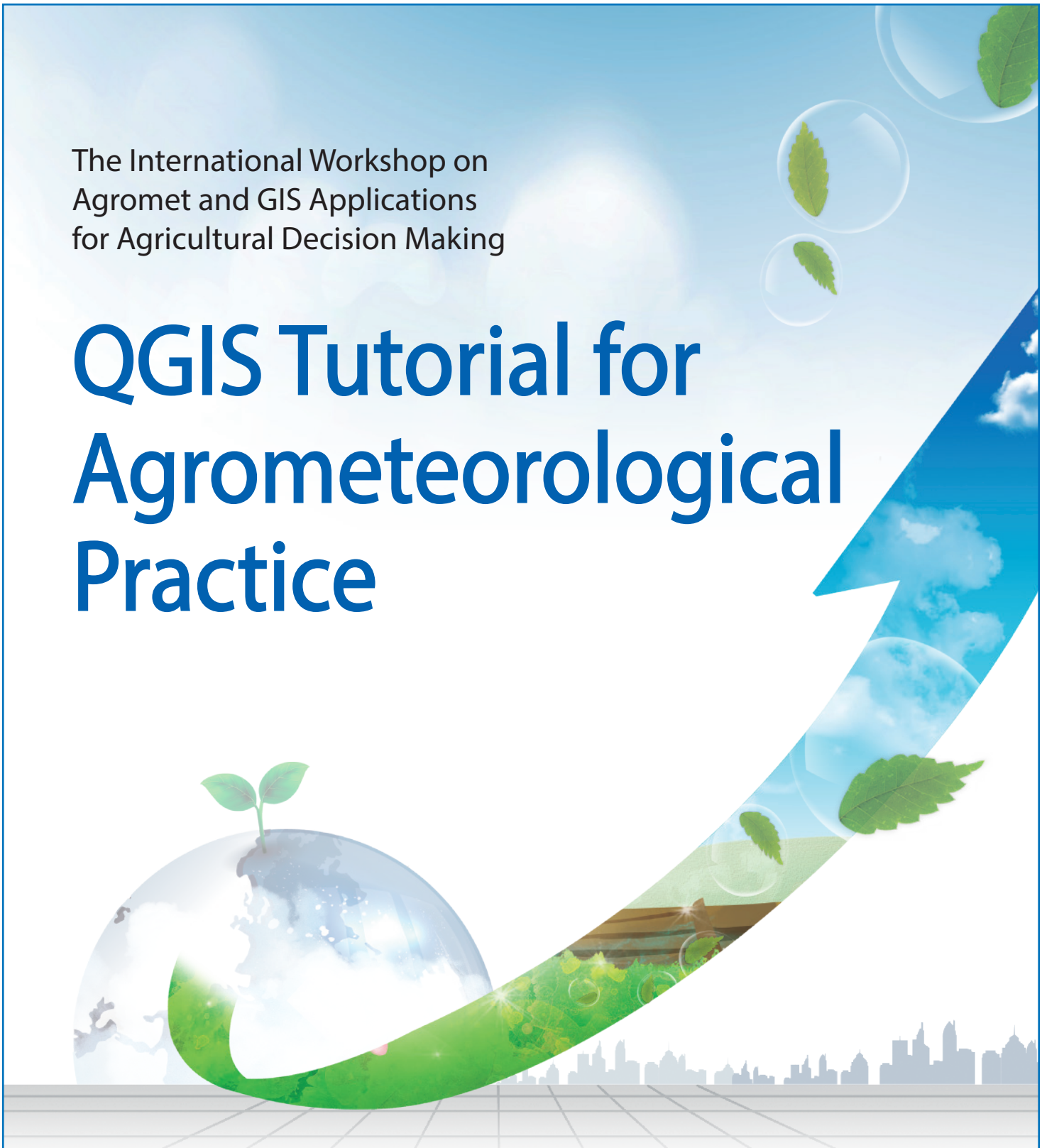
The International Workshop on
Agromet and GIS Applications
for Agricultural Decision Making

QGIS Tutorial for Agrometeorological Practice



Date : December 5(Mon)~9(Fri), 2016
Place : MSTAY Hotel JEJU
Hosted by : Korea Meteorological Administration(KMA)
Organized by : National Institute of Meteorological Sciences(NIMS)
Sponsored by : WMO CAgM / NCAM / APCC / OSGeo / PKNU / DU

Korea Meteorological Administration

National Institute of Meteorological Sciences

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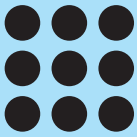
	QGIS Tutorial for Agrometeorological Practice Organized by Dr. PAEK, Doojin and Dr. LEE, Seongkyu
Instructor	Dr. PAEK, Doojin (Seoul Housing and Community Corporation), 1002jeen@daum.net Dr. LEE, Seongkyu (APEC Climate Center), geolegend@apcc21.org
Who is for	Anyone who is interested in GIS application for Agro-meteorology and this program is for beginner and low intermediate. It will be a good starting point for those who want to know how to apply climate/weather data with GIS tool to their own fields, especially agriculture field.
Prerequisite	The following items must be brought to the tutorial session : 1. His/her own notebook computer
Contents	The detailed programs are as follows: 1. GIS training beginning – 1 - Introduction for OSGEO Korean Chapter - Introduction for FOSS4G (Free and Open Sources Softwares (FOSS) for Geospatial - Overview of GIS (Geographic Information System) - QGIS installation*: program and example data* 2. GIS training beginning – 2 - QGIS' practice : *introduction for GIS data (vector & raster etc)* 3. GIS training intermediate – 1 - QGIS spatial analysis I 4. GIS training intermediate – 2 - QGIS spatial analysis II with agrometeorological example
Remarks	The contents may be subject to change without notification. The text book and sample data for GIS tutorial will be distributed in the tutorial session. Dr. CHUNG, Uran (APEC Climate Center) will support agrometeorological practice.



Introduction to QGIS

- Using QGIS and ISCGM Global Map -

Korean Chapter OSGeo
Your Open Source Compass

Introduction to QGIS

- Using QGIS and ISCGM Global Map -

Doojin Paek(1002jeen@daum.net)

I. Overview – QGIS

I-1. QGIS Overview

❑ QGIS → Free & Open Source Geographic Information System

OS

- MS Windows
- Mac OSX
- Linux, Unix

License

- GPL

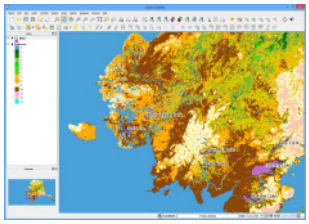
Language

- C++, Python, …

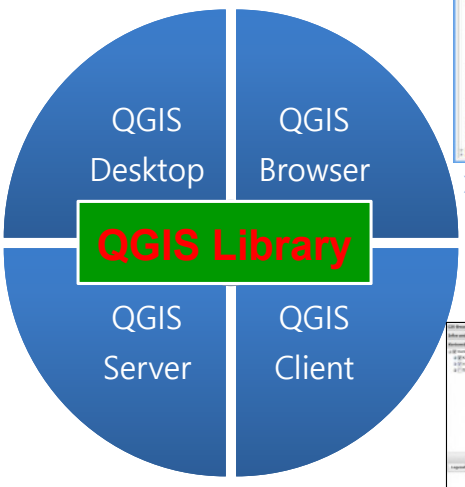
Release Date	Version	Codename
Jul-02	0.0.1-Alpha	Start!!!
3-May-08	0.1	"Io"
21-Jul-08	0.11.0	"Metis"
5-Jan-09	1.0.0	"Kore"
1-Sep-09	1.2.0	"Daphnis"
10-Jan-10	1.4.0	"Enceladus"
29-Jul-10	1.5.0	"Tethys"
27-Nov-10	1.6.0	"Copiapó"
19-Jun-11	1.7.0	"Wrocław"
21-Jun-12	1.8.0	"Lisboa"
8-Sep-13	2.0.0-2.0.1	"Dufour"
26-Feb-14	2.2	"Valmiera"
27-June-14	2.4	"Chugiak"
31-October-14	2.6	"Brighton"
20-Febrary-15	2.8	"Wein"
26-June-15	2.10	"Pisa"
23-October-15	2.12	"Lyon"
29-February-16	2.14	"Essen"
08-Jul-16	2.16	"Nødebo"

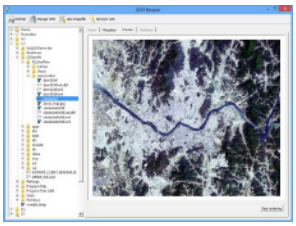
I. Overview – QGIS & Global Map

I-1. QGIS Overview



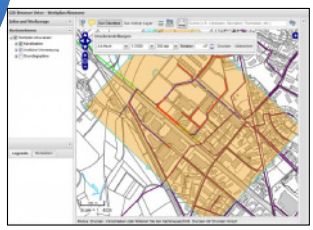
➢ Desktop GIS for querying, creating, editing, analyzing geospatial data





➢ Browser for spatial data

➢ Web Mapping Framework based on QGIS Server and GeoExt



➢ WMS 1.3.0, 1.1.1 Server
➢ FastCGI/CGI Program
➢ SLD Support

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II. Installing QGIS

II-1. Installing QGIS

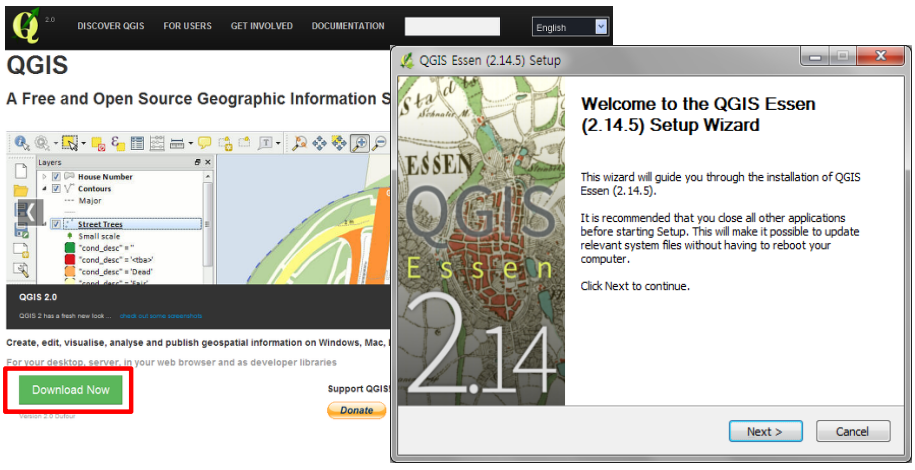
❑ Install QGIS Essen (2.14.5, LTR Version) on Windows OS

① Download latest QGIS Standalone Installer Version 2.14 from http://www.qgis.org/

② Save the File to your machine and double click on the .exe file to install

③ Accept the install defaults to complete the process

④ Launch QGIS



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II-1. Installing QGIS

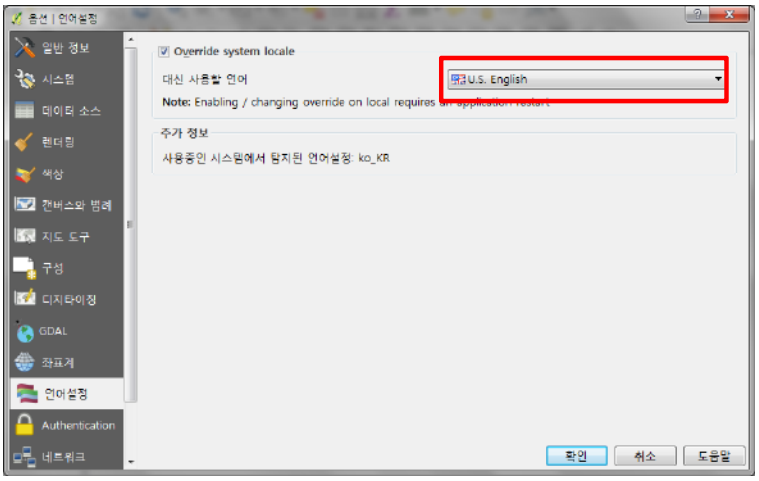
❑ Change the language setting/interface of QGIS

① Launch QGIS

② [설정] → [옵션...] → [언어설정] → [U.S. English] → [확인]

③ Select [Setting] → [Options...] menu and Select [Locale] → [U.S. English] → [OK]

④ Restart QGIS



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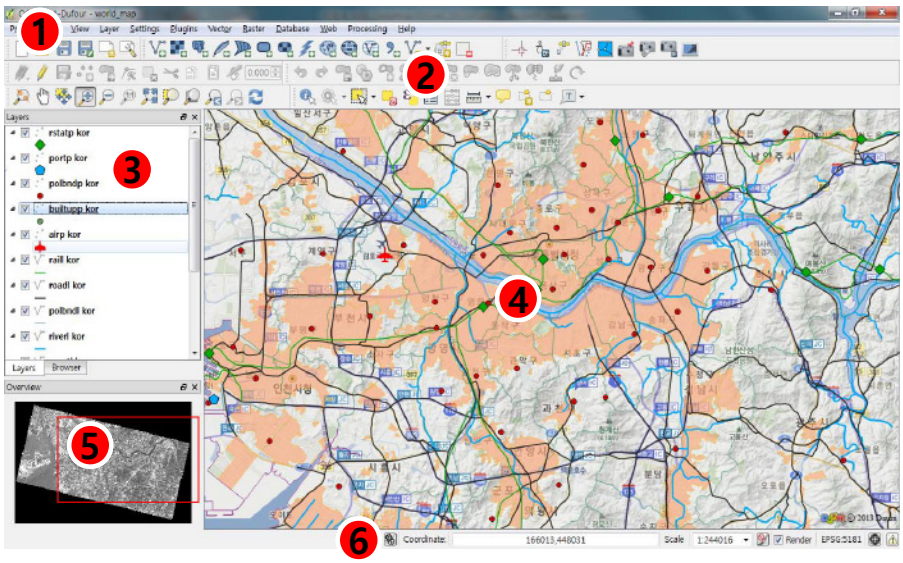
III. Using QGIS

III-1. QGIS GUI

❑ GUI Components

① Menu bar
② Tool bar
③ Layer List
④ Map View
⑤ Overview
⑥ Status bar



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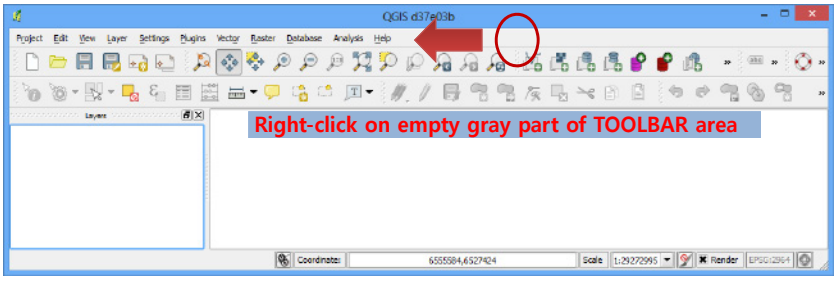
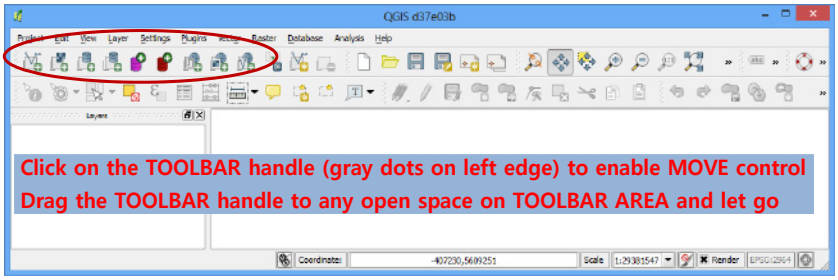
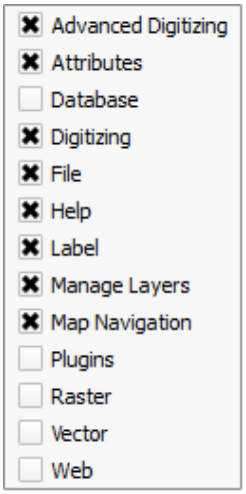
III-2. QGIS Toolbar

❑ Customizing toolbar







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III-3. Working with Vector Layer

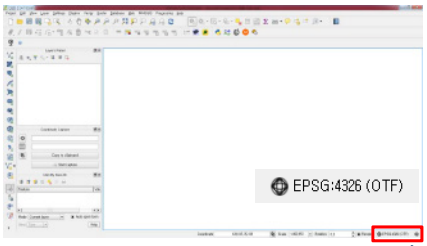
❑ Skills to Learn from This Chpater

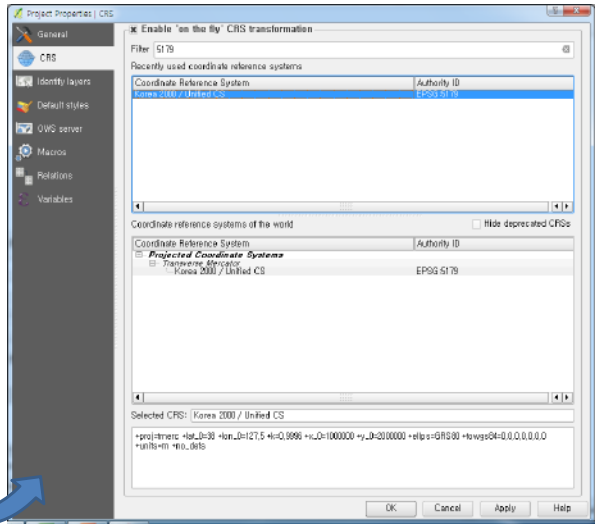
① Selecting CRS
② Creating a New Shape File
③ Adding a New Feature
④ How to Use Field Calculator
⑤ Labeling

III-3. Working with Vector Layer

❑ Start with Selecting CRS

① Click on the CRS Status Icon in the Lower Right-Hand Corner of the Status Bar
② Enter "5174" in "Filter" Field
③ Select "Korea 2000 / Unified CS

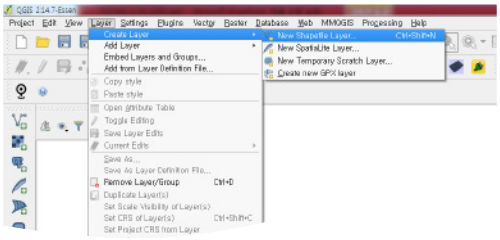


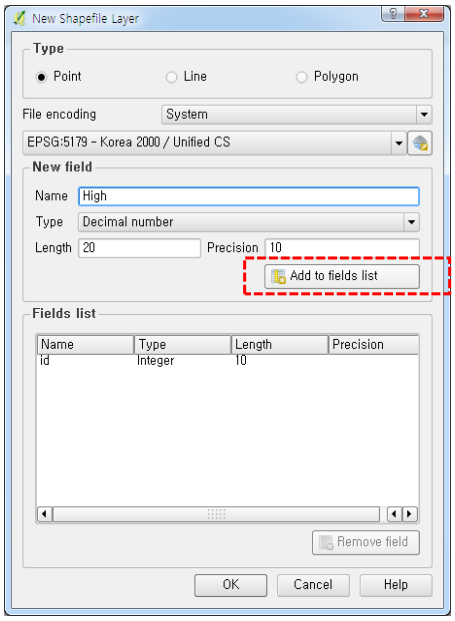


III-3. Working with Vector Layer

❑ New Shapefile Layer

① Layer → Create Layer → New Shapefile Layer...
② Add a New Field Named "High"
③ Add a New Field Named "Low"
④ Click "OK" and Save Layer as "temperature"





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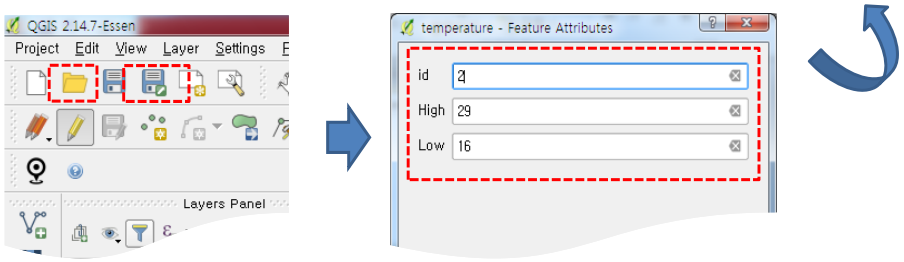
III-3. Working with Vector Layer

❑ Add a New Feature

① Click on the "Toggle Editing" Icon
② Click on the "Adding Feature" Icon
③ Click on Any Place on the Canvas
④ Fill in "id", "High" and "Low" Fields
⑤ Add 2 More New Features on the Canvas (3 New Features Total)
⑥ Finish Editing by Clicking on the "Toggle Editing" Icon and "Save" When a Prompt Window Pops Up



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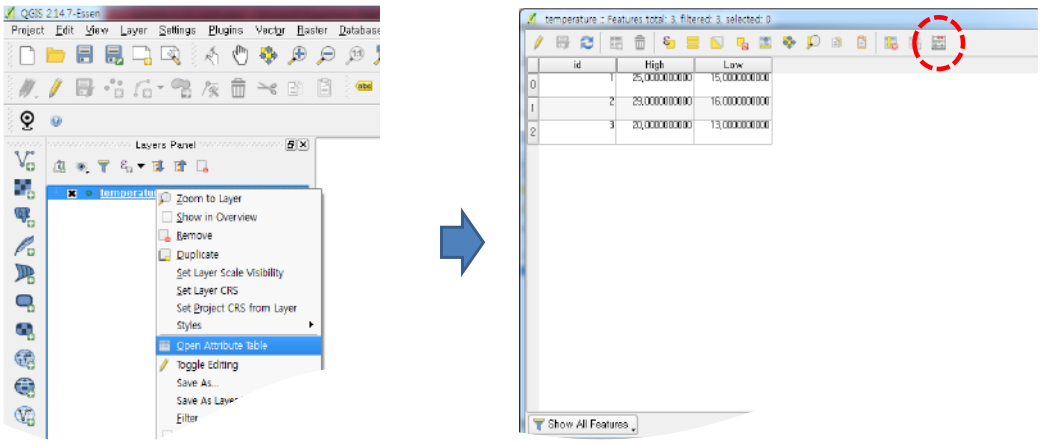
III-3. Working with Vector Layer

