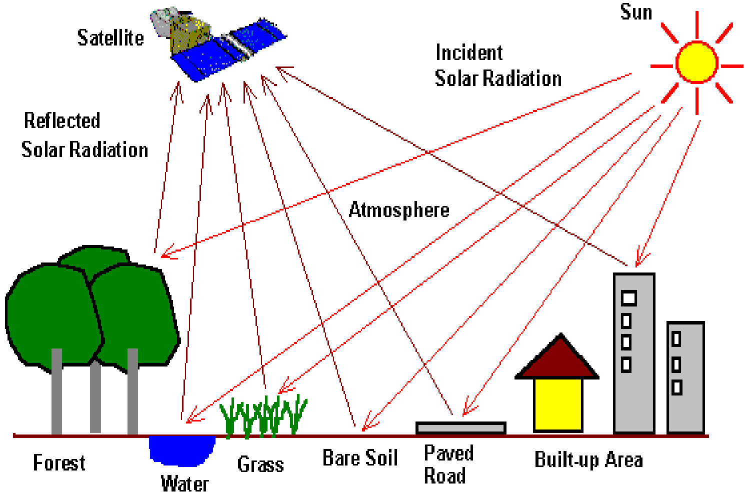
2019, The first INU-ENU joint form on TC305 geotechnical infrastructure for Mega cities and new capitals
Astana, Kazakhstan, 25th February 2019

VEGETATION ANALYSIS IN THE WESTERN PART OF SOUTH KOREA USING OPEN SOURCE QGIS TOOLKIT



Ph.D., Yong Chang LEE

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Incheon National University, Republic of Korea
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Presentation contents

Project motive

Remote sensing application using satellite and drones imagery have been used effectively in various industries.

The Korean government has been struggling for effective agricultural and forest policy. In particular, Seeking various policies to minimize the damage of domestic farmers due to imports of agricultural products under FDA agreement with foreign countries.

As an example, there is a system that provides compensation to farmers who stop farming. Therefore, the State should investigate agricultural land, forest area, etc. every year, Farmers are also adopting smart farming technology for efficient science farming.

