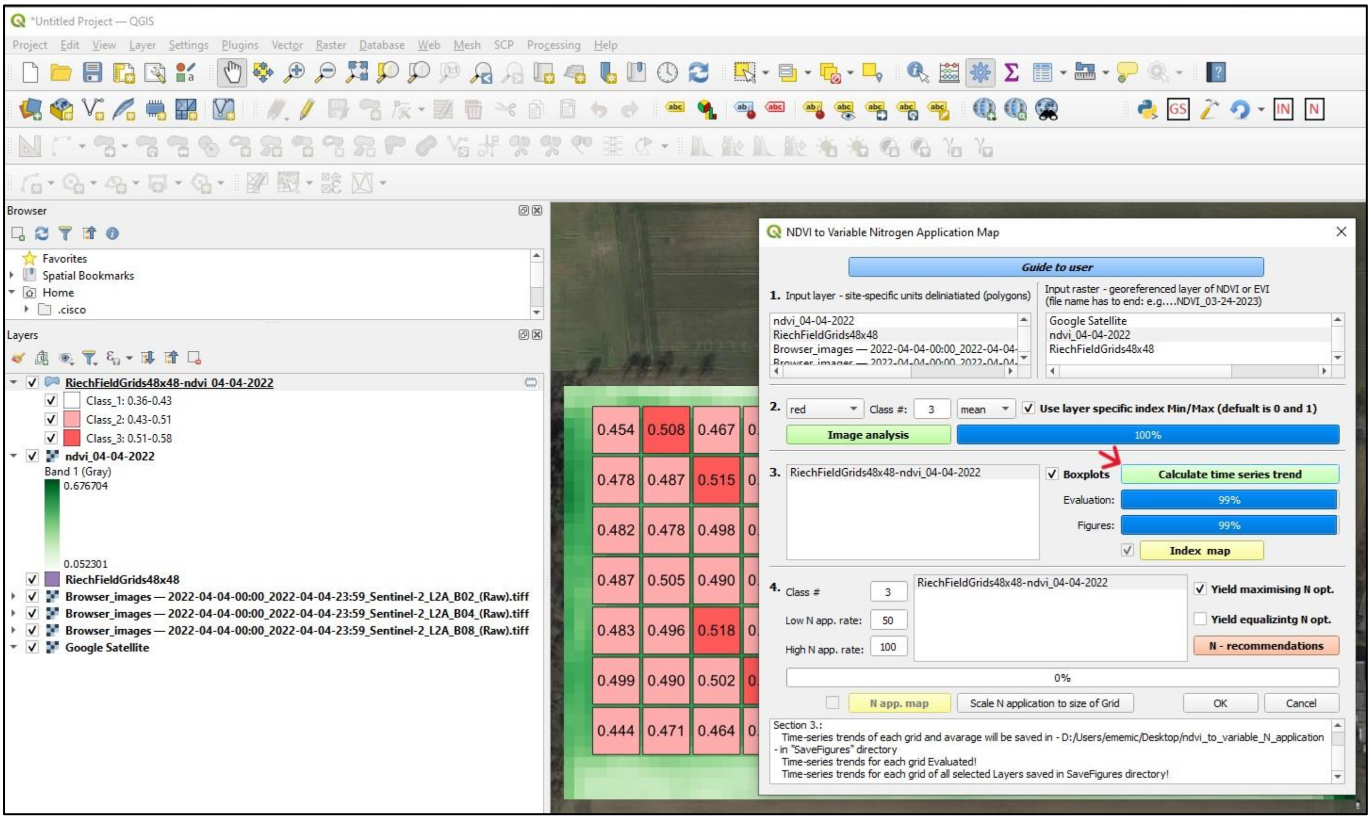

Figure 7. In the interface section 3 newly produced layer is added to the list widget window and is used for calculating time-series trends of all available indices. Output values are saved in the SaveFigures directory. SaveFigures directory is created in the directory from which Input layer is added. Index map in section 3 will produce photos (.png) of the layers in SavePDFs directory (also created in the same directory where Input layer is located. (*for multiple layer .png there is a problem with speed of image rendering!*)