❑ Field Calculator

① Right Click on the "temperature" Layer on the Layers Panel

② Select "Open Attribute Table"

③ Click on "Open field calculator" Icon



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III-3. Working with Vector Layer

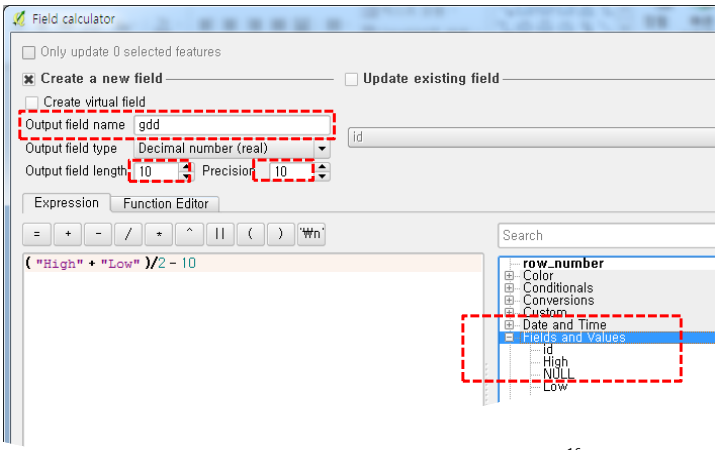
❑ Calculate Growing Degree-Day for Rice (Baseline = 10˚C)

① Fill in "Output field name" as "gdd"

② Select "Output field type" as "Decimal number(real)"

③ Input "10" into Precision Field

④ Type in a Formula for "gdd"



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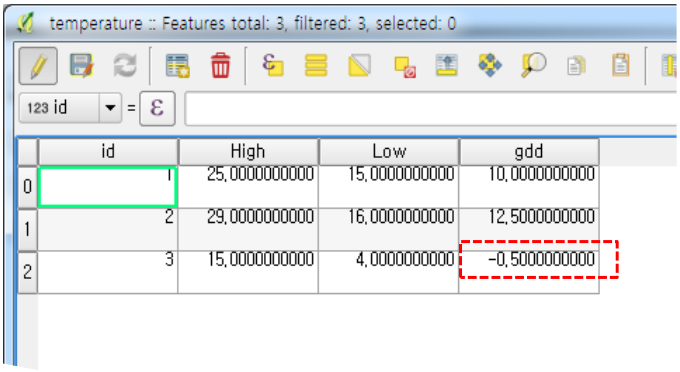
III-3. Working with Vector Layer

❑ Field Calculator - Result

① Right Click on the "temperature" Layer on the Layers Panel

② Select "Open Attribute Table"

③ Click on "Open field calculator" Icon



	id	High	Low	gdd
0	1	25,0000000000	15,0000000000	10,0000000000
1	2	29,0000000000	16,0000000000	12,5000000000
2	3	15,0000000000	4,0000000000	-0,5000000000

The Result Can be Below "0"

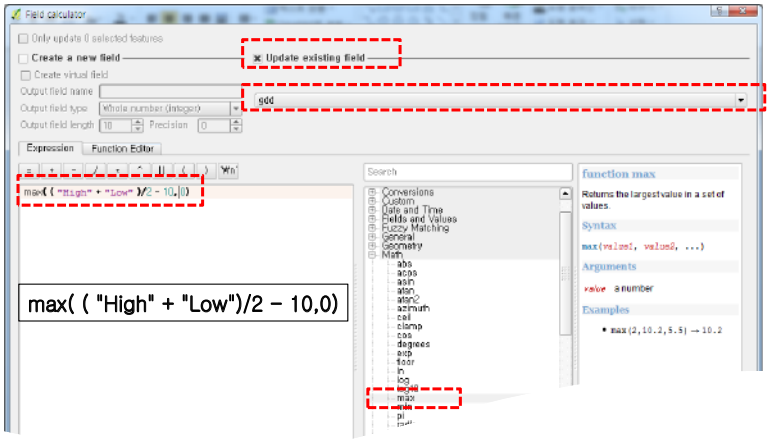
III-3. Working with Vector Layer

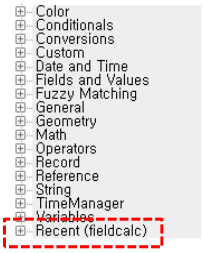
❑ Updating Existing Field

① Click Again on "Open field calculator" Icon

② Check "Update Existing Field"

③ Change the formula Using "Max" Function in "Math" Section

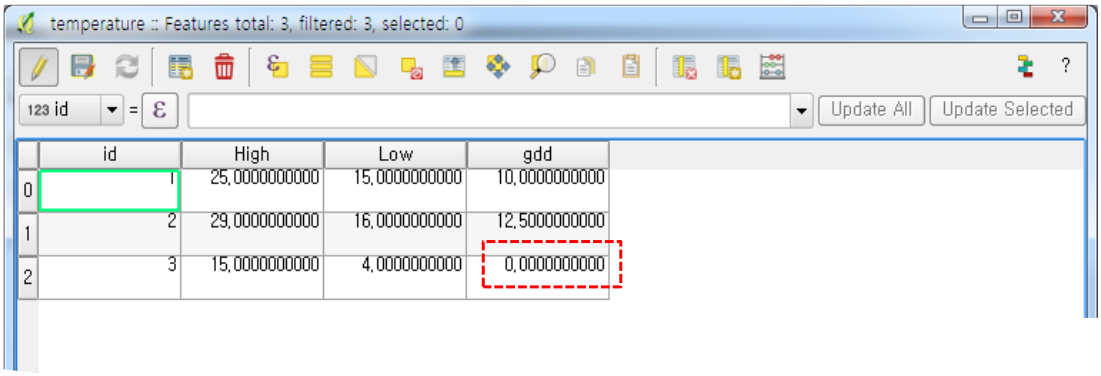




Use "Recent" Function To Bring up a Recently Used Formula

III-3. Working with Vector Layer

❑ Result



	id	High	Low	gdd
0	1	25,0000000000	15,0000000000	10,0000000000
1	2	29,0000000000	16,0000000000	12,5000000000
2	3	15,0000000000	4,0000000000	0,0000000000

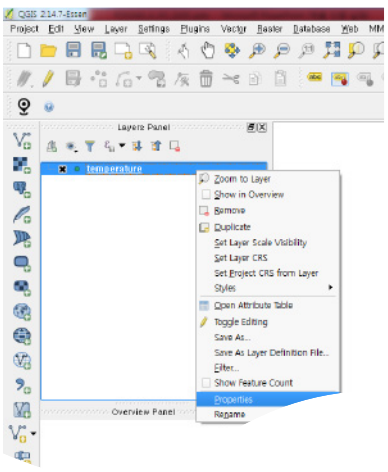
III-3. Working with Vector Layer

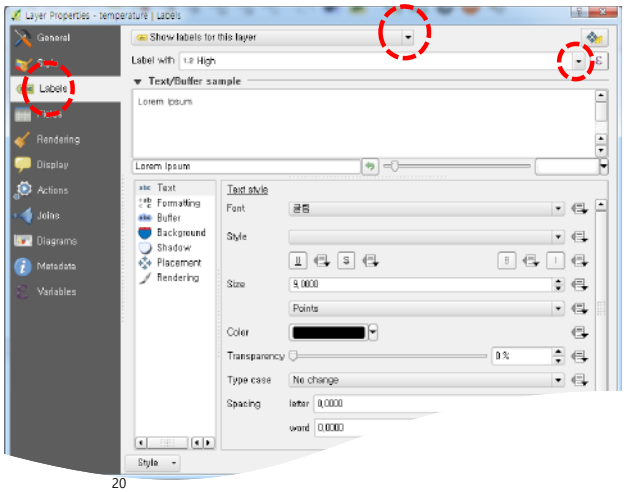
❑ Labeling

① Right Click on the "temperature" Layer on the Layers Panel

② Select "Properties"

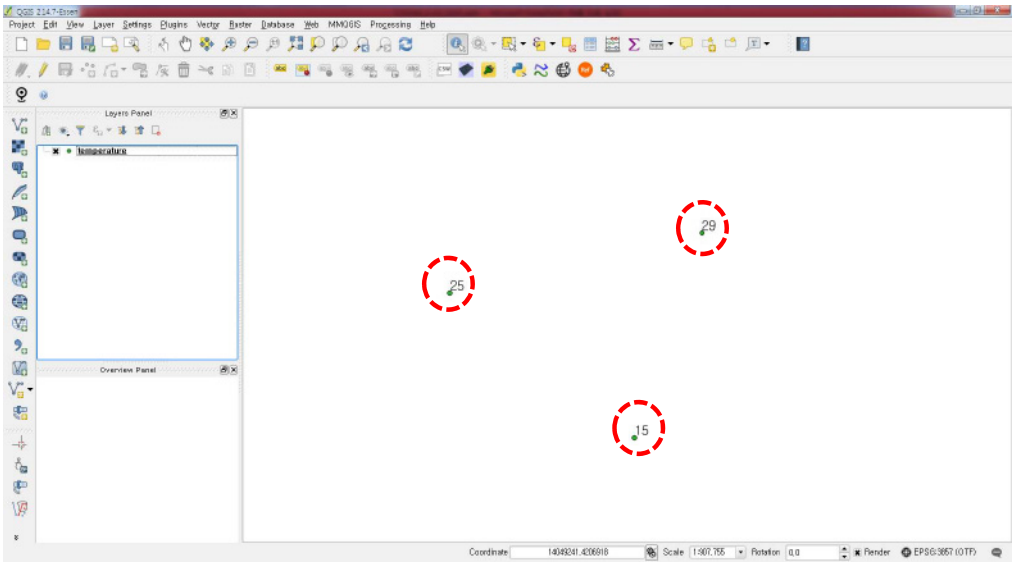
③ "Labels" → "Show labels for this layer" → Label with "High" → "OK"





III-3. Working with Vector Layer

❑ Result



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III-4. Interpolation

❑ Skills to Learn from This Chapter

① Capturing Coordinate
② Calculating Distance from Field Calculator
③ Using Field Calculator Built-in Functions
④ Built-in Interpolation Tool
⑤ How to Style a Raster Layer

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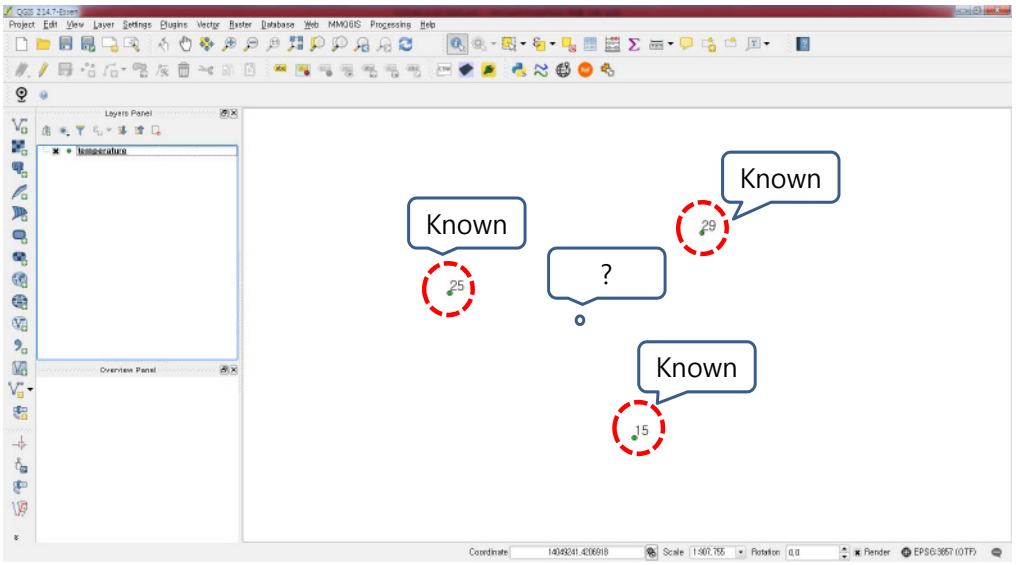
III-4. Interpolation

❑ Constructing new data points within the range of a set of known data point



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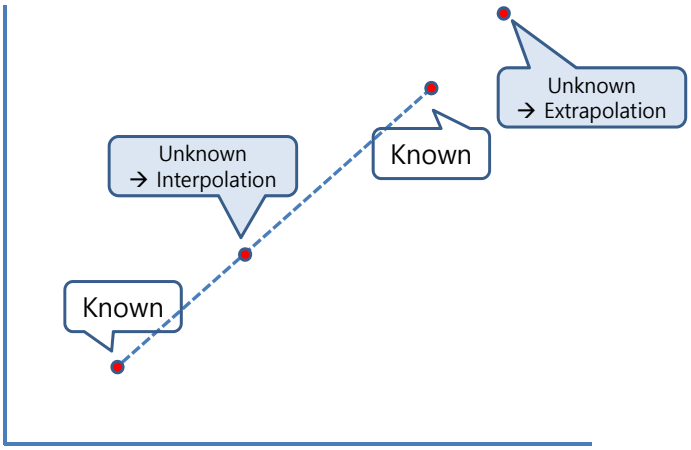
III. Using QGIS

III-4. Interpolation

❑ Constructing new data points within the range of a set of known data point



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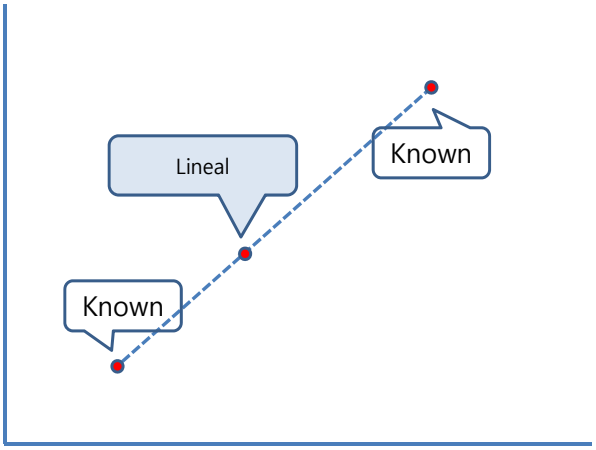
III-4. Interpolation

❑ Constructing new data points within the range of a set of known data point



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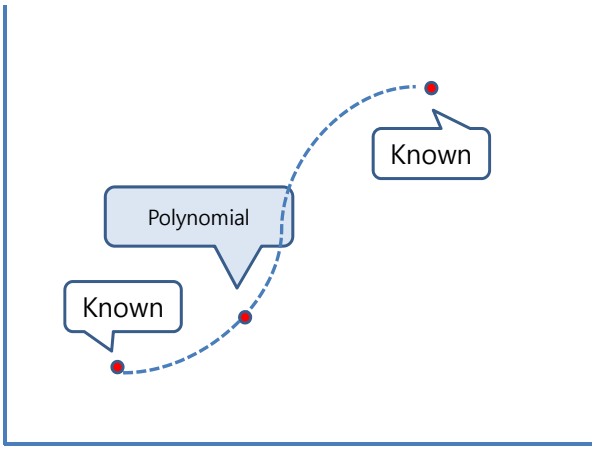
III-4. Interpolation

❑ Constructing new data points within the range of a set of known data point



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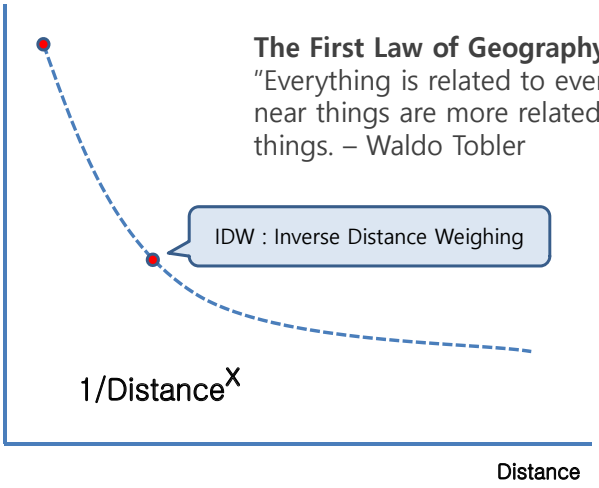
III-4. Interpolation

❑ IDW



The First Law of Geography
"Everything is related to everything else, but near things are more related than distant things. – Waldo Tobler

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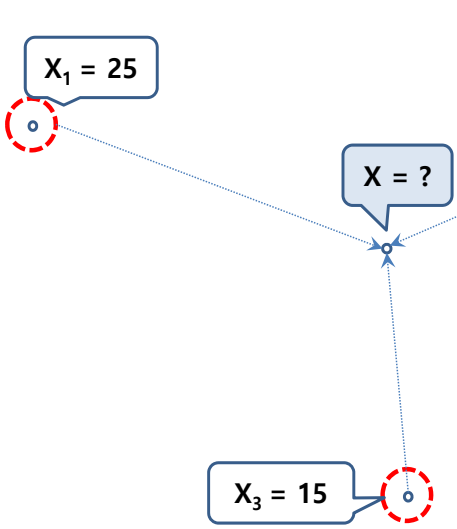
III-4. Interpolation

❑ IDW



$$u(\mathbf{x}) = \begin{cases} \dfrac{\sum_{i=1}^{N} w_i(\mathbf{x}) u_i}{\sum_{i=1}^{N} w_i(\mathbf{x})}, & \text{if } d(\mathbf{x}, \mathbf{x}_i) \neq 0 \text{ for all } i \\ u_i, & \text{if } d(\mathbf{x}, \mathbf{x}_i) = 0 \text{ for some } i \end{cases}$$

where

$$w_i(\mathbf{x}) = \frac{1}{d(\mathbf{x}, \mathbf{x}_i)^p}$$

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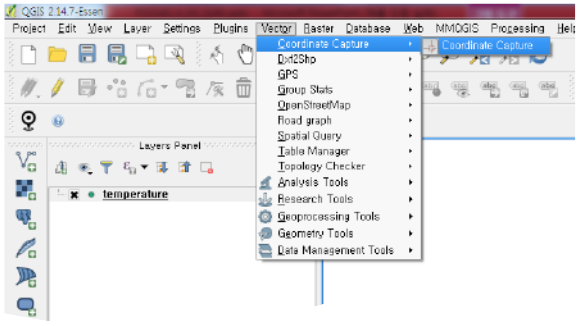
III-4. Interpolation

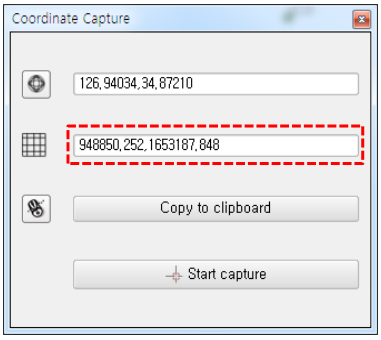
❑ Capture Coordinate of the Unknown Point

① Vector → Coordinate Capture → Coordinate Capture

② Click on the Canvas Where the Unknown Point Located

③ Copy the Coordinate





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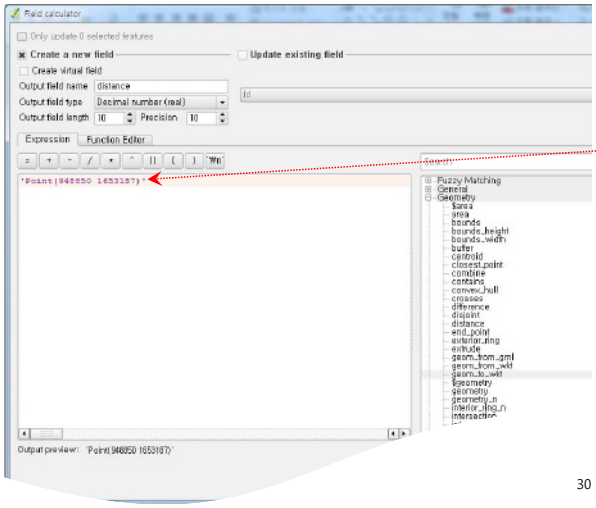
III-4. Interpolation

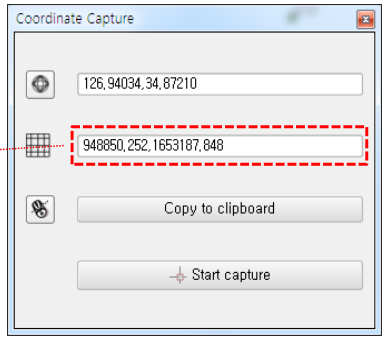
❑ Calculate Distance Using Field Calculator

① Open Field Calculator

② Create a New Field **"distance"**

③ Convert Copied Coordinate to WKT(Well-Known Text) → 'Point(948850 1653187)'





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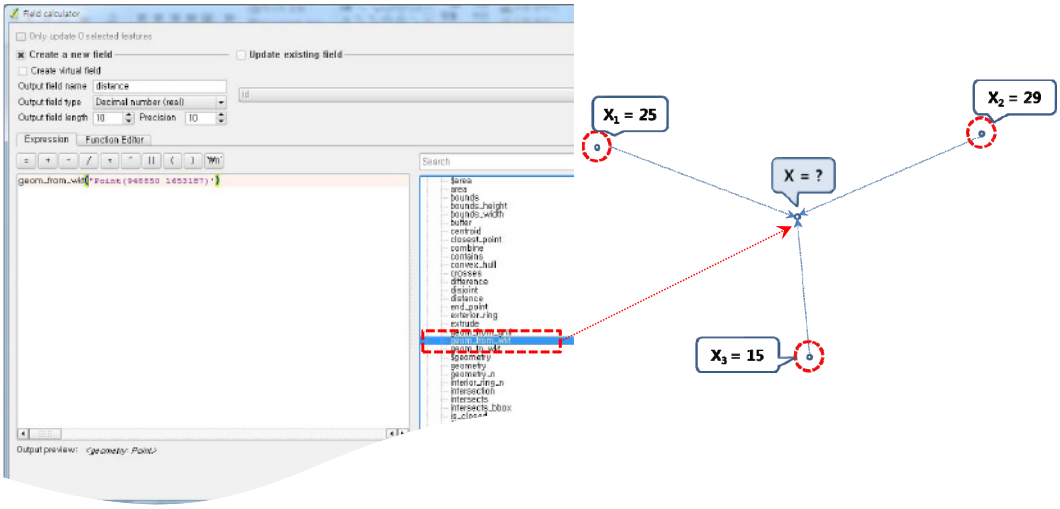
III-4. Interpolation