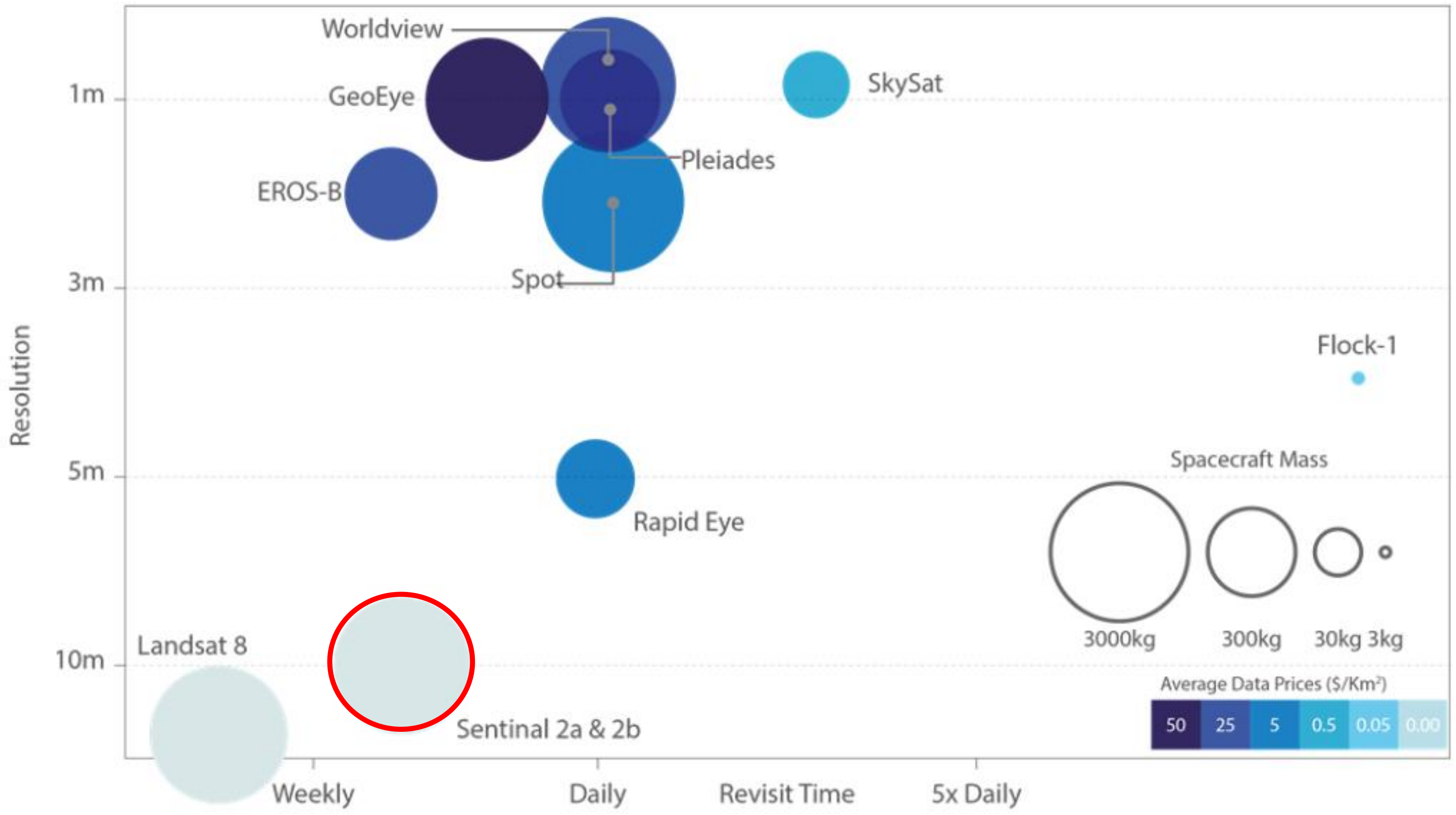


Figure : Spatial Resolution vs Revisit Time for various example satellites
(Source: Satellite Applications Catapult 2017, adapted from EO21 Project)

An overview of some of the more commonly used EO satellites in terms of spatial resolution and revisit time

Copernicus program mission operations

Sentinels for Copernicus

ESA is developing a new family of missions called Sentinels specifically for the operational needs of the Copernicus program. Each Sentinel mission is based on a constellation of two satellites to fulfil revisit and coverage requirements, providing robust datasets for Copernicus Services**. These missions carry a range of technologies, such as radar and multi-spectral imaging instruments for land, ocean and atmospheric monitoring**

Sentinel-2 is a polar-orbiting, multispectral high-resolution imaging mission for land monitoring to provide, for example**, imagery of vegetation, soil and water cover, inland waterways and coastal areas**. Sentinel-2 can also deliver information for emergency services. Sentinel-2A was launched on 23 June 2015 and Sentinel-2B followed on 7 March 2017.

Sentinel-2 mission is based on a constellation of **two identical satellites in the same orbit, 180° apart for optimal coverage and data delivery.** The Sentinel 2 satellites have **a Multi-Spectral Instrument (MSI) with 13 spectral bands** that range from the visible range to **the shortwave infrared (SWIR)**. Bands come in variable resolutions from 10 to 60 meter and their wavelength is determined based on specific purposes. False color images are used to enhance certain cover types as vegetation on the image representation.

The mission supports operational applications primarily for land services, including the **monitoring of vegetation, soil and water cover, as well as the observation of inland waterways and coastal areas**. Sentinel-2 will complement mission such as SPOT or Landsat.

Sentinel-2 Bands	Central Wave length [micrometers]	Resolution [meters]
Band 1 - Coastal aerosol	0.443	60
Band 2 - Blue	0.490	10
Band 3 - Green	0.560	10
Band 4 - Red	0.665	10
Band 5 - Vegetation Red Edge	0.705	20
Band 6 - Vegetation Red Edge	0.740	20
Band 7 - Vegetation Red Edge	0.783	20
Band 8 - NIR	0.842	10
Band 8A - Vegetation Red Edge	0.865	20
Band 9 - Water vapour	0.945	60
Band 10 - SWIR - Cirrus	1.375	60
Band 11 - SWIR	1.610	20
Band 12 - SWIR	2.190	20

Sentinel-2 Data Offer

The Sentinel-2 data offer for the Open Access Hub will consist of Level-1C and Level-2A user products.

Copernicus Open Access Hub

The Copernicus Open Access Hub is a web based system designed to provide EO data users with distributed mirror archives and bulk dissemination capabilities for the Sentinels products.

Terms of Copernicus Open Access Hub portal and Data supply conditions

https://scihub.copernicus.eu/dhus/#/home

Data Hub System 0.14.7-2 developed by a Serco and GAEL Systems consortium under a contract with the European Space Agency - Funded by the EU and ESA

serco copernicus esa EUROPEAN UNION

https://scihub.copernicus.eu/userguide/

https://sentinels.copernicus.eu/web/sentinel/sentinel-data-access/typologies-and-services

SNAP

Sentinel Application Platform

A common architecture for all Sentinel Toolboxes is being **jointly developed** by Brockmann Consult, Array Systems Computing and C-S called the **SNAP** which **is ideal for Earth Observation processing and analysis.**

Sentinel-2 Toolbox

Radiometric Indices Processor – Sen2Rad

Radiometric indices are quantitative measures of features that are obtained by combining several spectral bands

Vegetation indices

- DVI, RVI, PVI
- NDVI, WDVI, TNDVI, GNDVI
- SAVI, TSAVI, MSAVI, MSAVI2
- GEMI
- ARVI
- NDI45
- MTCI, MCARI, PSSRa
- S2REP, REIP, IRECI

Soil indices

- BI
- BI2
- RI
- GEMI

Water indices

- NDWI
- NDWI2
- MNDWI
- NDPI
- NDTI

- **Third Party Plugin : SEN2COR**

seom scientific exploitation of operational missions

FOSS4G

Free and Open Source Software for Geospatial

https://www.osgeo.org/initiatives/foss4g/

QGIS, SCP plugin

Developed by Luca Congedo , the Semi-Automatic Classification Plugin (SCP) is **a free open source plugin for QGIS** that allows for the semi-automatic classification (also supervised classification) of remote sensing images. It provides several tools for the download of free images, the preprocessing, the postprocessing, and the raster calculation.