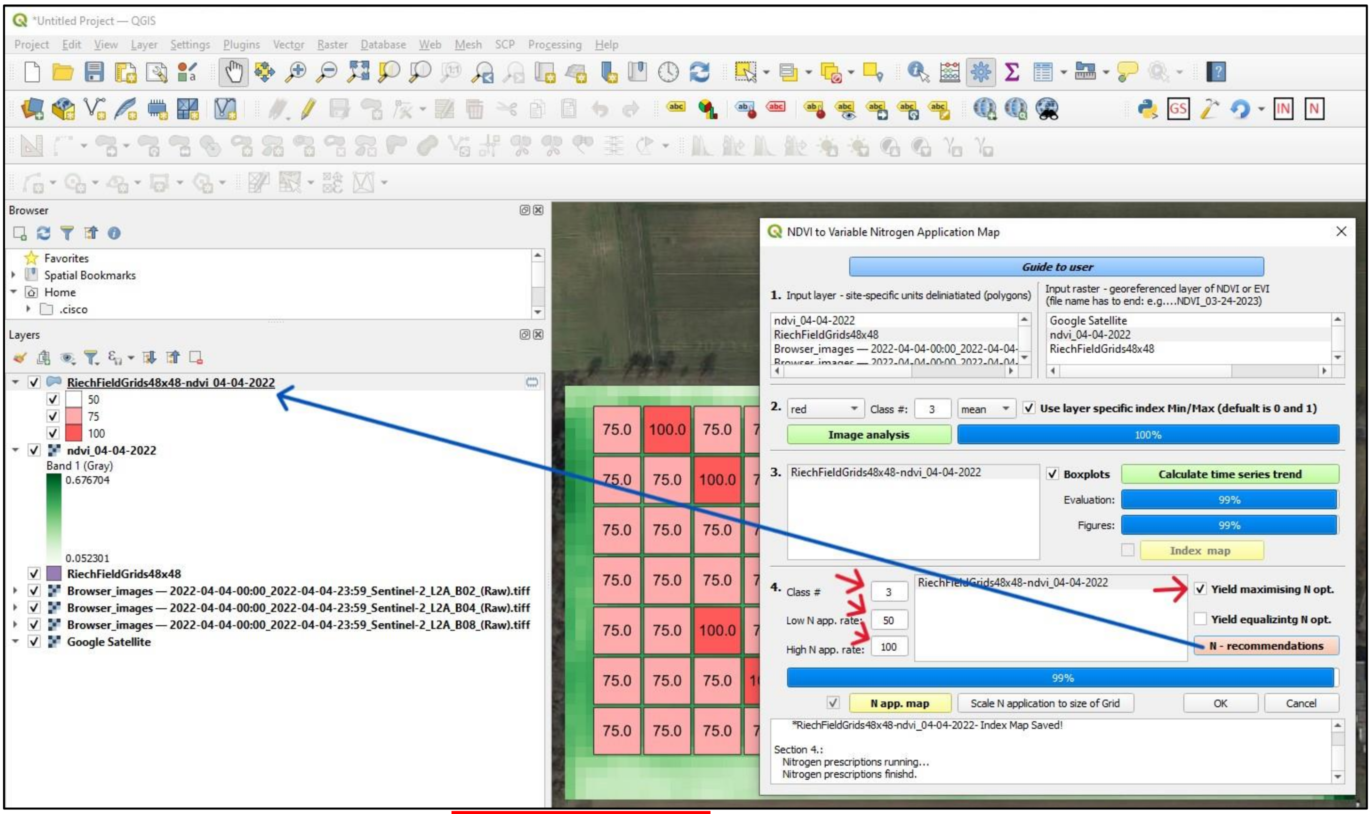

Figure 8. In section 4 site-specific N recommendations are created. The N recommendations push button will produce information about distribution (Figure 9) of the N application values, in the SavePDFs directory.