❑ Calculate Distance Using Field Calculator

④ Convert WKT to Geometry → geom_from_wkt('Point(9488850 1653187)')
(Now, the Field Calculator Can Identify "**X**")



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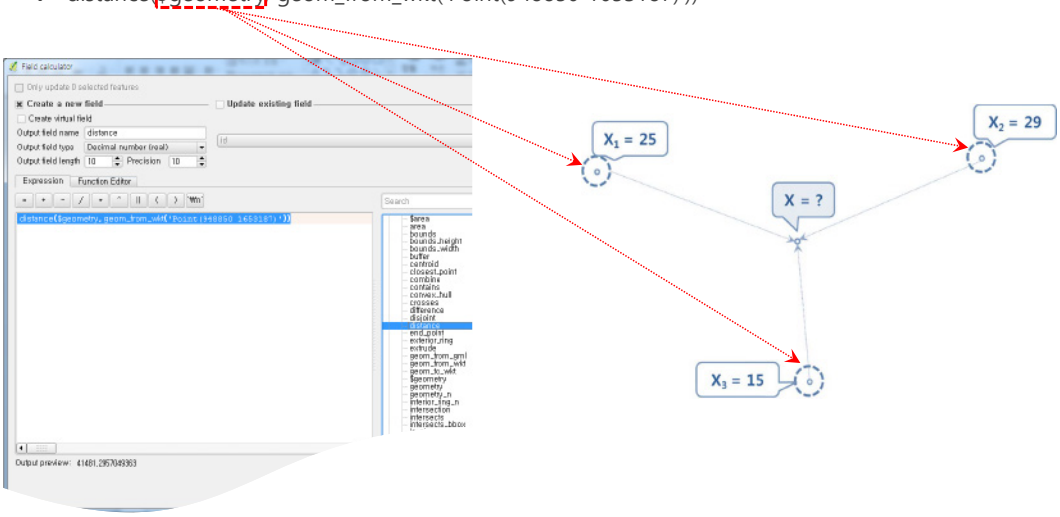
III-4. Interpolation

❑ Calculate Distance Using Field Calculator

⑤ Calculate Distances Between **X** and ($\mathbf{X_1}$, $\mathbf{X_2}$, and $\mathbf{X_3}$)
→ distance($geometry, geom_from_wkt('Point(948850 1653187)'))



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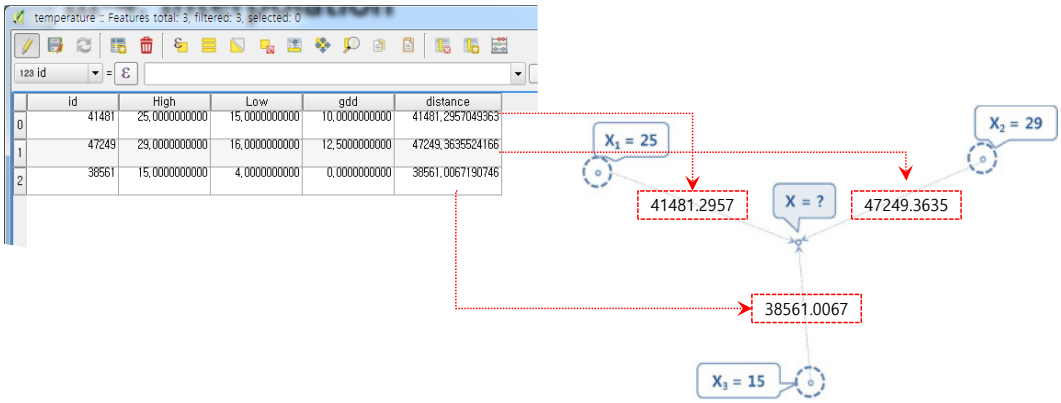
III-4. Interpolation

❑ Calculate Distance Using Field Calculator

⑥ Result



III-4. Interpolation

❑ Calculate Inverse Distance Weight Using Field Calculator

① Open Field Calculator

② Create a New Field **"weight"**

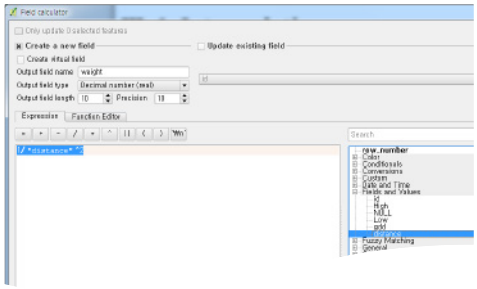
③ Calculate weight → **1 / "distance" ^2**

④ Click "**OK**"

$$u(\mathbf{x}) = \begin{cases} \dfrac{\sum_{i=1}^{N} w_i(\mathbf{x}) u_i}{\sum_{i=1}^{N} w_i(\mathbf{x})}, & \text{if } d(\mathbf{x}, \mathbf{x}_i) \neq 0 \text{ for all } i \\ u_i, & \text{if } d(\mathbf{x}, \mathbf{x}_i) = 0 \text{ for some } i \end{cases}$$

where

$$w_i(\mathbf{x}) = \frac{1}{d(\mathbf{x}, \mathbf{x}_i)^p}$$



III-4. Interpolation

❑ Calculate $w_i(x)u_i$ Using Field Calculator

① Open Field Calculator

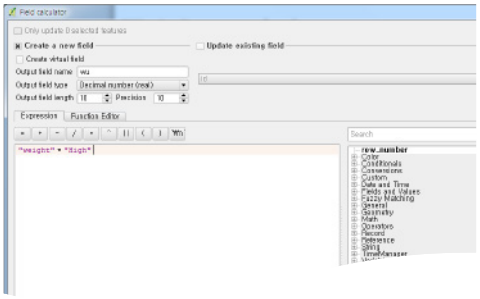
② Create a New Field **"wu"**

③ Calculate weight → **"weight" * "High"**

$$u(\mathbf{x}) = \begin{cases} \dfrac{\sum_{i=1}^{N} w_i(\mathbf{x}) u_i}{\sum_{i=1}^{N} w_i(\mathbf{x})}, & \text{if } d(\mathbf{x}, \mathbf{x}_i) \neq 0 \text{ for all } i \\ u_i, & \text{if } d(\mathbf{x}, \mathbf{x}_i) = 0 \text{ for some } i \end{cases}$$

where

$$w_i(\mathbf{x}) = \frac{1}{d(\mathbf{x}, \mathbf{x}_i)^p}$$



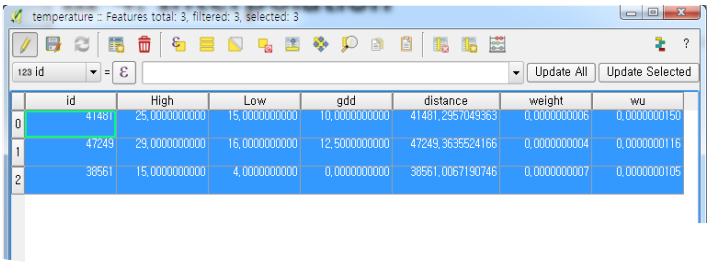
III-4. Interpolation

❑ Calculate $w_i(x)$ Using Field Calculator

① Click on the Right Upper Corner of the Attribute Table

② Copy the Table (**Ctrl + C**)

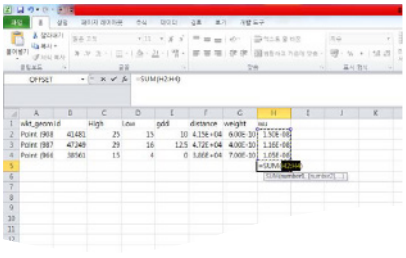
③ Open MS Excel and Paste (**Ctrl + V**)



$$u(\mathbf{x}) = \begin{cases} \dfrac{\sum_{i=1}^{N} w_i(\mathbf{x}) u_i}{\sum_{i=1}^{N} w_i(\mathbf{x})}, & \text{if } d(\mathbf{x}, \mathbf{x}_i) \neq 0 \text{ for all } i \\ u_i, & \text{if } d(\mathbf{x}, \mathbf{x}_i) = 0 \text{ for some } i \end{cases}$$

where

$$w_i(\mathbf{x}) = \frac{1}{d(\mathbf{x}, \mathbf{x}_i)^p}$$



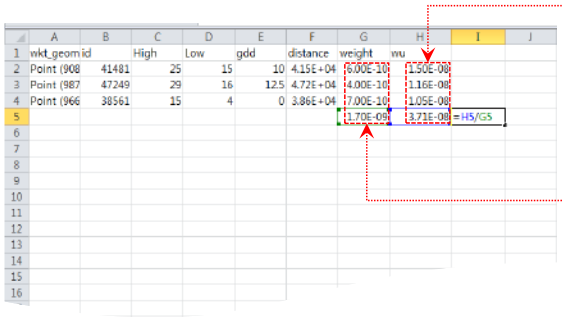
III-4. Interpolation

❑ Calculate **Interpolated X** Using Excel

① Click on the Right Upper Corner of the Attribute Table

② Copy the Table (**Ctrl + C**)

③ Open MS Excel and Paste (**Ctrl + V**)



$$u(\mathbf{x}) = \begin{cases} \dfrac{\sum_{i=1}^{N} w_i(\mathbf{x}) u_i}{\sum_{i=1}^{N} w_i(\mathbf{x})}, & \text{if } d(\mathbf{x}, \mathbf{x}_i) \neq 0 \text{ for all } i \\ u_i, & \text{if } d(\mathbf{x}, \mathbf{x}_i) = 0 \text{ for some } i \end{cases}$$

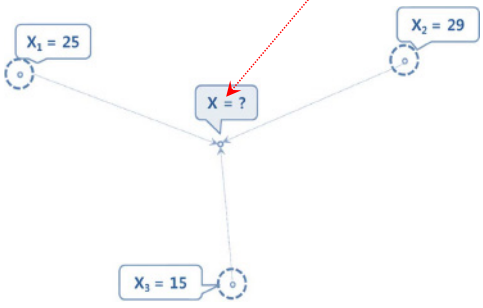
where

$$w_i(\mathbf{x}) = \frac{1}{d(\mathbf{x}, \mathbf{x}_i)^p}$$

III-4. Interpolation

❑ Result

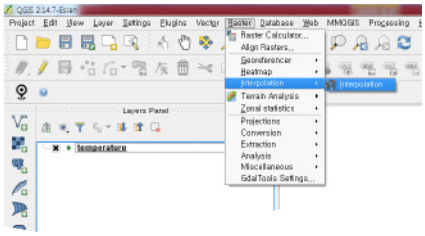
A	B	C	D	E	F	G	H	I
wkt_geom	id	High	Low	gdd	distance	weight	wu	
Point (908	41481	25	15	10	4.15E+04	6.00E-10	1.50E-08	
Point (987	47249	29	16	12.5	4.72E+04	4.00E-10	1.16E-08	
Point (966	38561	15	4	0	3.86E+04	7.00E-10	1.05E-08	
						1.70E-09	3.71E-08	21.8235

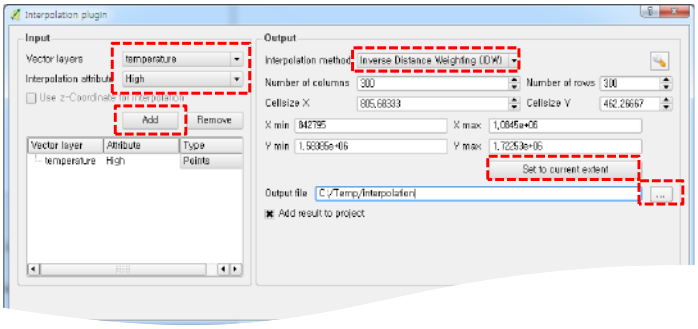


III-4. Interpolation

❑ Built-In Interpolation Tool

① Raster → Interpolation → Interpolation
② Select Vector Layer and Attribute
③ Click on "**Add**" Button
④ Select Interpolation Method → IDW
⑤ Click on "**Set to current extent**" Button
⑥ Save

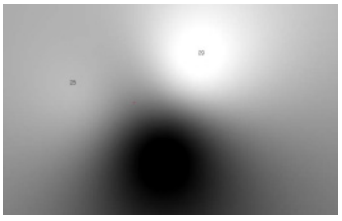


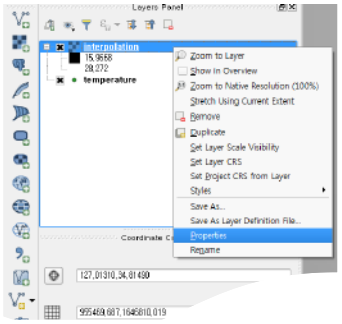


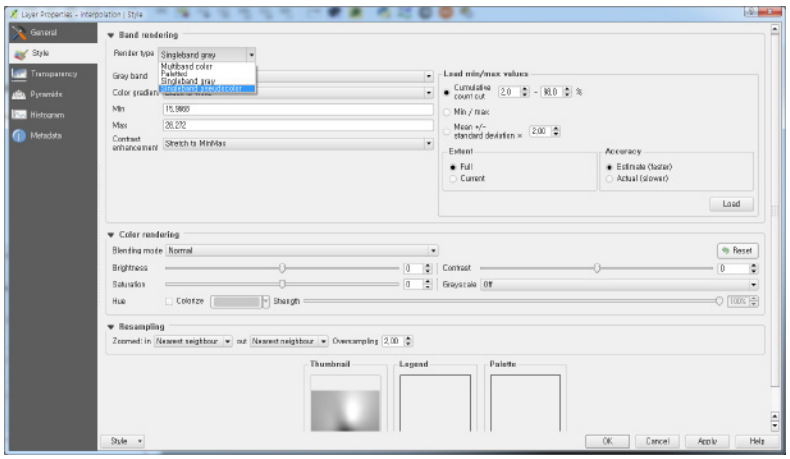
III-4. Interpolation

❑ Built-In Interpolation Tool

① Result
② Properties → Style → Render type(single band pseudocolor)







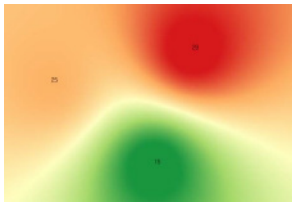
III-4. Interpolation

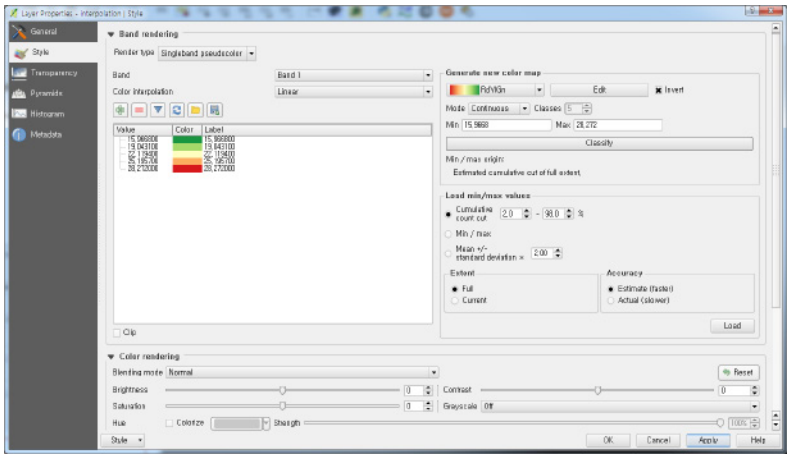
❑ Built-In Interpolation Tool

③ Check "**Invert**"

④ Click on "**Classify**" Button

⑤ Click on "OK" Button





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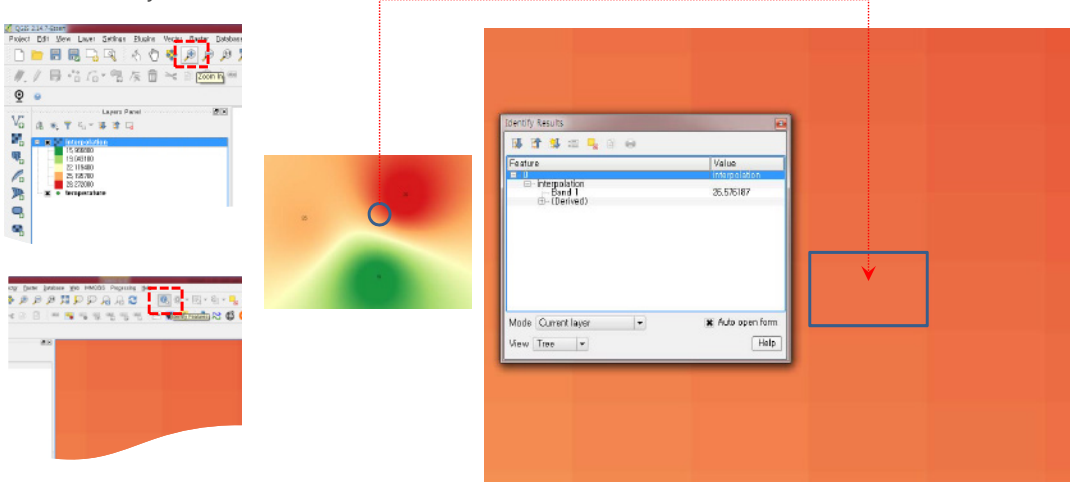
III-4. Interpolation

❑ Built-In Interpolation Tool

⑥ Zoom-In

⑦ Identify Feature

⑧ Click on Any Place on the Canvas



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III-5. Modeling with Vector Grid

❑ Scenario

- ✓ Chemicals leaked from a special vehicle that was carrying toxic substance.
- ✓ This chemical is a colorless and odorless that diffuses into the air
- ✓ It is not a problem if it is exposed to less than 11,900 nanograms, but exposed to more than that, the exposed need to be examined.
- ✓ Thus, the authority made the following request to you.
- ✓ What is the range of areas exposed above 11,900 nanograms?

This tutorial is inspired by Barry Rowlingson's online R workshop linked below.
Barry Rowlingson. 2012. Geospatial Data in R and Beyond. Available at: http://www.maths.lancs.ac.uk/~rowlings/Teaching/UseR2012/plume.html

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III. Using QGIS

III-5. Modeling with Vector Grid

❑ Object

- ✓ Modeling a process using vector grid
- ✓ Advanced use of field calculator
- ✓ Visualization of a process
- ✓ Presentation of deterministic model

$$f=\alpha\exp(-(d/\beta)^2 e^{-k\cos(\theta-\emptyset)^2})$$

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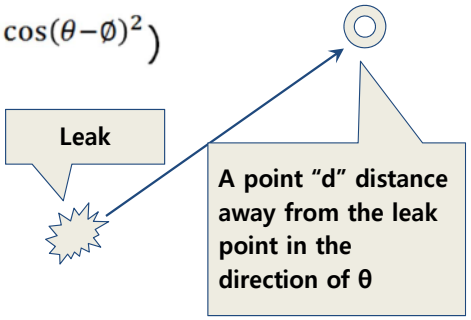
III-5. Modeling with Vector Grid

❑ Basic Information

✓ When chemicals are diffused into the air at a certain point, chemical exposure in the area is expressed as a function of the following.

$$f = \alpha \exp(-(d/\beta)^2 e^{-k\cos(\theta - \emptyset)^2})$$

- α = Exposure level
- d = Distance from the release to a certain point
- β = Distance scale factor
- κ = Eccentricity (=strength of the wind)
- θ = Wind direction



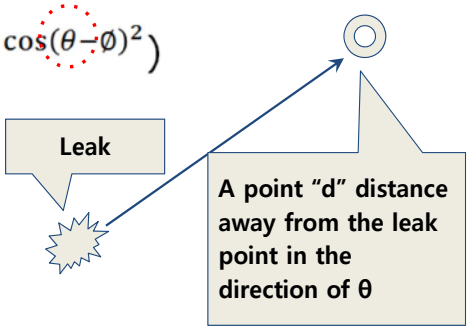
III-5. Modeling with Vector Grid

❑ Basic Information

✓ Information on the situation at the time of exposure was obtained below.

$$f = \alpha \exp(-(d/\beta)^2 e^{-k\cos(\theta - \emptyset)^2})$$

- α = Exposure level = 12,000
- d = ?
- β = 400
- κ = Eccentricity (=strength of the wind = 5)
- θ = Wind direction = North East = 45º (1/4pi)



III-5. Modeling with Vector Grid

❑ How to Calculate the Distance between Two Points in Field Calculator

✓ **"distance()" function : Returns the minimum distance between two geometries**

→ distance(geometry a, geometry b)

Example
distance(geomFromWKT('POINT(4 4)') , geomFromWKT('POINT(4 8)')) → returns 4

$$f=\alpha\exp(-(d/\beta)^2 e^{-k\cos(\theta-\emptyset)^2})$$

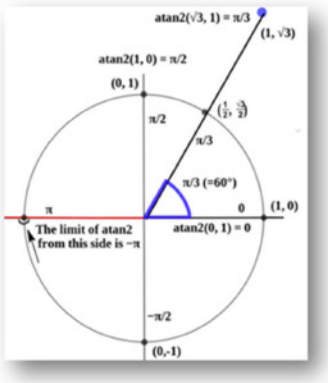
III-5. Modeling with Vector Grid

❑ How to Calculate the Angle between Two Points in Field Calculator

✓ **"atan2()" function : Returns the inverse tangent of dy/dx**

→ atan2(dy, dx)

$$f=\alpha\exp(-(d/\beta)^2 e^{-k\cos(\theta-\emptyset)^2})$$



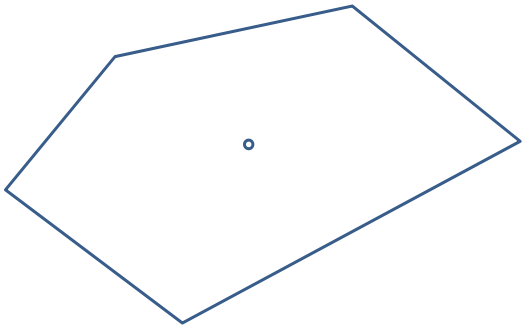
Example
atan2(1.0, 1.732) → 0.523611477769969

III-5. Modeling with Vector Grid

❑ How to Calculate a Centroid of a Polygon in Field Calculator

✓ **"centroid()" function : Returns the geometric center of a geometry**

→ **centroid(geom)**

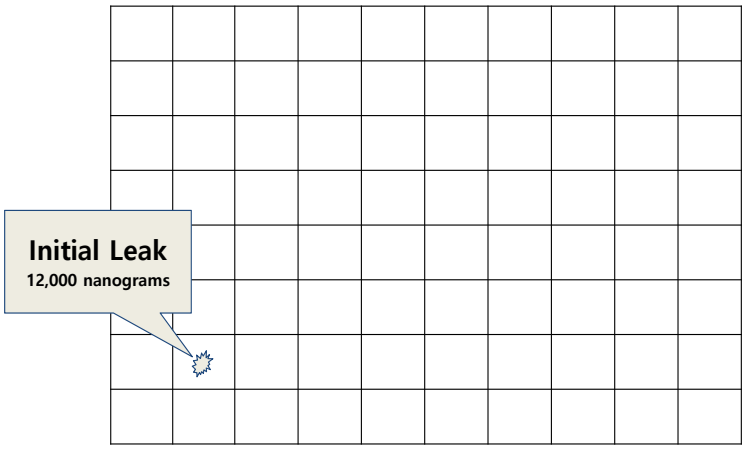


Example
centroid($geometry) → returns geometry

III-5. Modeling with Vector Grid

❑ Procedure

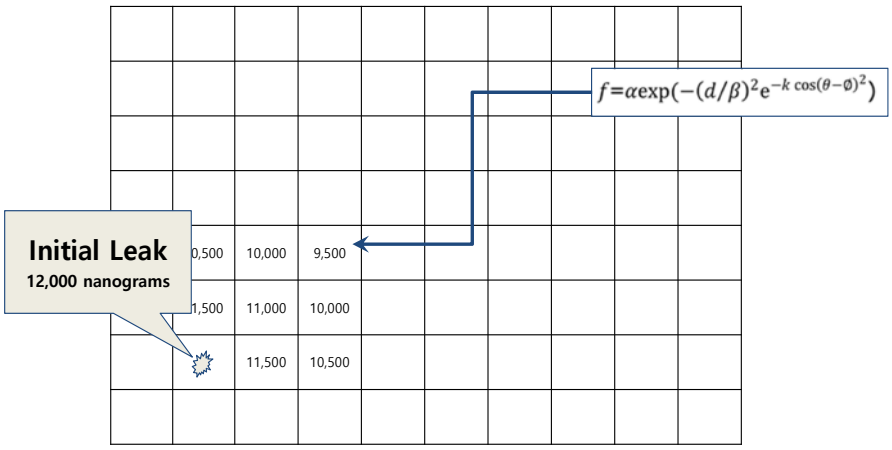
① Create a grid in the scope of analysis.



III-5. Modeling with Vector Grid

❑ Procedure

② Fill each grid with a function result.



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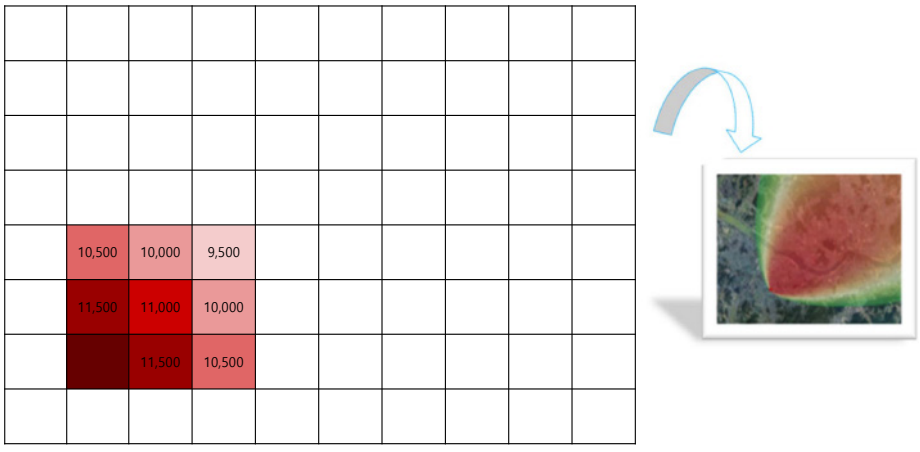
III-5. Modeling with Vector Grid

❑ Procedure

③ Adjust the color according to the function result.



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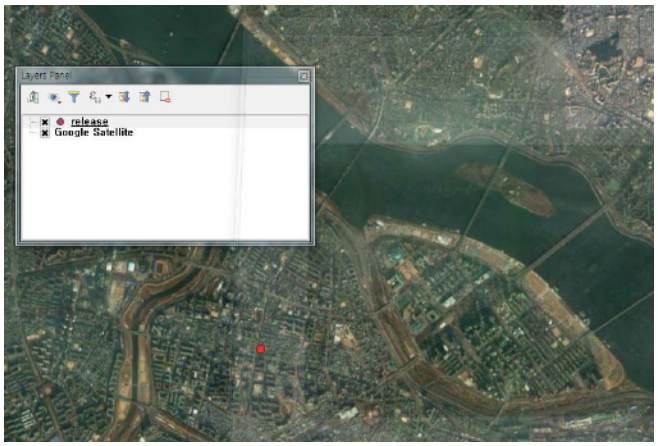
III-5. Modeling with Vector Grid

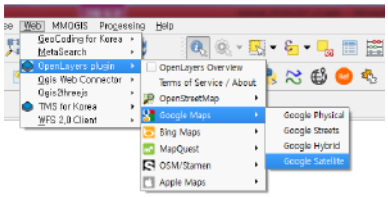
❑ Exercise

① Add a leak point layer (release.shp) and a background map(EPSG=3857)



Google Satellite can be imported by

Web → Openlayers Plugin → Google Maps → Google Satellite

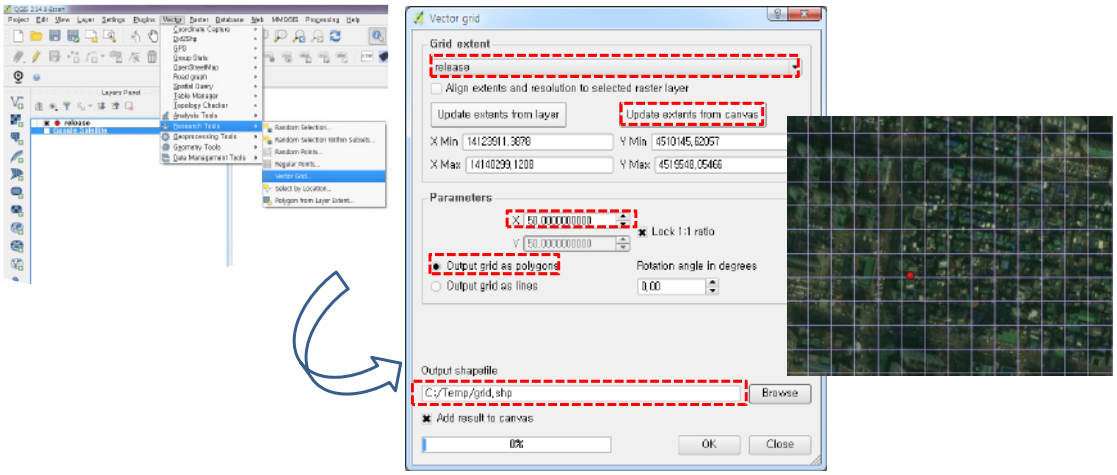


✓ Plugins can be installed from **Plugins → Manage and Install Plugins** ...

III-5. Modeling with Vector Grid

❑ Exercise

② Add a Vector Grid and Save as **grid.shp**



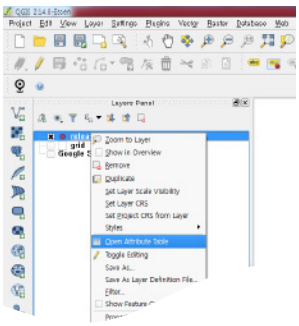
III-5. Modeling with Vector Grid

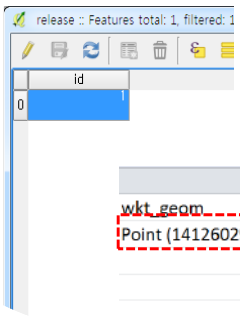
❑ Exercise

③ Capture the Coordinates of the Release

→ Right Click on the "release" layer → Open Attribute Table → Click at the Top-Left Blank

→ Copy by Ctrl+C → Paste in Excel Sheet





Point (14126029 4512152)

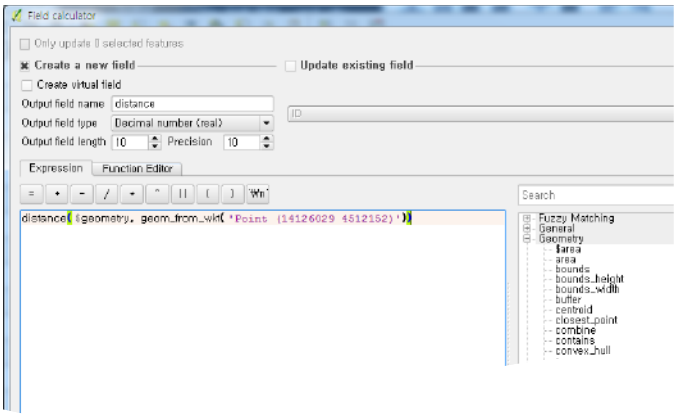
	A	B
	wkt_geom	id
	Point (14126029.153070431202650074512152.5080350236967206)	1

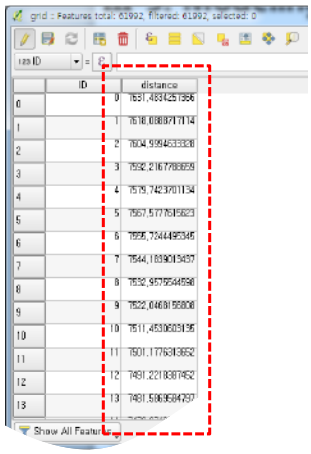
III. Using QGIS

III-5. Modeling with Vector Grid

❑ Exercise

④ Distance between the Release Point and Each Grid Centroids → Field Calculator on "**grid**" layer





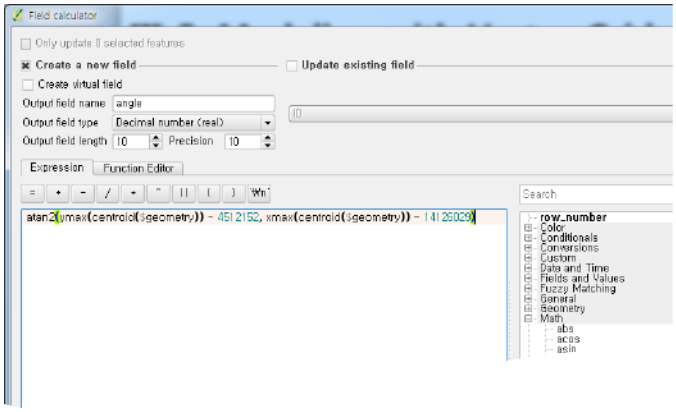
distance($geometry, geom_from_wkt('Point (14126029 4512152)'))

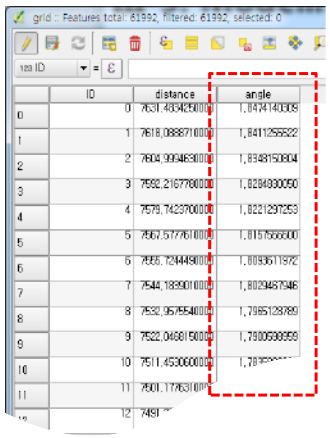
$$f=\alpha\exp(-(\frac{d}{\beta})^2 e^{-k\cos(\theta-\emptyset)^2})$$

III-5. Modeling with Vector Grid

❑ Exercise

⑤ Angle between the Release Point and Each Grid Centroids





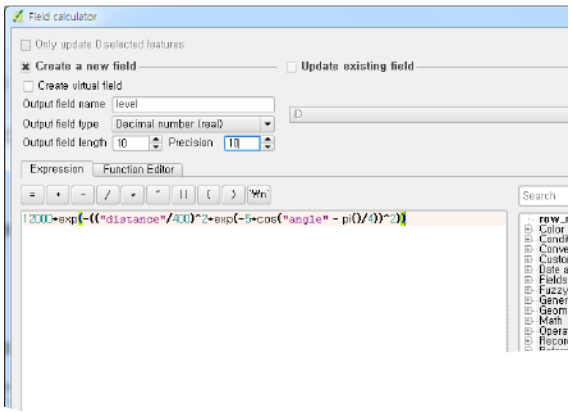

```
distance( $geometry,  geom_from_wkt( 'Point (14126029 4512152)'))
```

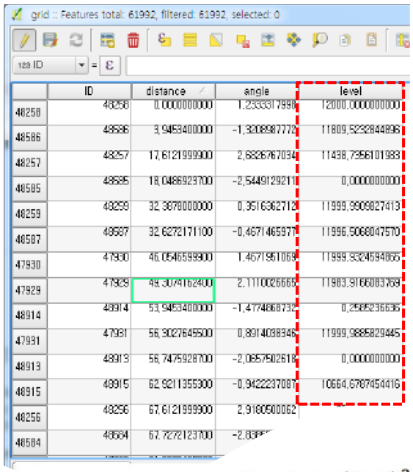
$$f=\alpha\exp(-(d/\beta)^2 e^{-k\cos(\theta-\emptyset)^2})$$

III-5. Modeling with Vector Grid

❑ Exercise

⑥ Calculating Exposure Level of Each Grid Cell






```
12000*exp(-(("distance"/400)^2*exp(-5*cos("angle" - pi()/4))^2))
```

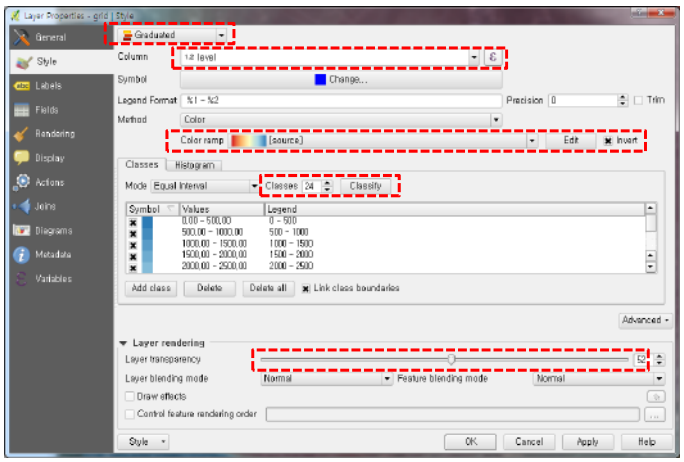
$$f=\alpha\exp(-(d/\beta)^2 e^{-k\cos(\theta-\emptyset)^2})$$

III-5. Modeling with Vector Grid

❑ Exercise

⑦ Visualize Exposure Level of Each Grid Cell

→ Right Click on "grid" Layer → Properties → Style → Graduated



III-5. Modeling with Vector Grid

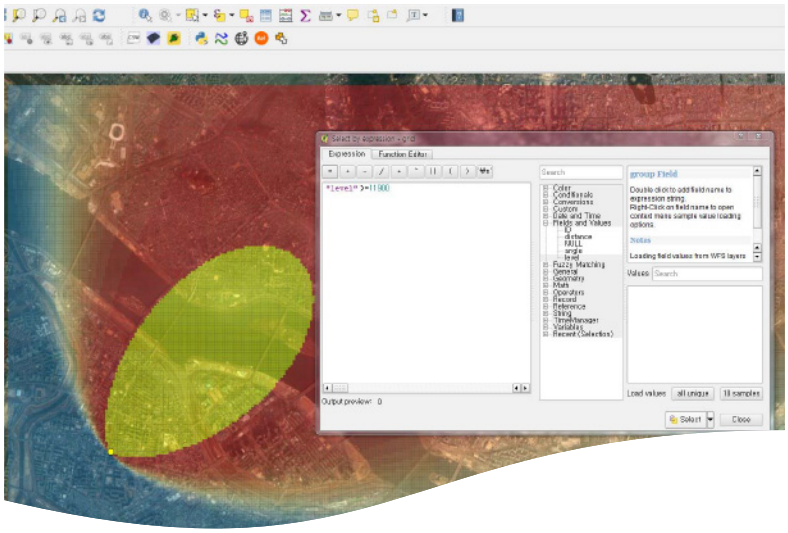
❑ Exercise

⑧ Result

III-5. Modeling with Vector Grid

❑ Exercise

⑨ Over 11,900 exposed areas → Select by expression



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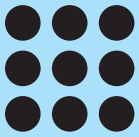
Thank you

Q&A



Exercise 1

Calculation of GDD from the digital map of temperature

Exercise 1 – Calculation of GDD from the digital map of temperature

Objectives: The goal of the first exercise for Agro-meteorology is to generate the digital map of growing degree day (GDD) from the digital map of temperature. In order to create the digital map of temperature, we first need to join CSV/Text file which has temperature information (i.e., maximum temperature or minimum temperature) to vector data (i.e., shape file) having coordination such as latitude and longitudes and interpolate. In particular, we need the base temperature to calculate GDD of crops; in case of rice, a summer crop, it starts growing at 10 Celsius degree.

1. Open the weather shape file. You can open the shape file from two ways. First one is using the menu and the other one is just adding layers from "Drag and Drop from Window Explorer" (*see Note 1, Fig. 3*).
   - go to the file menu "Layer" >> click "Add Layer" >> select "Add Vector Layer" (Fig. 1)
   - click "Browse" button in 'Add vector layer' box and find the shape file: (Fig.2)
   - file location: QGIS Tutorial – Data – Tutorial Session 2 – ASOS Observation: kma_asos58.shp

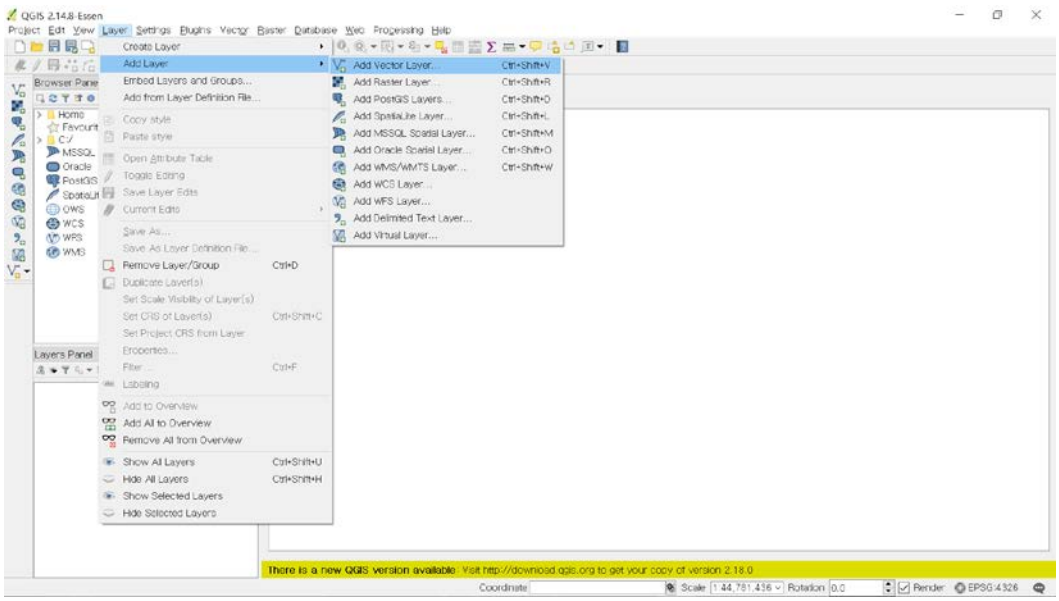


Fig. 1.

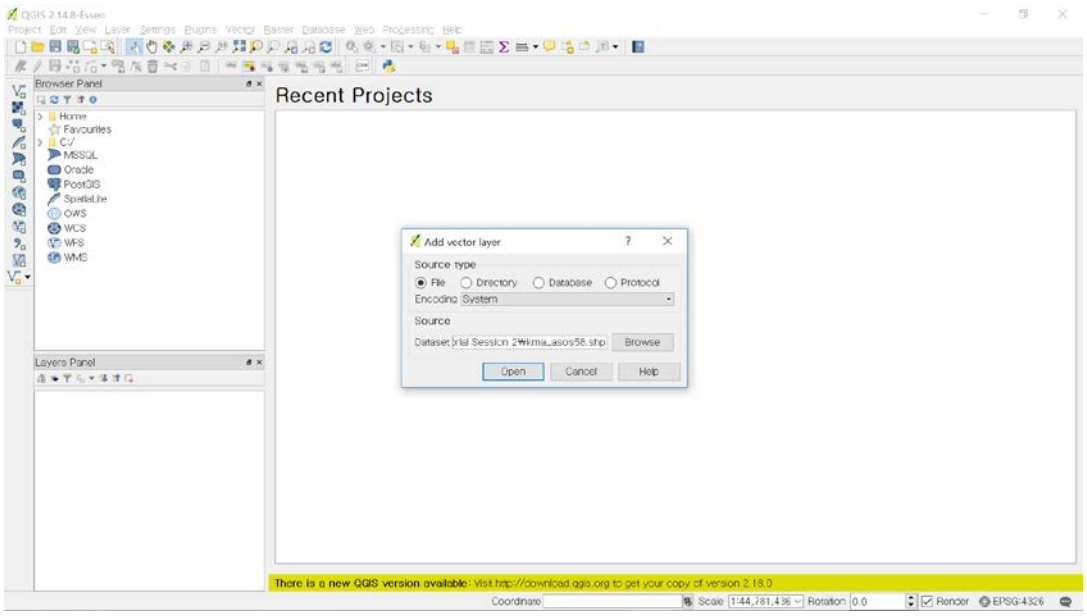


Fig. 2.

Note 1: the way of “Drag and Drop”

Drag a shape file from the Windows Explorer and drop it on the ‘Layers Panel’.