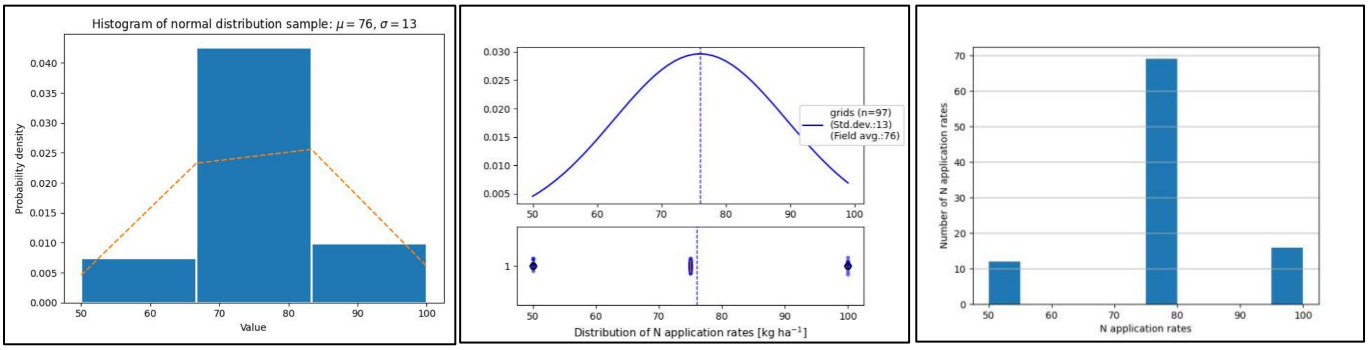

Figure 9. This information will give a user a better idea of how many grids belong to which category.

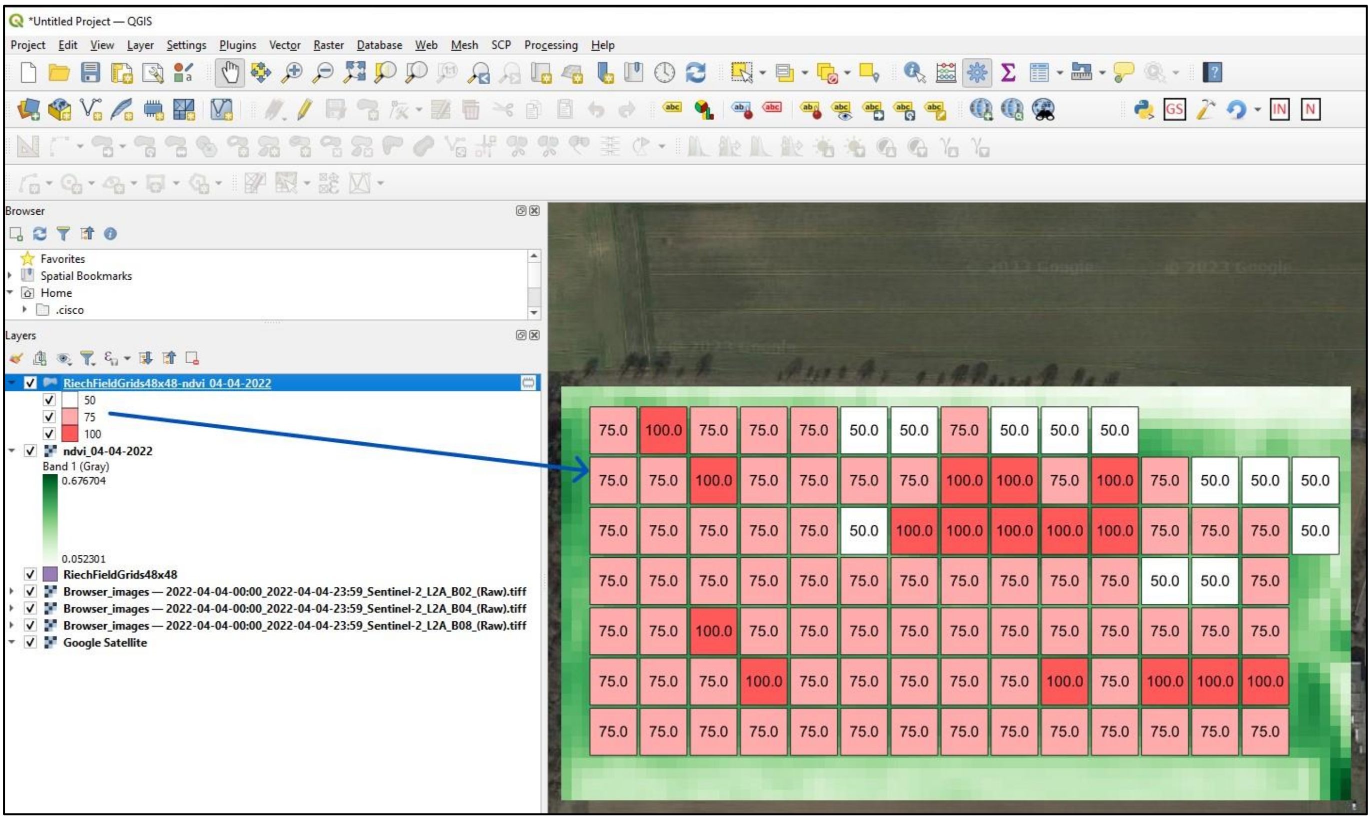

Figure 10. Output heat map of site-specific N recommendations. This is hectare scale recommendation. If the user wants to see what nitrogen recommendation would be depending on the size of the grid (rescaled according to size of site-specific unit) user can achieve that by pressing the push button Scale N application to size of grid. This push button will create an additional field in the Attribute table named "actualNkg". In the Layer Properties -> Labels -> Single Labels -> value: actualNkg -> Apply will show values as shown in Figure 11.