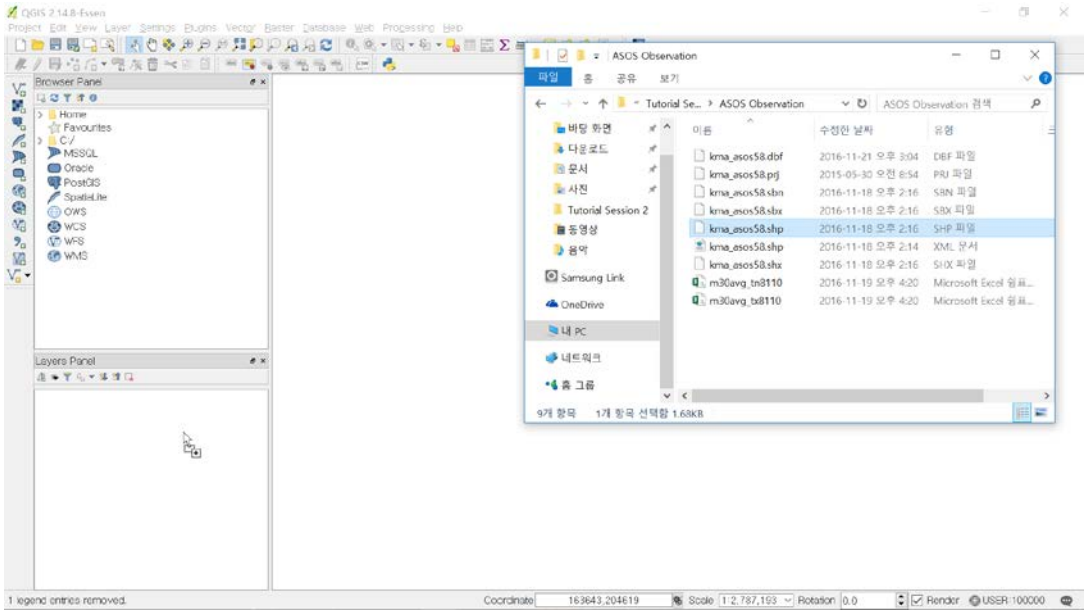


Fig. 3.

2. Open the text file which has the monthly maximum temperature of Normal (1981-2010).
   - go to file menu “Layer” >> click “Add Layer‘ >> Select “Add Delimited Text Layer” (Fig. 4)

- click “Browse” button in ‘Create a Layer from a Delimited Text File’ box and find the text file. In addition, should select the options of ‘CSV’ and ‘No geometry’ (Fig. 5)
- file location: QGIS Tutorial – Data – Tutorial Session 2 – ASOS Observation: m30avg_tx8110.csv

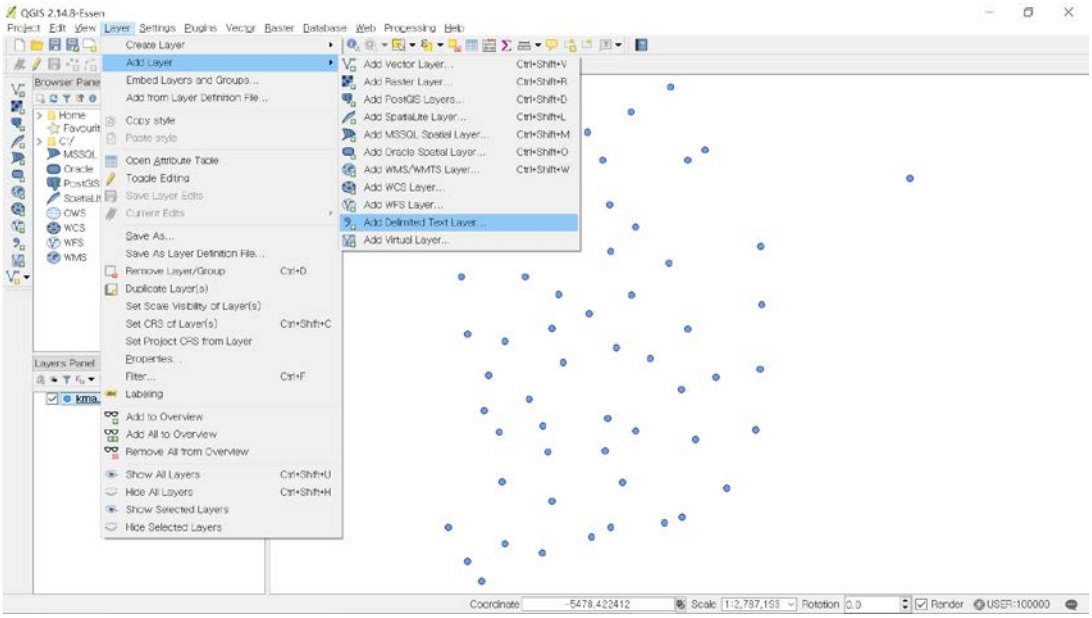


Fig. 4.

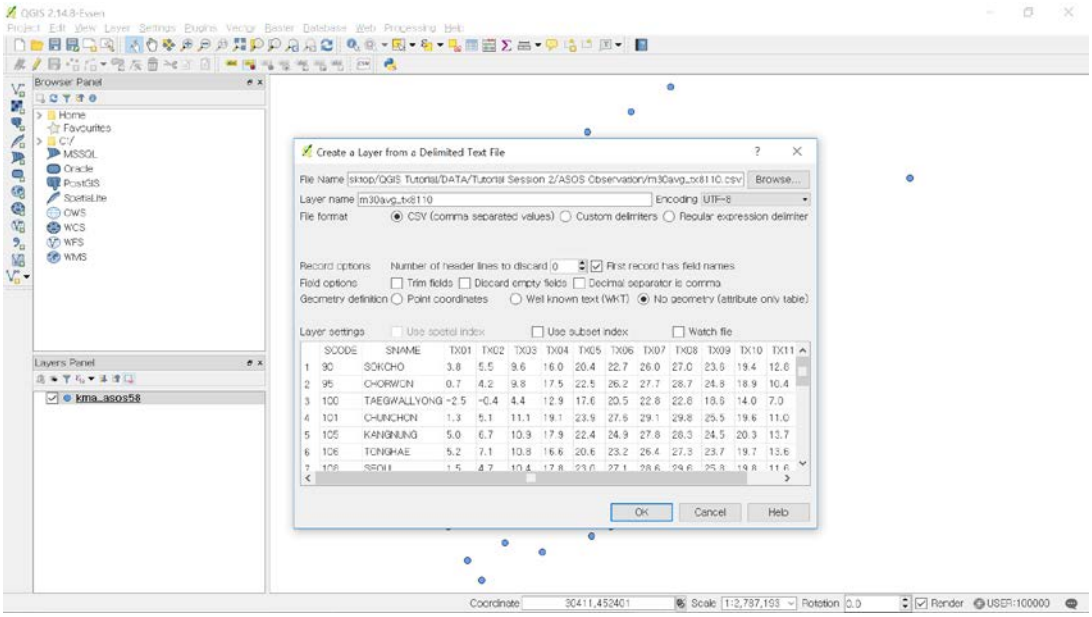


Fig. 5.

3. In order to Join the text file to the vector. First of all, select ‘kma_asos58.shp’ on the

'Layers Panel' and click the right button of Mouse to open properties box.

- click the right button of Mouse and select "Properties" (Fig. 6)
- click the 'Joins' tab in the left contents' list of 'Layer Properties – kma_asos58' box (Fig. 7)

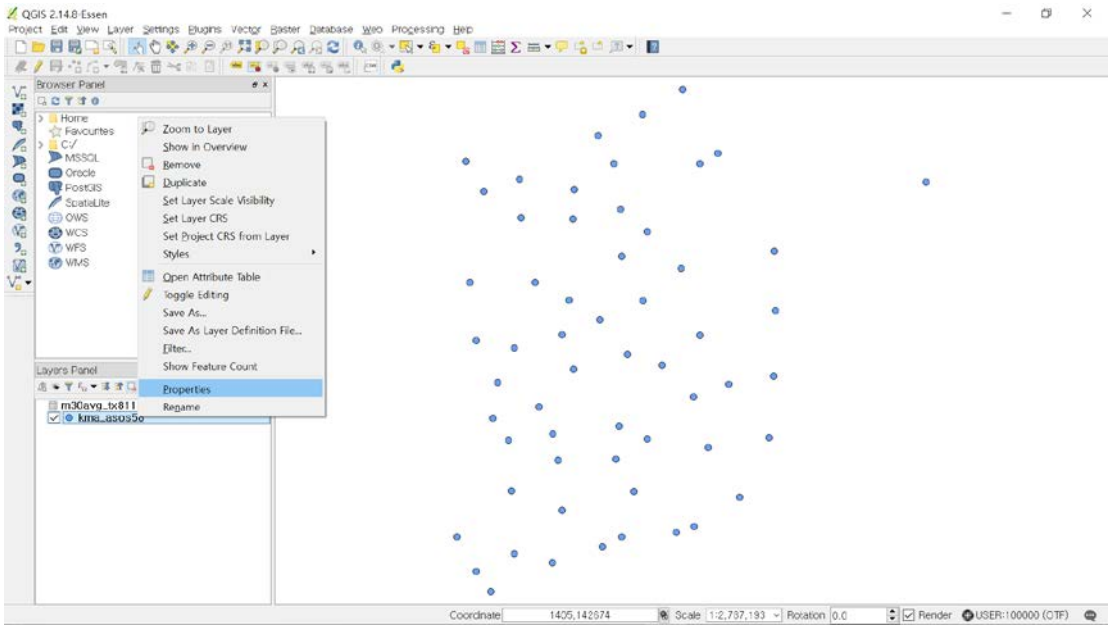


Fig. 6.

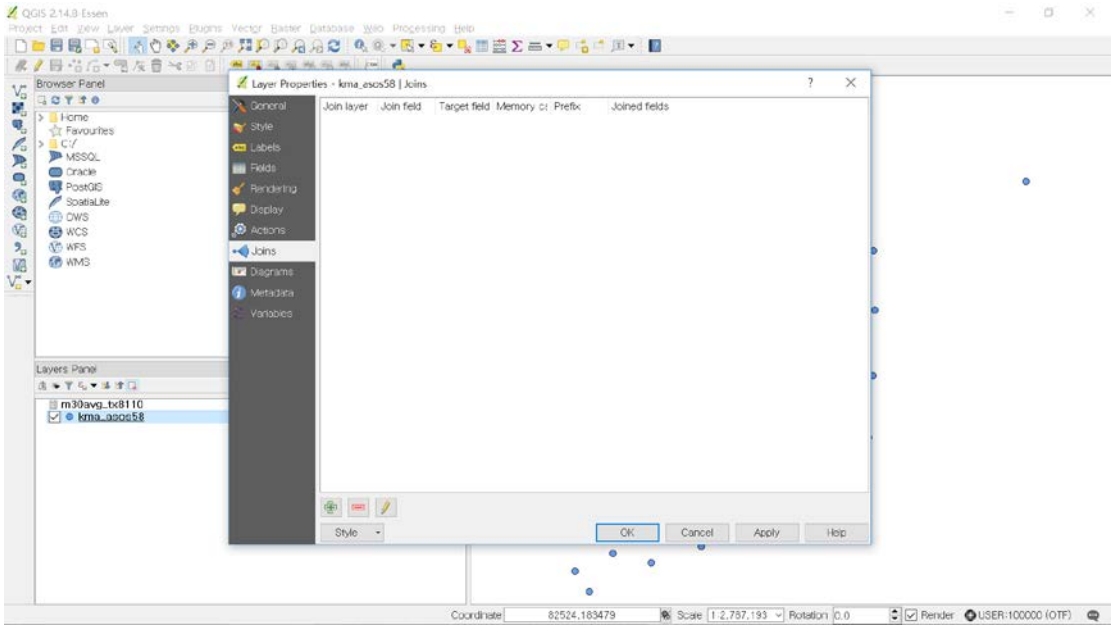


Fig. 7.

4. Select the icon  (cross symbol) in the 'Lay properties – kma_asos58' box and

you set up configurations to join the two files in ‘Add vector join’ box as below (Fig. 8).

- Join layer: m30avg_tx8110
- Join field: SCODE
- Target field: SCODE
- if you want to choose which fields are joined: you click combo box ‘Choose which fields are joined’ and you can select fields you want to join
- additionally, we need to make prefix to avoid the long name of field. So, click ‘Custom field name prefix’ and input the text what you want to be shown for the field. For this exercise, we input the prefix ‘M30_’ as figure 8.

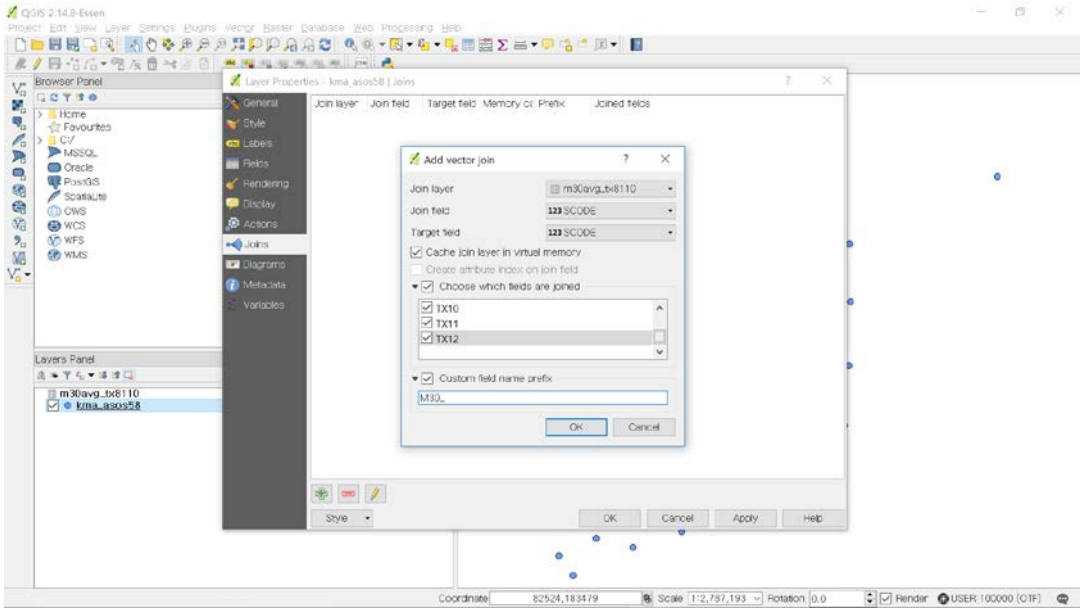


Fig. 8.

- you can check by opening the attribute table: Select ‘kma_asos58.shp’ on the ‘Layers Panel’ and click the right button of Mouse, then click ‘Open Attribute Table’ (Fig. 9 and Fig. 10).

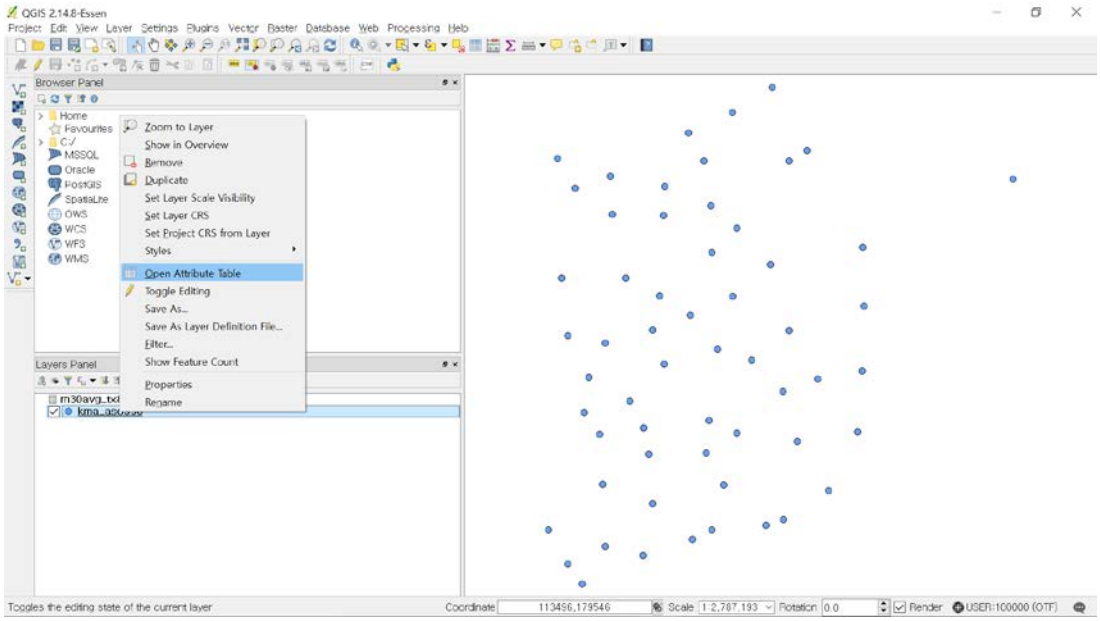


Fig. 9.

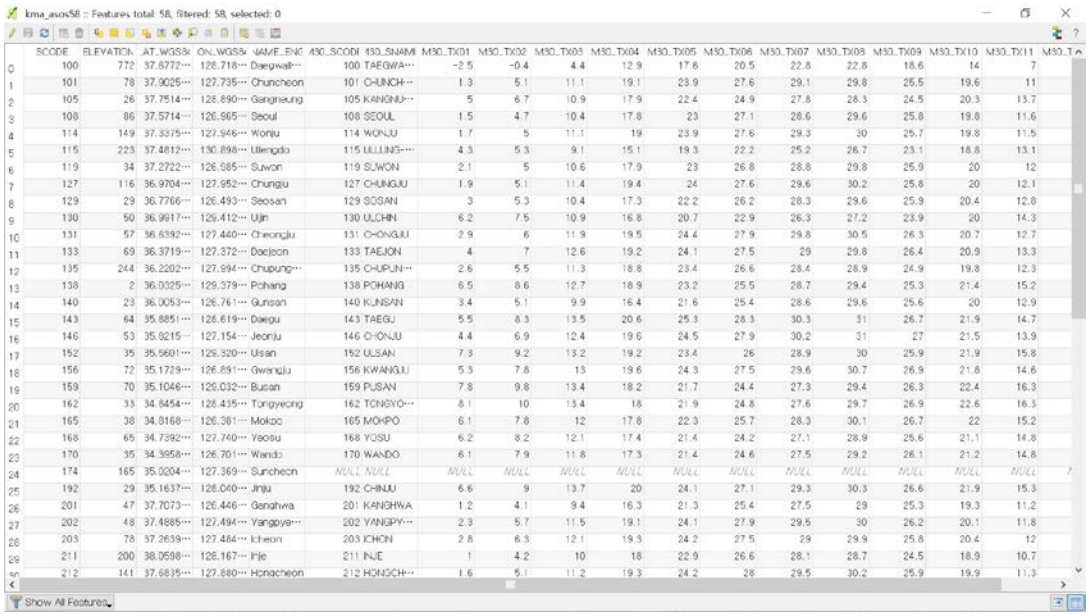


Fig. 10.

5. Save the vector file which have the temperature information by using ‘Save as’.
   - select ‘kma_asos58.shp’ and click the right button of Mouse, and then click ‘Save as’ (Fig. 11)
   - select the button ‘Browse’ in ‘Save vector layer as’ and type in the file name. We will type in ‘m30_tx8100’ to the folder ‘exercise’ (Fig. 12)
   - file location: QGIS Tutorial – exercise

- You do not need to change any other configurations and just click the button ‘OK’.

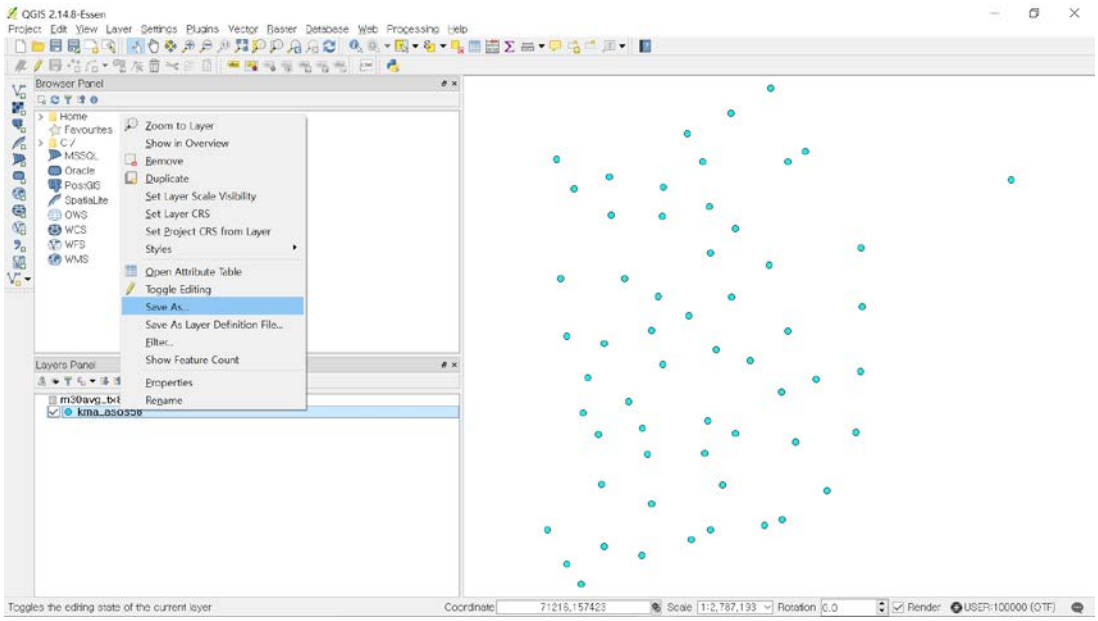


Fig. 11.

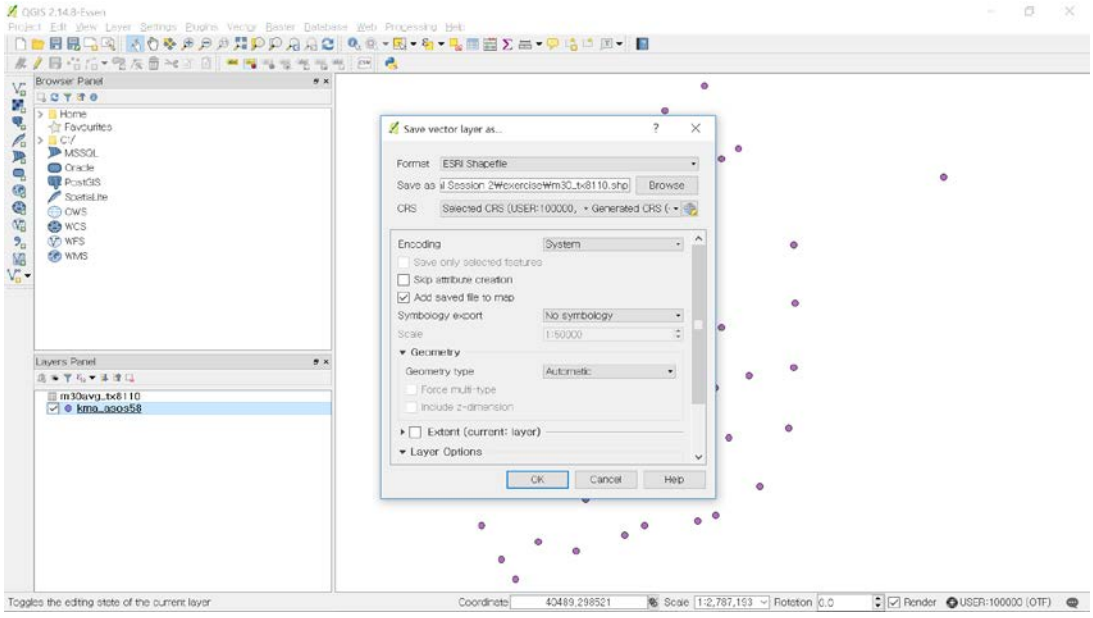


Fig. 12.

6. Open the saved vector file at the step 5.
   - go to the file menu “Layer” >> click “Add Layer” >> select “Add Vector Layer”
   - file location: QGIS Tutorial – Data – Tutorial Session 2 – exercise: m30_tx8110.shp

- this shape file would be that you saved at the step 5. (Fig. 13)

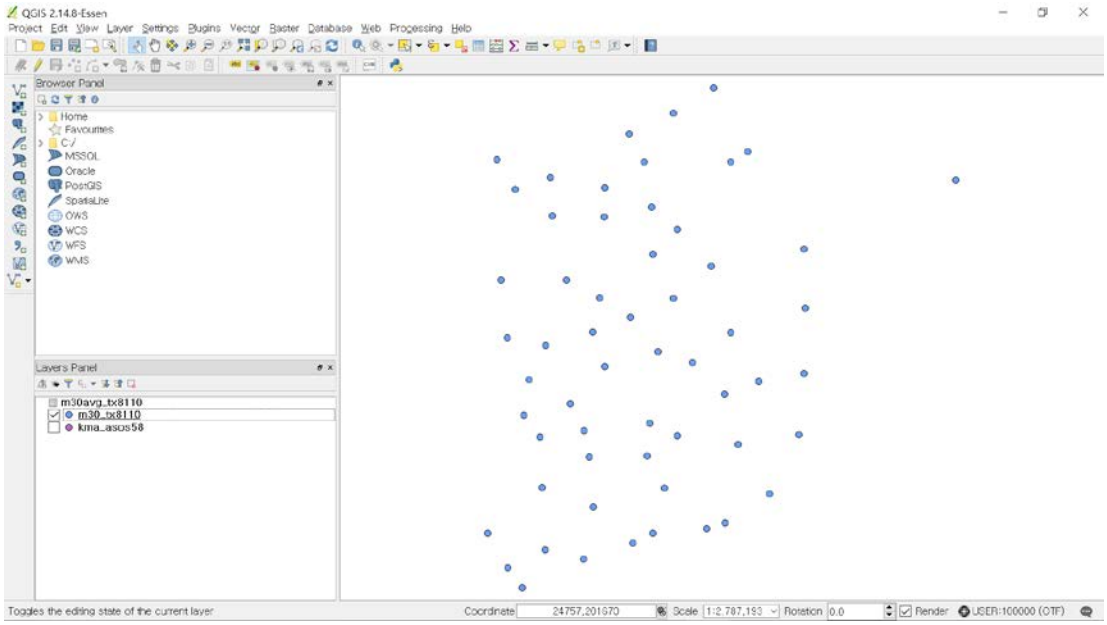


Fig. 13.

7. We will interpolate with the temperature information. First, go to the menu 'Raster' and click 'Interpolation' and then click again "Interpolation" at the extended pull-down menu (Fig. 14).

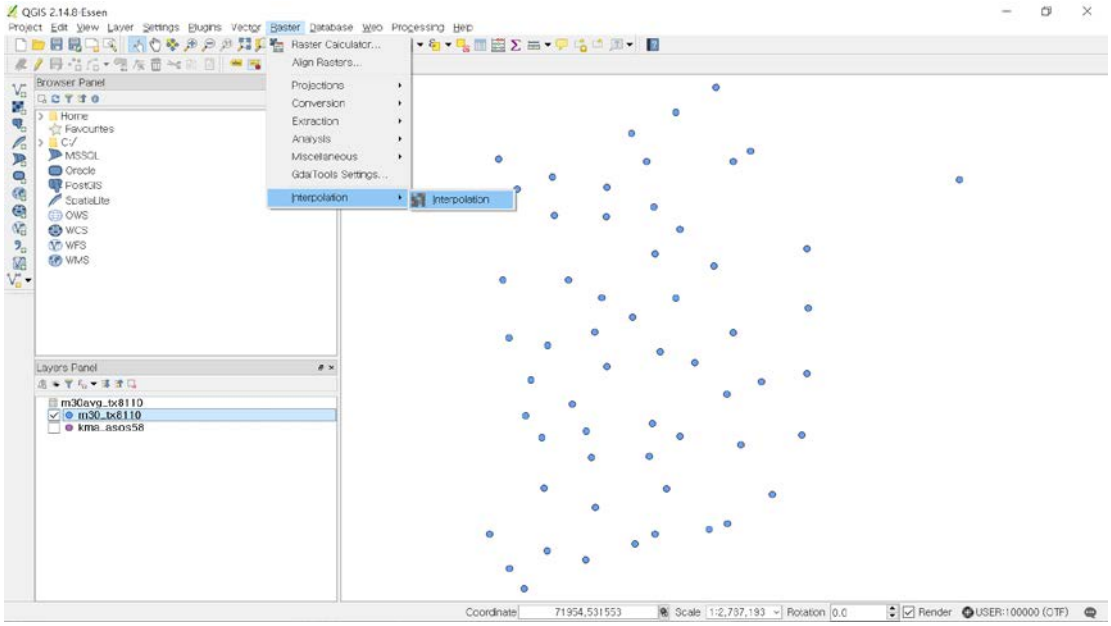


Fig. 14.

8. Set up the configurations as below (Fig. 15):

- first, look at ‘Input’ panel in the left of ‘Interpolation plugin’ box, then
- click the combo box at ‘Vector layers’ and choose ‘m30_tx8110’
- again click the combo box at ‘Interpolation attribute’ and choose ‘M30_TX01’
- click the button ‘Add’ to input the selected field to the text box
- look at ‘Output’ panel in the right of ‘Interpolation plugin’ box,
- select ‘Inverse Distance Weighting (IDW)’ in ‘Interpolation method’
- type in ‘400’ for ‘Number of columns’ and ‘427’ for ‘Number of rows’, respectively.
- we need to setup extent of map, type in X min and Y min, respectively: 51832.3 for X min,-33145 for Y min
- additionally, 546767.24 for X max, 569052.49 for Y max
  (see Extent_Interpolation.txt file in DATA – Tutorial Session 2 folder)
- type in ‘m30_tx01’ in the folder ‘exercise’ to save the interpolation.
- file location: QGIS Tutorial – Data – Tutorial Session 2 – exercise (Fig. 15)

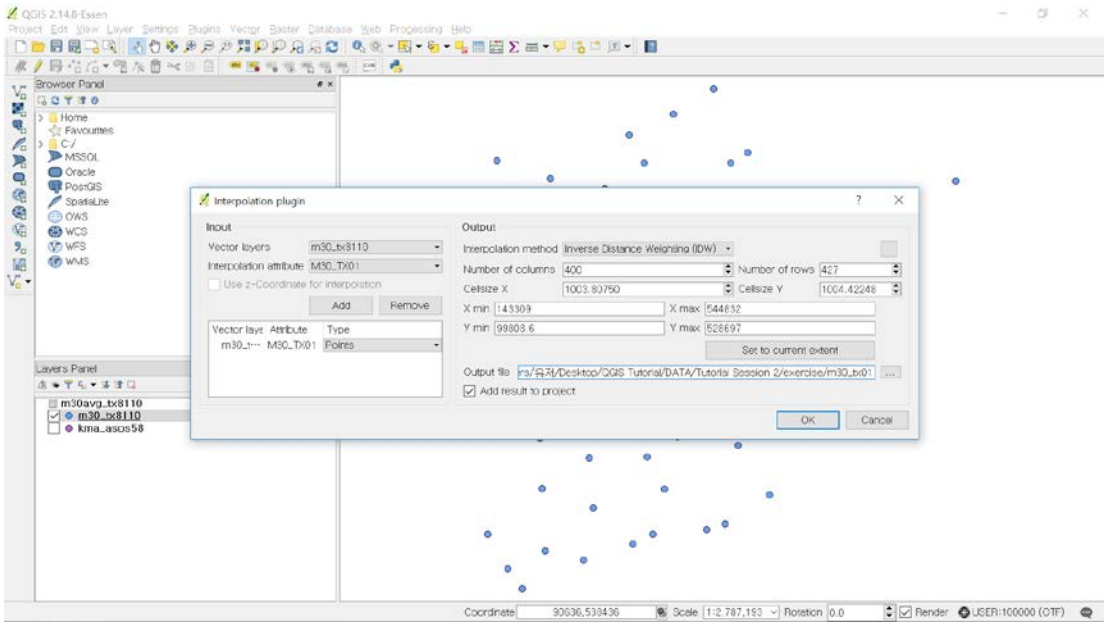


Fig. 15.

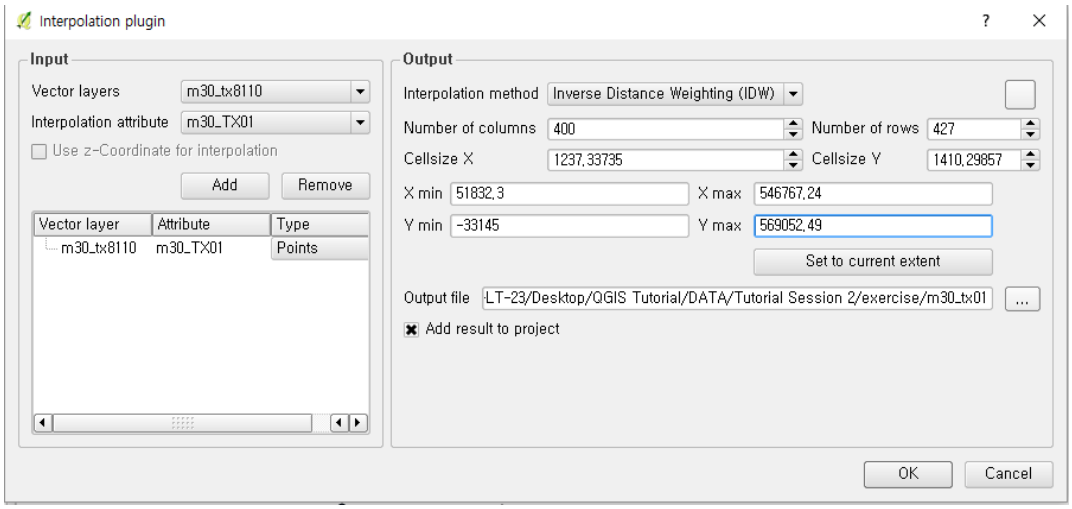


Fig. 16.

9. You can make interpolation from February to December
   - file names for saving: m30_tx02 ~ m30_tx12

10. Likewise, you open the text file which has the minimum temperature and the shape file. You interpolate then them. Remember from the step 2 to 9. So, you can have 24 digital temperature maps to calculate GDD of crop.
   - file location to open the text file: QGIS Tutorial – Data – Tutorial Session 2 – ASOS Observation: m30avg_tn8110.csv
   - file location to open the shape file: QGIS Tutorial – Data – Tutorial Session 2 – ASOS Observation: kma_asos58.shp
   - file location and file name to save the vector file joined with the minimum temperature: QGIS Tutorial – Data – Tutorial Session 2 – exercise: m30_tn8110.shp
   - then, save the interpolations as those filenames: m30_tn01 ~ m30_tn12

11. Now, you can calculate GDD by using 'Raster calculator' if you have 24 digital temperature maps. Go to the menu 'Raster Calculation" and open 'Raster calculator' box. (Fig. 17 and Fig. 18)

    We will GDD equation as below (Kim *et al.*, 2008):

$$\mathrm{GDD} = \mathrm{N} \times \left[\left(\frac{(T_x - T_n)}{2} \right) - T_b + L \times \sigma \times \sqrt{N} \right]$$

    N: the number of month, T_x: the maximum temperature, T_n: the minimum

temperature, T_b: the base temperature of crop, L: constant, σ: the standard deviation of the average temperature

You can refer Thom (1954) since the constant L was calculated from that.

- should open the raster, constant L and standard deviation:
  file location to open the raster, constant L: QGIS Tutorial – GDD – Constant L: m30_L01 ~ m30_L12
  file location to open the raster, standard deviation of the average temperature: QGIS Tutorial – GDD – SD Tavg: m30_ta_sd01 ~ m30_ta_sd12

- type in equitation for January GDD as below, click operators as well (Fig. 17),
  31 * (("m30_tx01@1" + "m30_tn01@1") / 2) - 10 + "m30_L@1" * "m30_ta_sd01@1" * sqrt (31)
- click the button '…' of 'Output layer' in 'Result layer'
- file location and file name to save the calculated GDD: QGIS Tutorial – Data – Tutorial Session 2 – exercise: m30_gdd01
- just check 'GeoTIFF' of 'Output format'

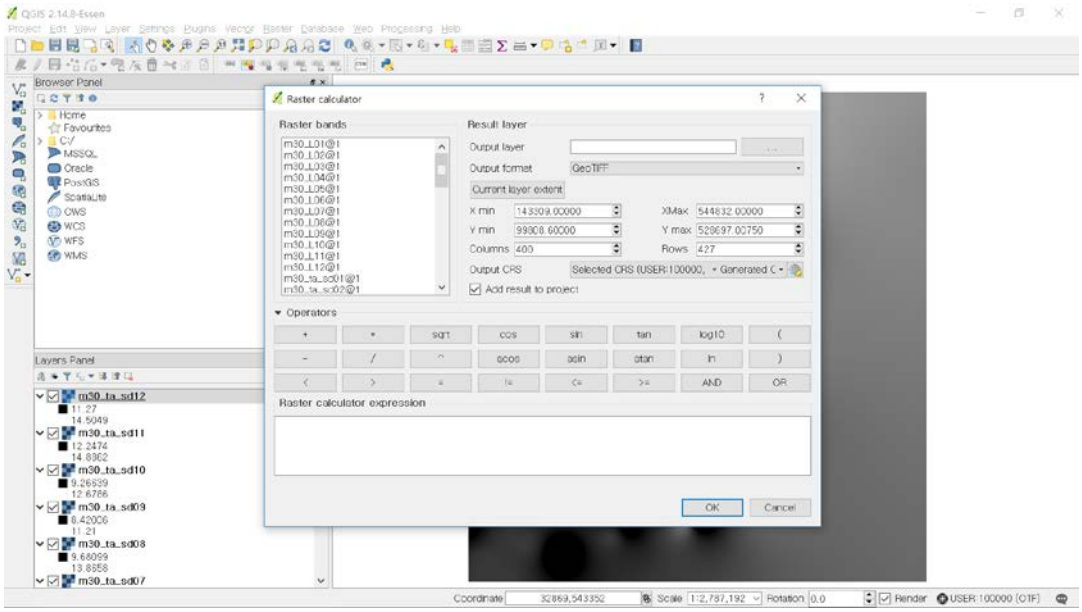


Fig. 17.

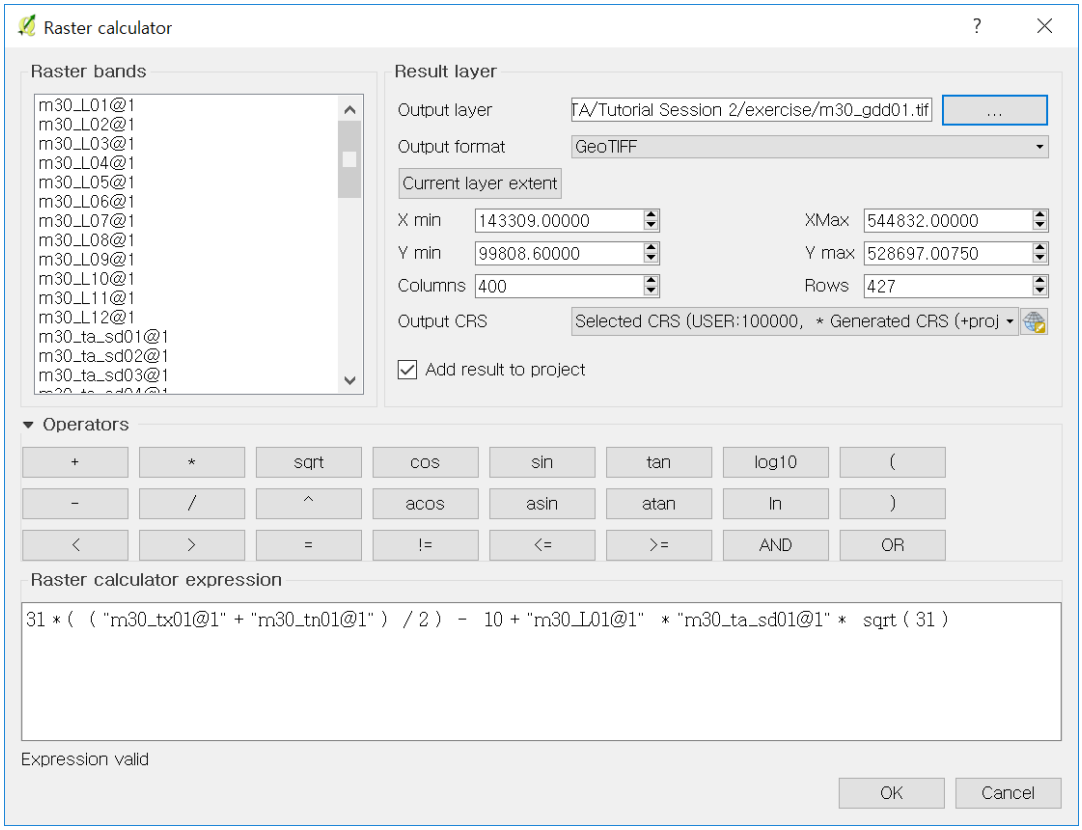


Fig. 18.

12. You calculate the rest of GDDs from February to December
    - file location and file names to save the results from February to December: QGIS Tutorial – Data – Tutorial Session 2 – exercise: m30_gdd02 ~ m30_gdd12

13. Then, accumulate 12 GDDs from January to December, or 10 GDDs from January to October.
    - type in equation: "m30_gdd01@1" + "m30_gdd02@1" + "m30_gdd03@1" + "m30_gdd04@1" + "m30_gdd05@1" + "m30_gdd07@1" + "m30_gdd08@1" + "m30_gdd09@1" + "m30_gdd10@1" + "m30_gdd11@1" + "m30_gdd12@1"
    - click the button '…' of 'Output layer' in 'Result layer'
    - file location and file name to save the accumulated all GDDs: QGIS Tutorial – Data – Tutorial Session 2 – exercise: m30_tb10_gdd_tiff

14. Convert the GeoTIFF to ASCII
    - go to the menu "Raster" >> click "Conversion" >> click "Translate (Convert Format…)" (Fig. 19)

- if you want to translate the files are not in ‘Layers Panel’, can click the button ‘Select’ in ‘Translate (Convert format)’ box.
- but, we will translate the file which already opened in ‘Layers Panel’, so just click the combo box and click ‘m30_tb10_gdd_tiff’ (Fig. 20).
- select the format ‘Arc/Info ASCII Grid (*.asc *.ASC)’ in the list and type in the file name to save (Fig. 20).
- if finish type in the file name, do not change any options, and click ‘OK’.

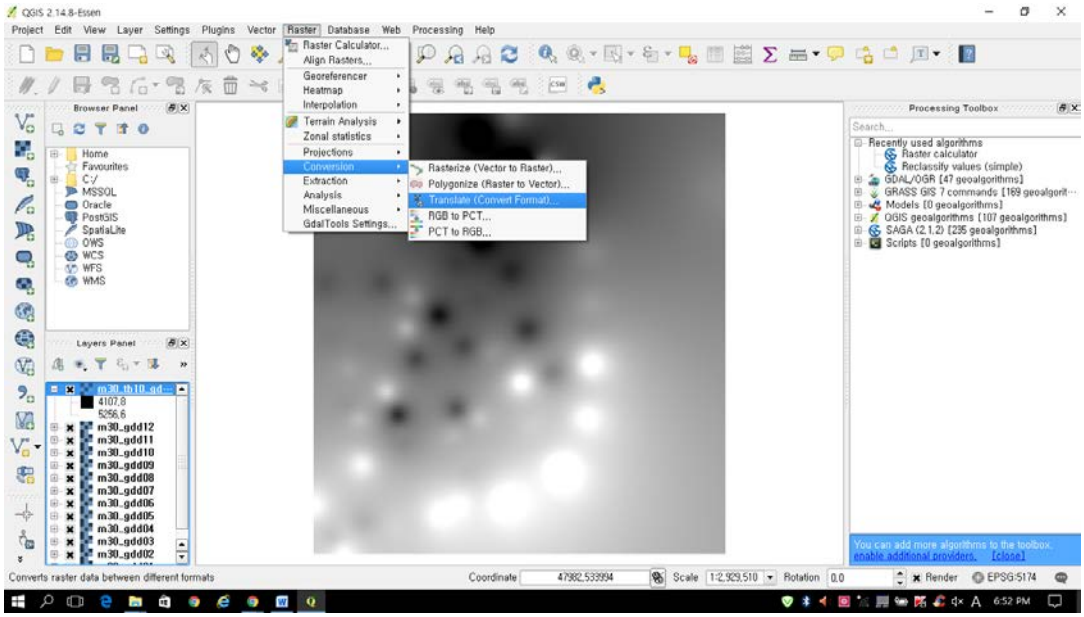


Fig. 19.