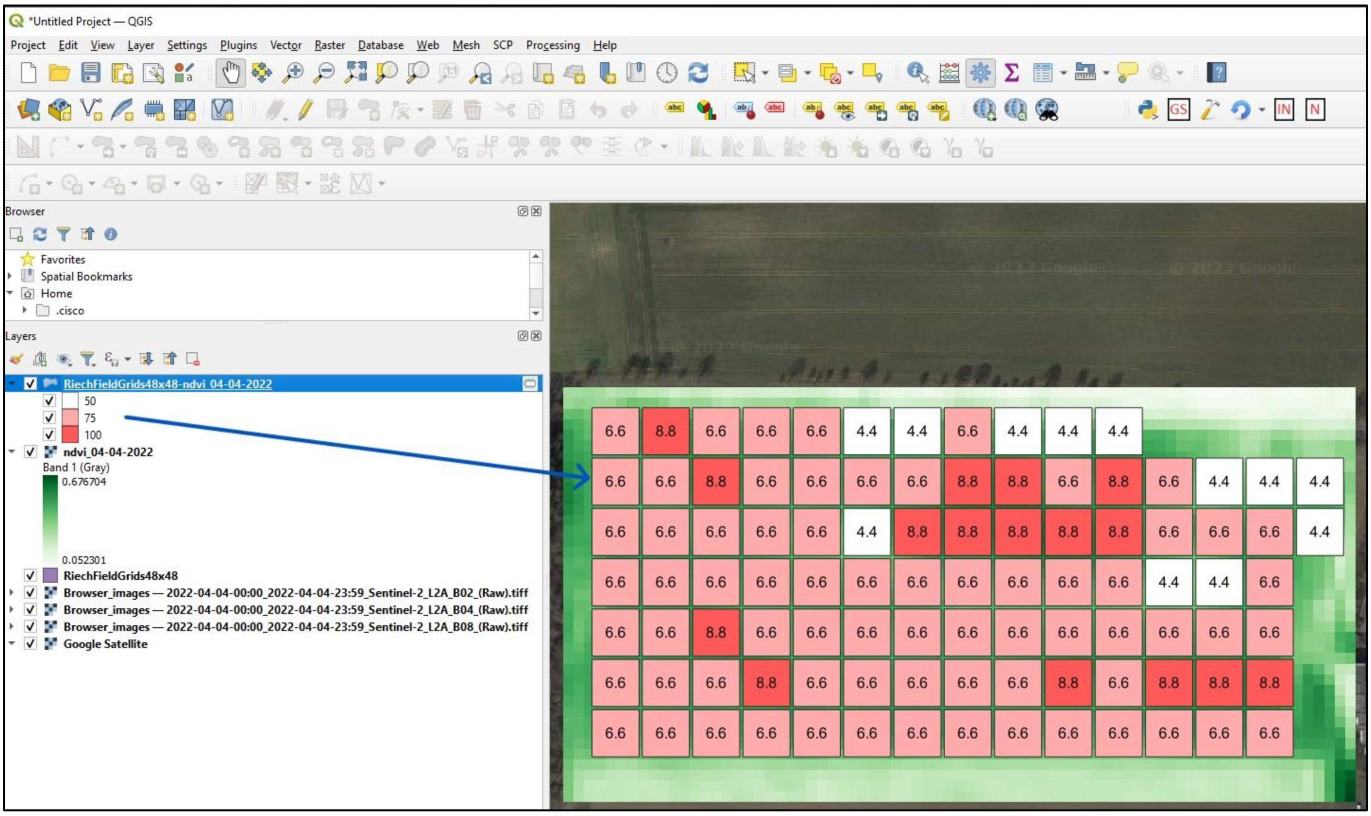

Figure 11. Site-specific N kg application based on actual size of grid.