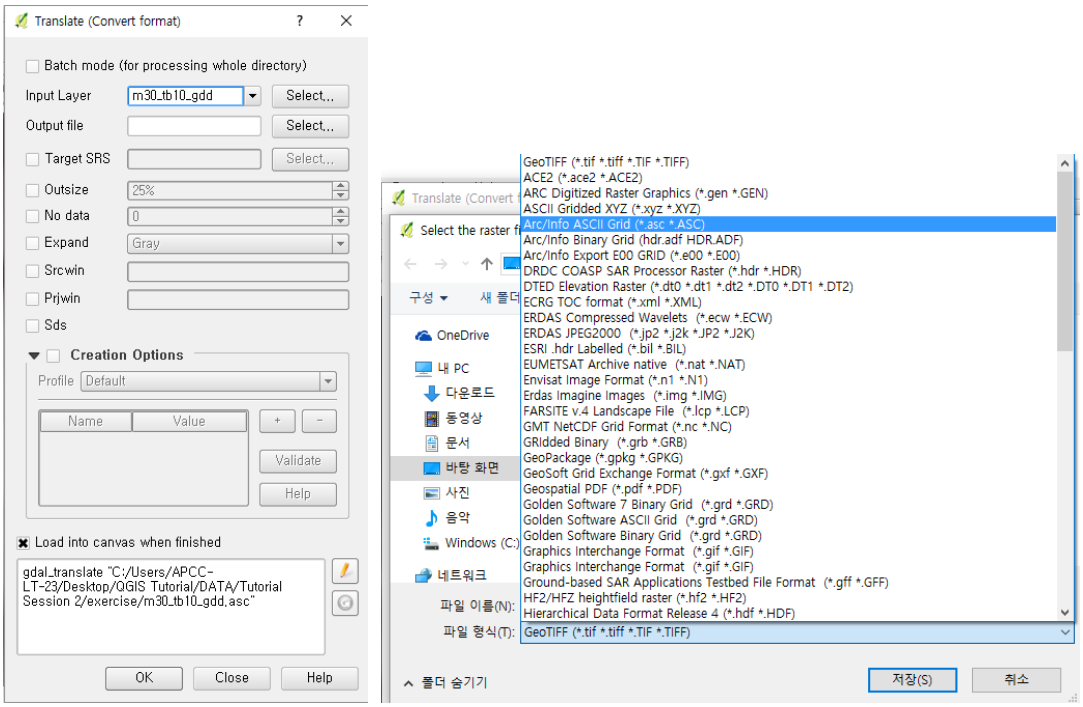


Fig. 20.

- when finish conversion, the popup boxes 'Finished' and 'qgis-ltr-bin' will be shown, click 'OK' and 'OK' in order, and just click 'Close' (Fig. 21).

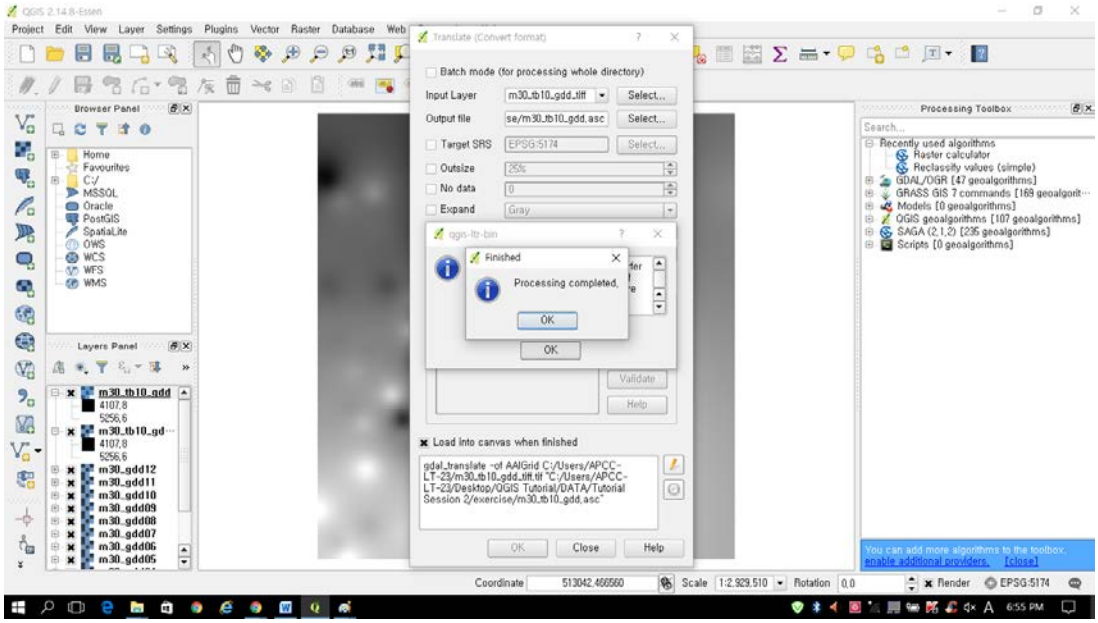


Fig. 21.

Reference:

Thom, H. C. S., 1954: The relationship between heating degree-days and temperature. Monthly Weather Review, 82(9), 1-6.

Kim, J. H., J. I. Yun, 2008: On mapping growing degree-Days (GDD) from monthly digital climatic surfaces for South Korea. Korean Journal of Agricultural and Forest Meteorology, 10 (1), 1~8.

Exercise 2 – Exploration of the areas which reach to the effective GDD

Objectives: In the second exercise for Agrometeorology, we will explore the effective GDD of the crop. For example, we can find the pixels which reach to the flowering or the maturity time from the effective GDD of the crop. We already calculated the GDD of rice. When the growth of rice reaches the maturity, the range of the effective GDD at the base temperature 10°C is known as from 3800°C to 4800°C. Find the pixels that reach to the effective GDD of crop 'Rice'.

1. Open the accumulated GDD 'm30_tb10_gdd'and open 'Raster calculator' as well.
   - file location to open raster file: QGIS Tutorial – Data – Tutorial Session 2 – exercise: m30_tb10_gdd
   - this raster file, m30_tb10_gdd would be that you saved at the step 14 in excise I.

2. Go to the menu 'Raster calculator" and type in the equation.
   - type in the box as below: (Fig. 22)
     ("m30_tb10_gdd@1" >= 3800.0 AND "m30_tb10_gdd@1" <= 4800.0) * "m30_tb10_gdd@1"
   - file location to save the result: QGIS Tutorial – Data – Tutorial Session 2 – exercise: rice_gdd

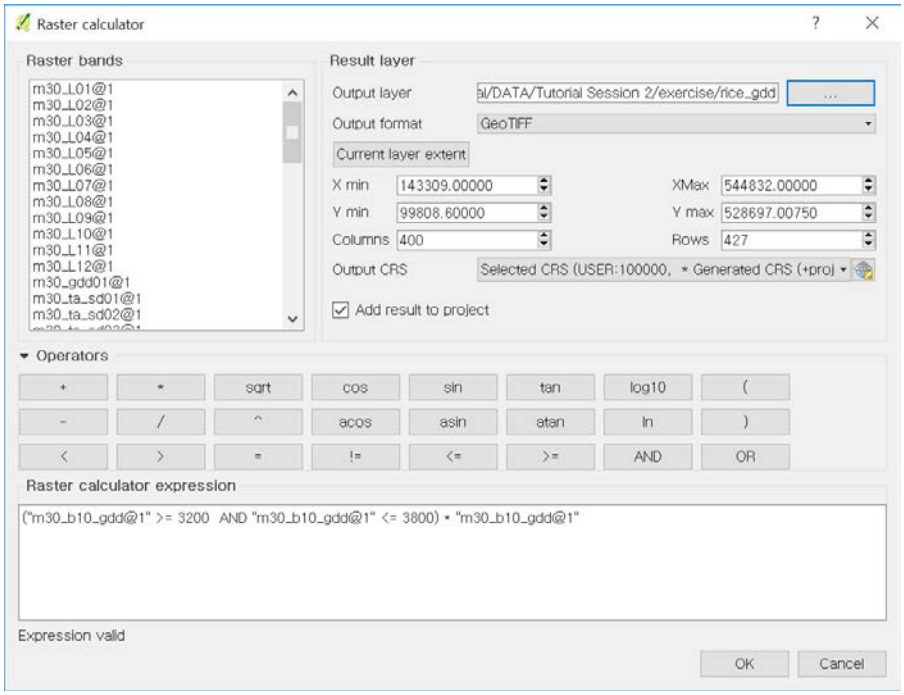


Fig. 22.

Exercise 3 – Presentation of layout GDD

Objectives: We will make presentation with your results in the last exercise. First, change legend and color scheme using 'Style layer' in properties of the raster, and then make layout from "Map composer" (you already practiced at **Introduction part of QGIS – day I** (7 December)).

1. Select the raster file, 'm30_tb10_gdd' in 'Layers Panel', click the right button of Mouse and 'Properties' (Fig. 23).
   - click 'Style' in 'Layer Properties – m30_tb10_gdd' box.
   - click 'Singleband pseudocolor' of 'Render type' in the combo box.
   - select 'Classify' of 'Generate new color map' in the right.
   - if you change mode of classification, there two modes 'Continuous' and 'Equal Interval'.
   - let's change 'Continuous' to 'Equal Interval', then change 5 to 8 in Classes.
   - lastly, select 'Apply' and 'OK'.

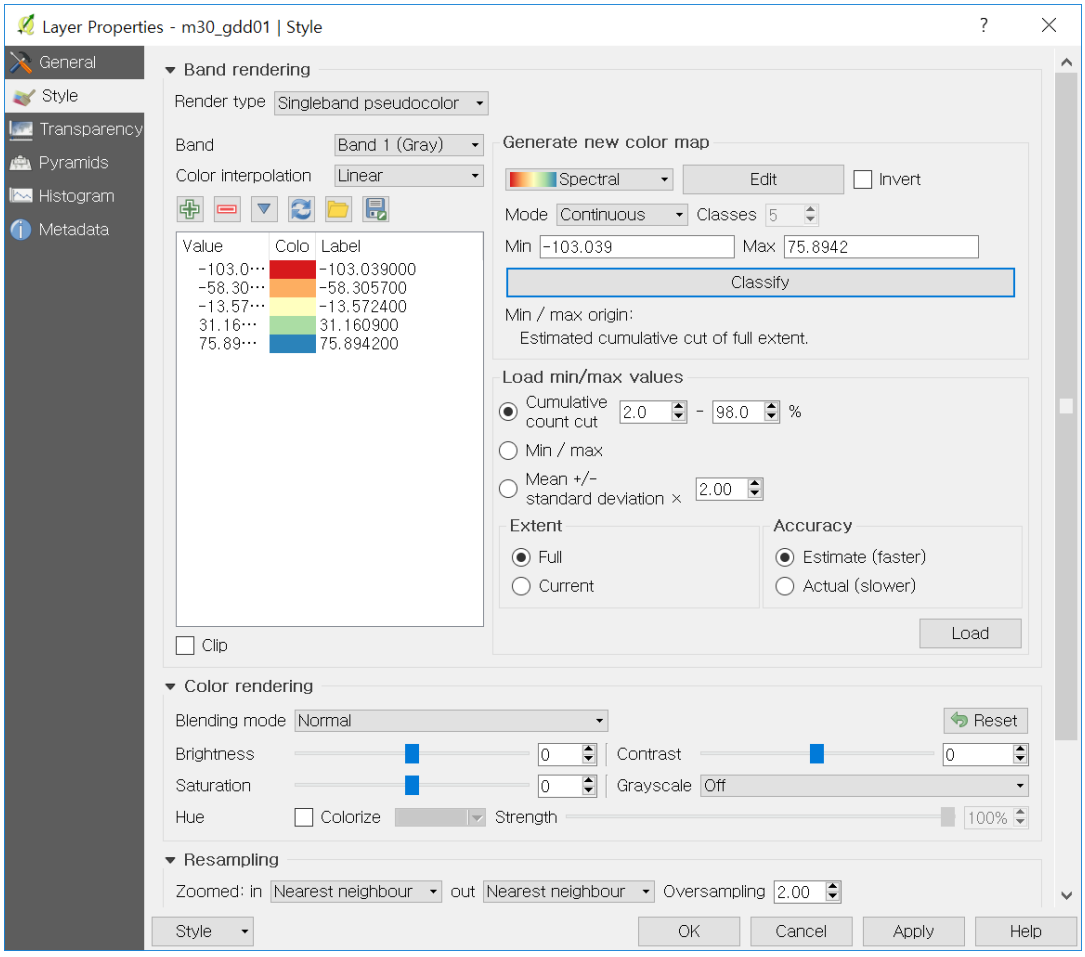


Fig. 23.

- you can see the color legend of the raster, ‘m30_t b10_gdd’ in ‘Layers Panel’ (Fig. 24).
- if you want to overlap a vector has the administration boundary, open the vector, ‘Ws_Sido.shp’ (Fig. 25).
- file location: QGIS Tutorial – Data – Tutorial Session 2 – ASOS Observation: WS_sido.shp

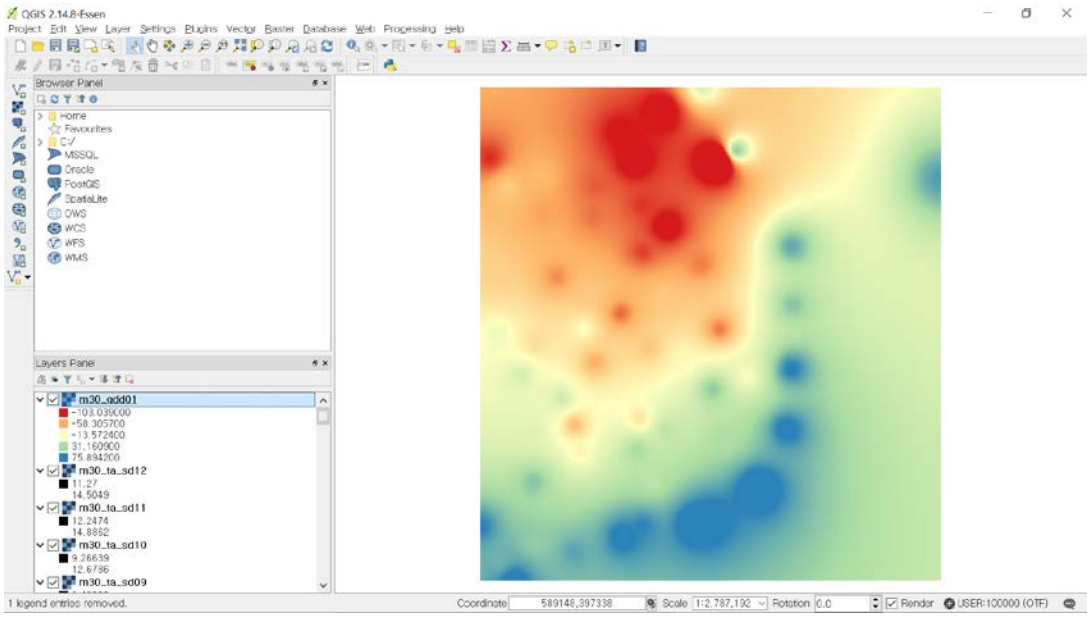


Fig. 24.

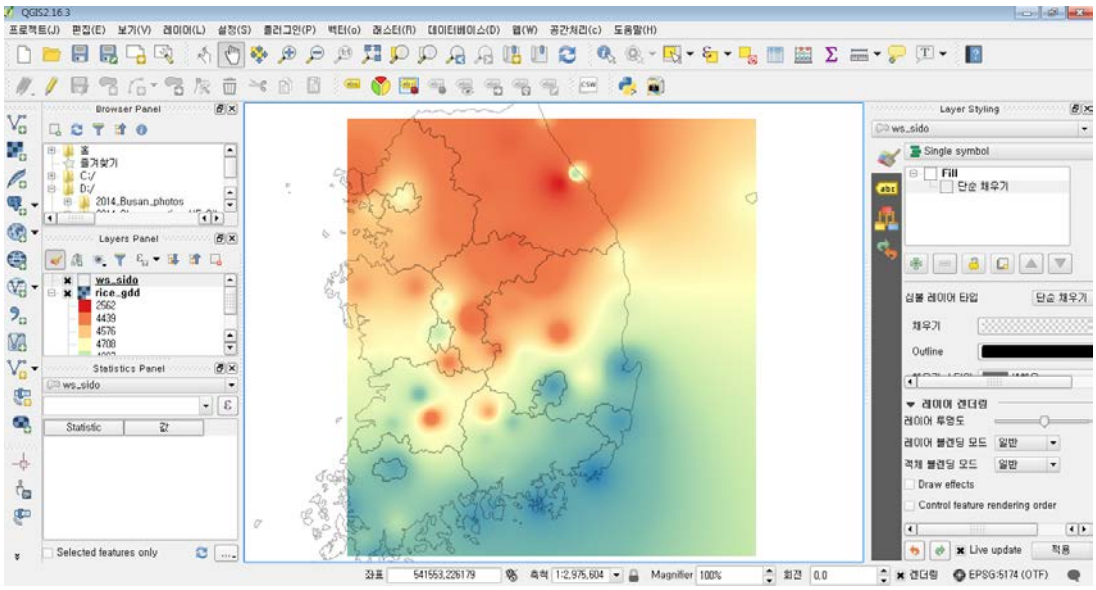


Fig. 25.

2. Go to the menu ‘Project’ and select ‘Composer manager’ (Fig. 26).
   - Click ‘ADD’ button in ‘Composer manager’, and in order to create map, type in the name of map: Rice_GDD in ‘Composer title’ box and click ‘OK’ (Fig. 27 and Fig. 28)

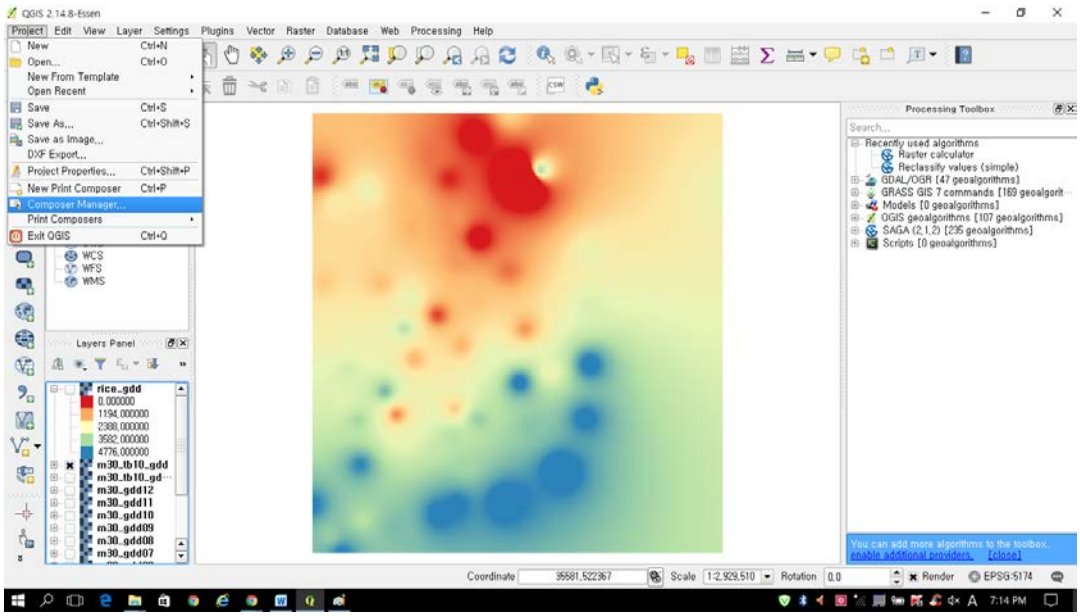


Fig. 26.

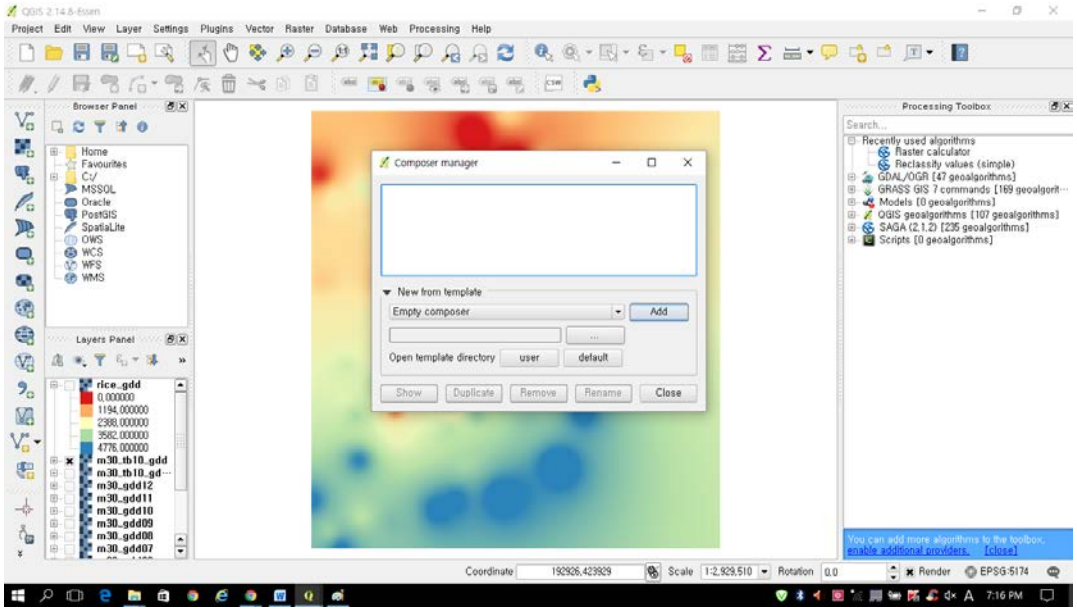


Fig. 27.

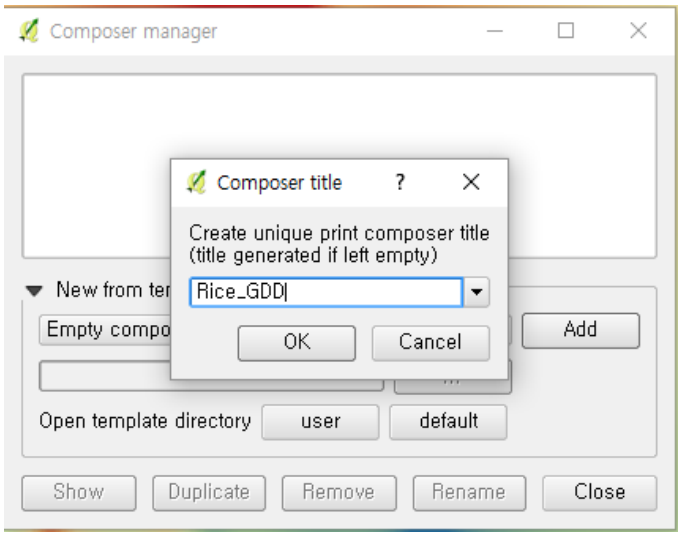


Fig. 28.

- You can see a new window 'Rice_GDD' (Fig. 29).

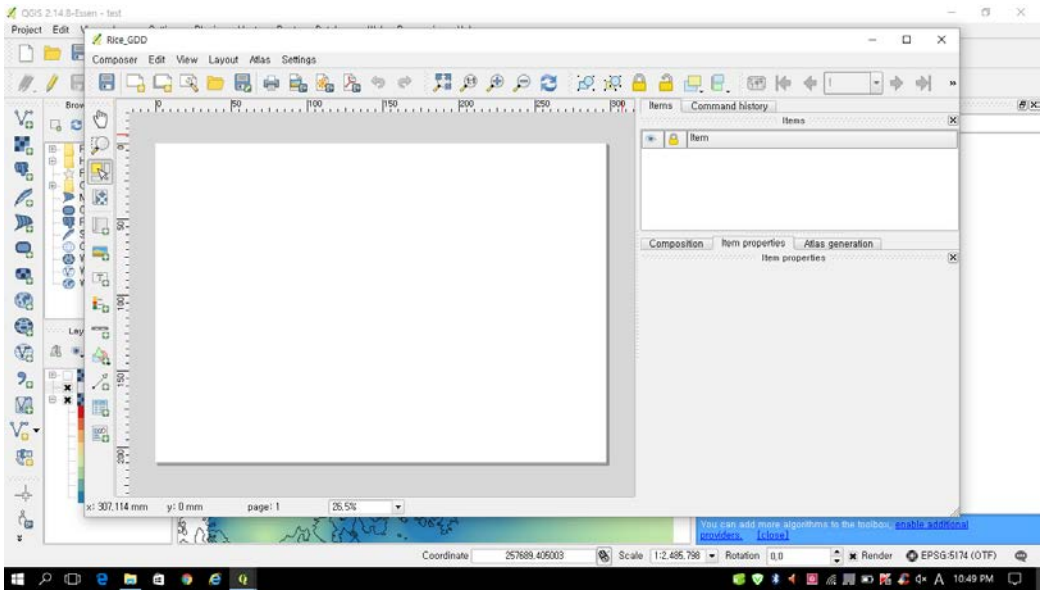


Fig. 29.

- go to the menu 'Layout' and click 'Add Map' in the pull-down menu (Fig. 30).
- you can check the figure of mouse pointer '+' (cross). So, you drag the box in the white box, then the map will be shown (Fig. 31).
- in addition, you can make other components of map, in instance legend, scale-bar, and labels such as text (Fig. 32).
- click 'Add Scalebar' and drag the box to make scalebar.
- click 'Add Legend' and drag the box to make legend.

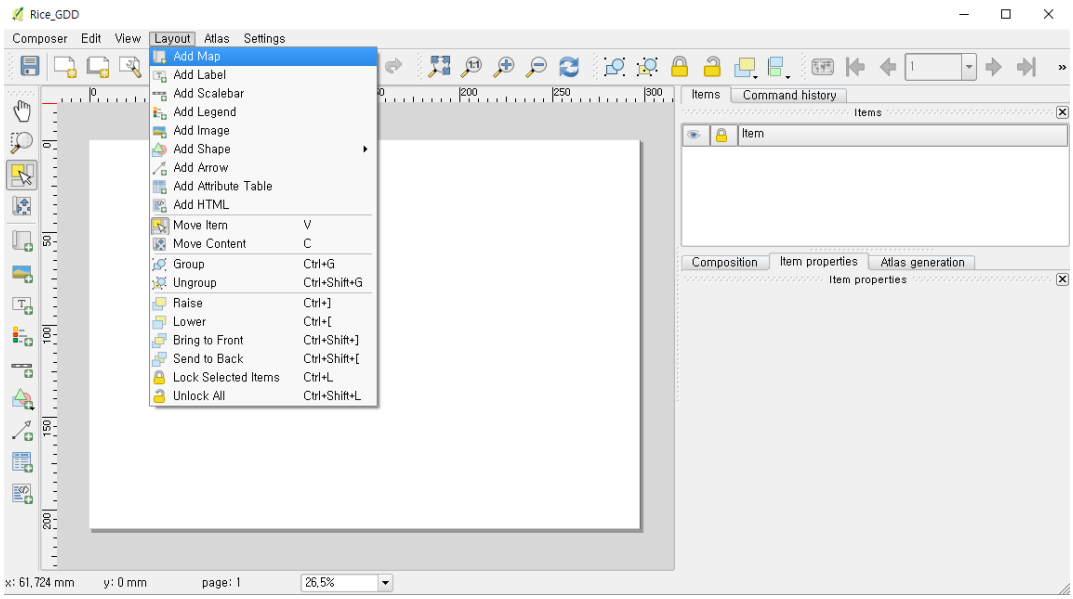

Rice_GDD
Composer Edit View Layout Atlas Settings
Add Map
Add Label
Add Scalebar
Add Legend
Add Image
Add Shape
Add Arrow
Add Attribute Table
Add HTML
Move Item V
Move Content C
Group Ctrl+G
Ungroup Ctrl+Shift+G
Raise Ctrl+]
Lower Ctrl+[
Bring to Front Ctrl+Shift+]
Send to Back Ctrl+Shift+[
Lock Selected Items Ctrl+L
Unlock All Ctrl+Shift+L
Items Command history
Item
Composition Item properties Atlas generation
Item properties
x: 61,724 mm y: 0 mm page: 1 26,5%

Fig. 30.

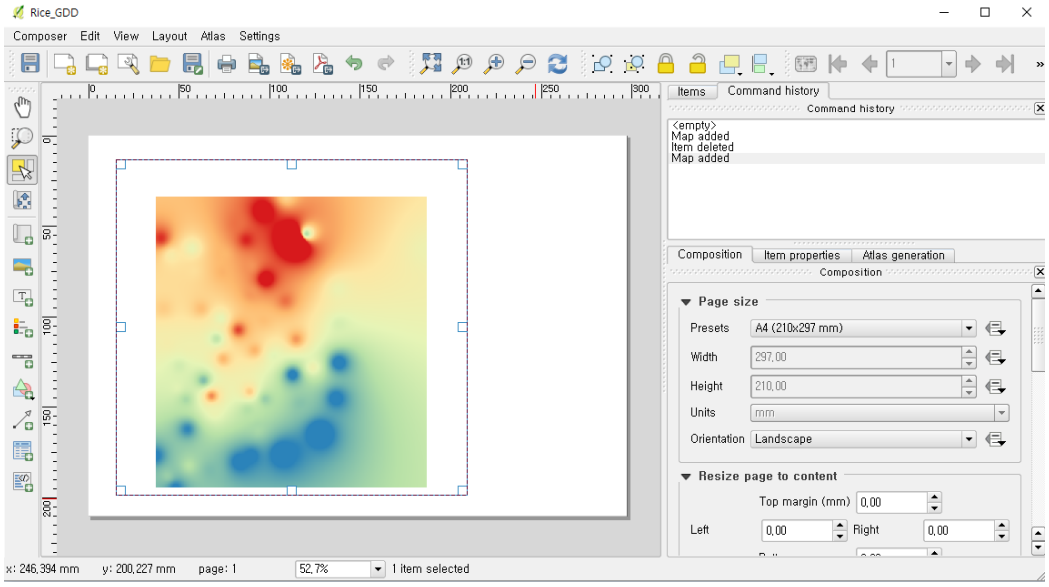

Rice_GDD
Composer Edit View Layout Atlas Settings
Items Command history
Command history
<empty>
Map added
Item deleted
Map added
Composition Item properties Atlas generation
Composition
Page size
Presets A4 (210x297 mm)
Width 297,00
Height 210,00
Units mm
Orientation Landscape
Resize page to content
Top margin (mm) 0,00
Left 0,00 Right 0,00
x: 246,394 mm y: 200,227 mm page: 1 52,7% 1 item selected

Fig. 31.

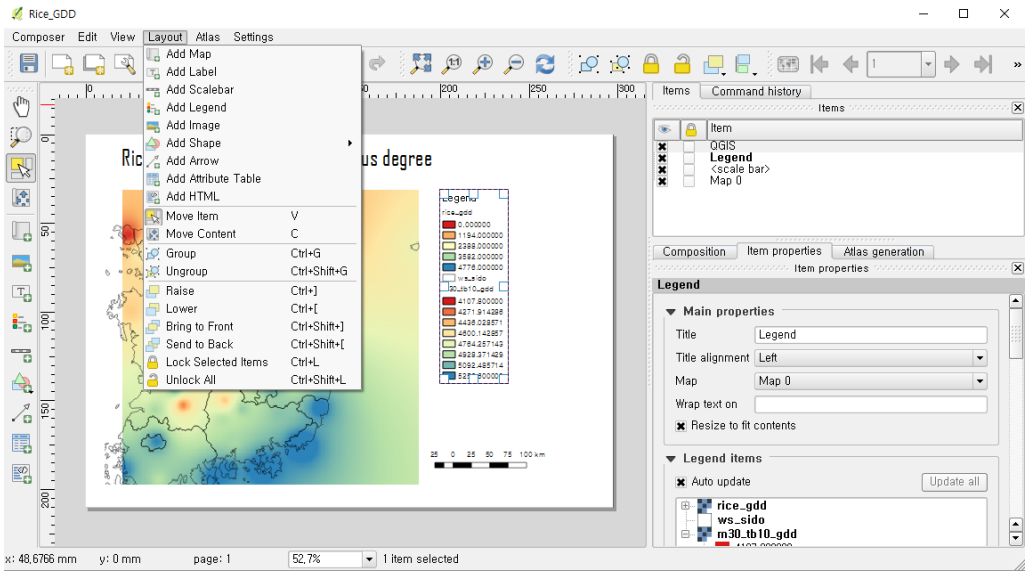


Fig. 32.

- let's make the title of map. Go to the menu 'Layout' and click 'Add Label', then drag the box at top of the layout (Fig. 33).

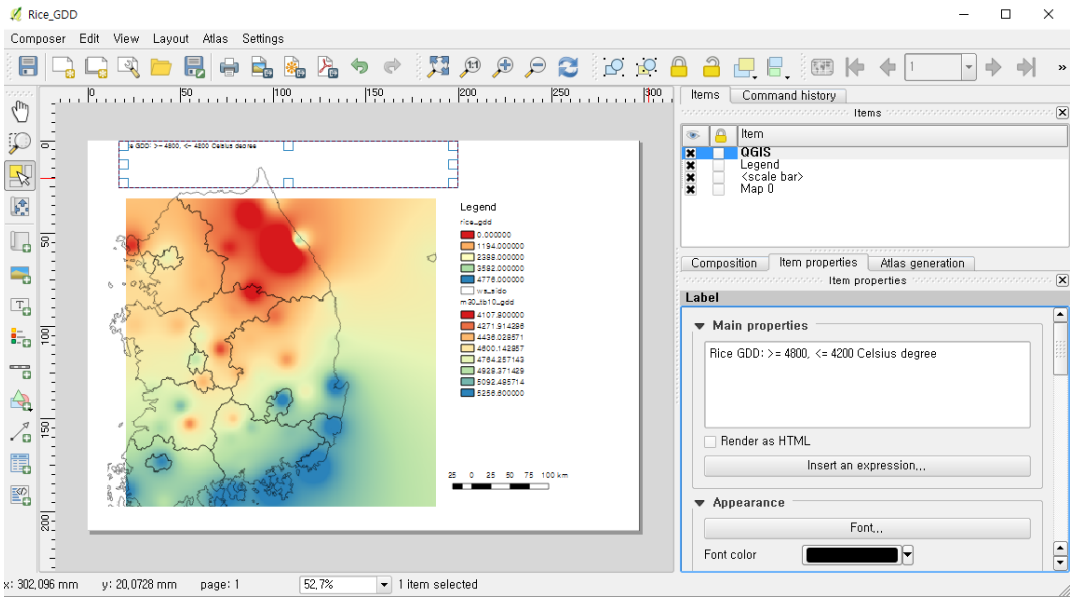


Fig. 33.

- click the tab 'Items' in the right panel and click 'QGIS' (Fig. 34).
- click the tab 'Items properties' and the black triangle toggle symbol of 'Label' to spread 'Main properties' box and type in the title: Rice GDD: >= 4800, <= 4200 Celsius degree (Fig. 34).
- click the toggle to expand of 'Appearance' and click the button 'Font' (Fig. 35).

- change the size of font as 36 in ‘Select Font’ box (Fig. 36).
- click the option ‘Center’ for ‘Horizontal alignment’ and click the option ‘Middle’ for ‘Vertical alignment’ (Fig. 37).
- now, finish making the map layout (Fig. 38). If you want to make image, or PDF etc, go to the menu ‘Composer’ and click ‘Export as Image…’ or ‘Export as PDF…’ (Fig. 39).

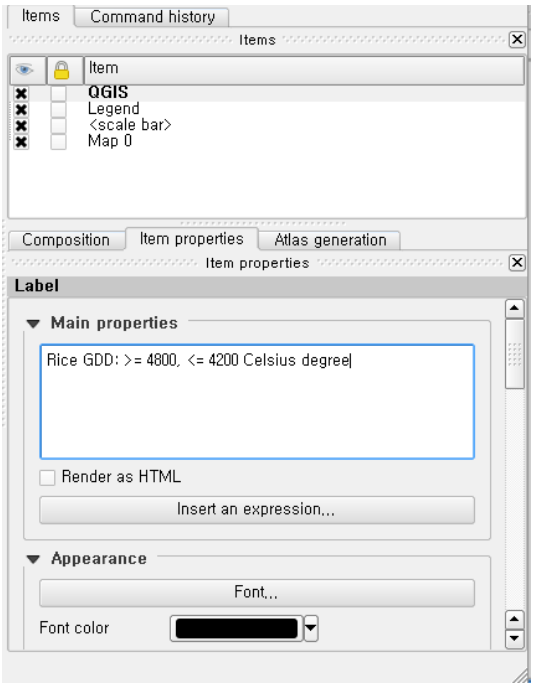


Fig. 34.

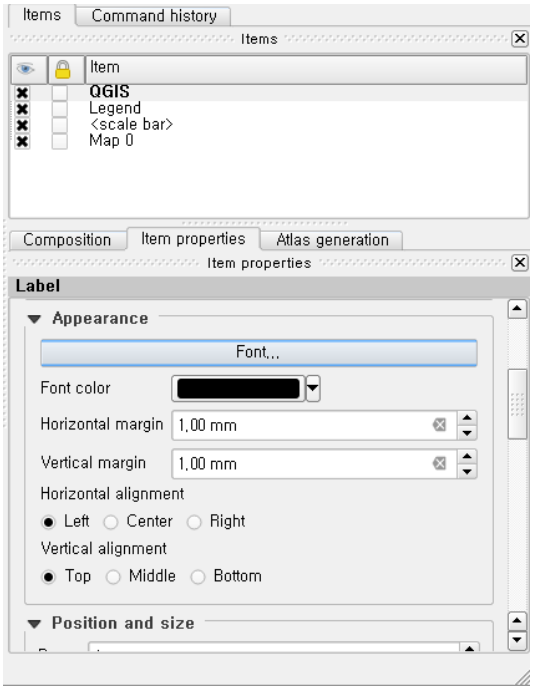


Fig. 35.

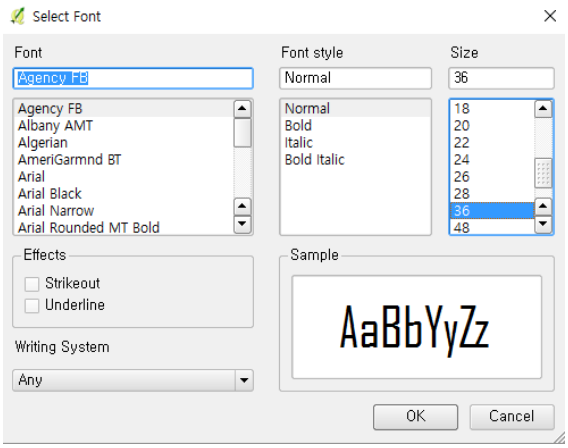


Fig. 36.

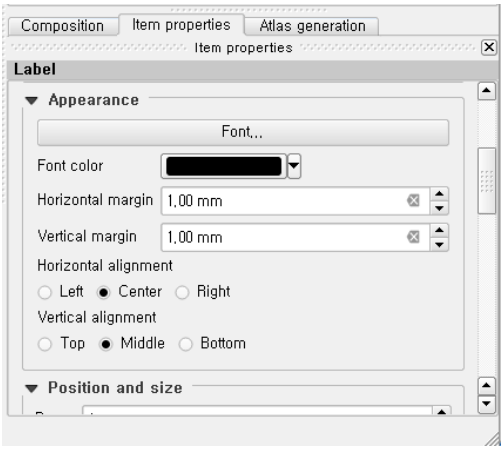


Fig. 37.

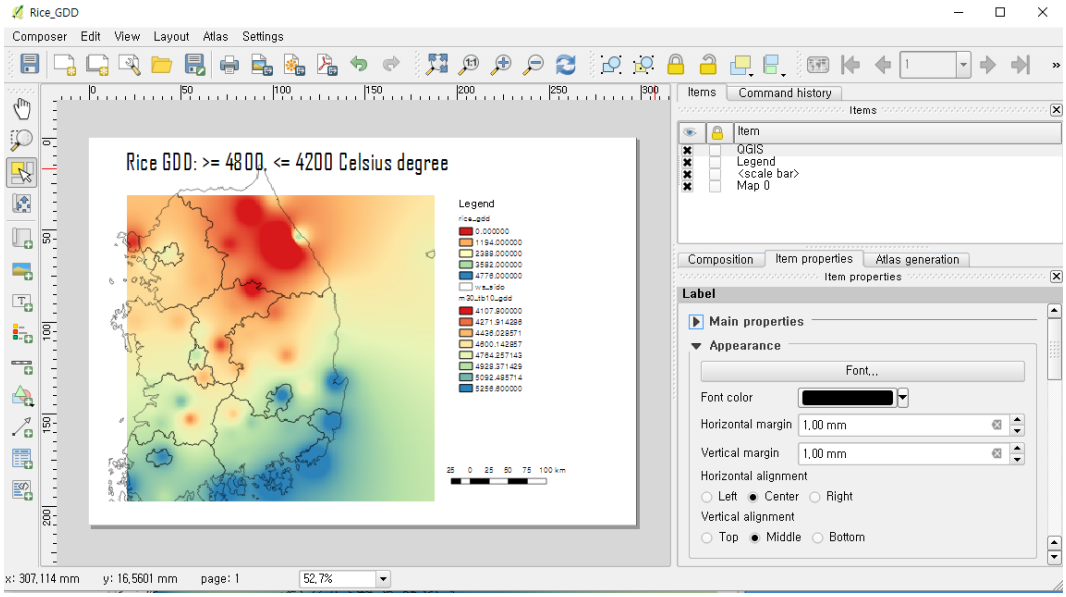


Fig. 38.

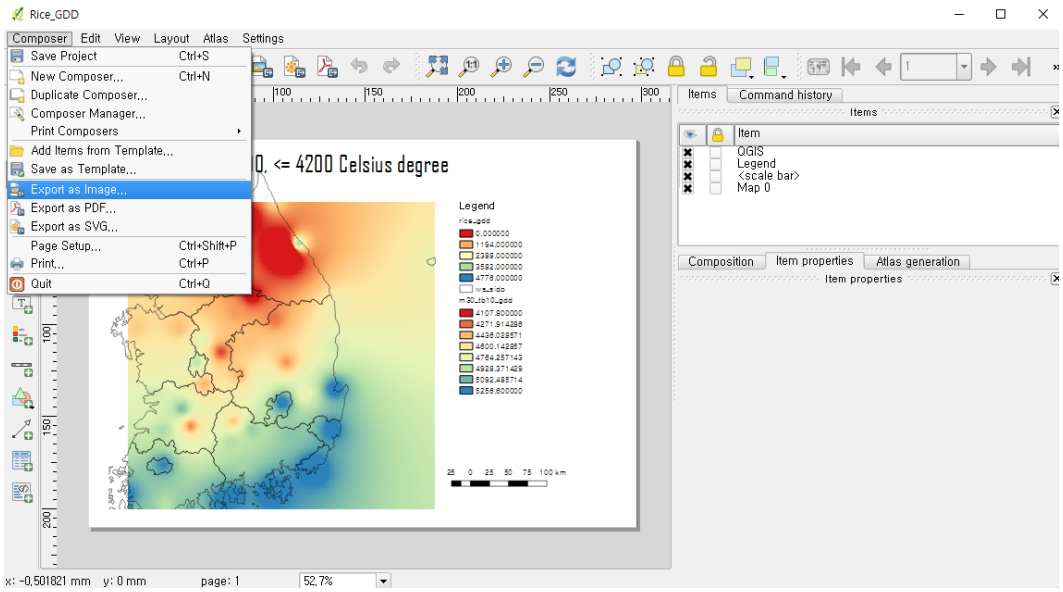


Fig. 39.

Note 2:

TM coordination in QGIS: EPSG:5174

WGS 84 in QGIS: EPSG:4326