Luca Congedo

SCP Manual : https://fromgistors.blogspot.com/p/user-manual.html?spref=scp

The objective of this project

was to investigate the application to **the national agricultural policy and the utilization of smart scientific farming for farmer** from consideration of the time series distribution of the vegetation index at the field test for the western part of South Korea **with the open source toolkits**.

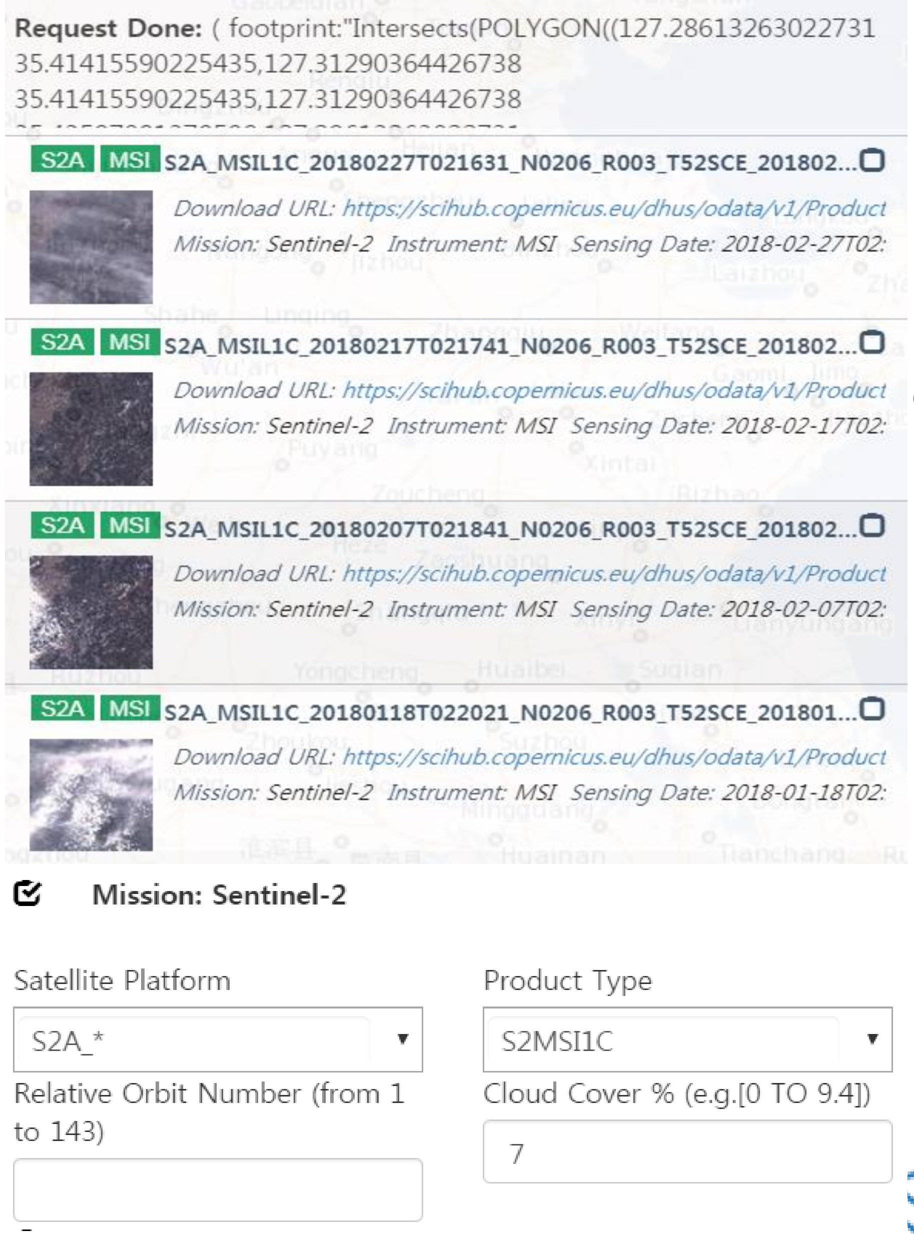
For these objects, we analyzed **Sentinel-2 satellite imagery** to investigate the distribution of green space ratio of crop field and forest **by both calculation of several vegetation indices and combination of various RGB bands.**

A special feature of this project

is that **both satellite imagery and image analysis tools utilize open source**.

The spatial resolution of Sentinel 2 satellite image is 10m, which is free to use as Landsat satellite image and has better resolution than Landsat image with 30m spatial resolution. Especially, in case of commercial supply, the average price of satellite imagery is **$50 per square km.**

Study Site and Materials



Cloud Cover Percentage

6.7

6.6

10.8

83.2

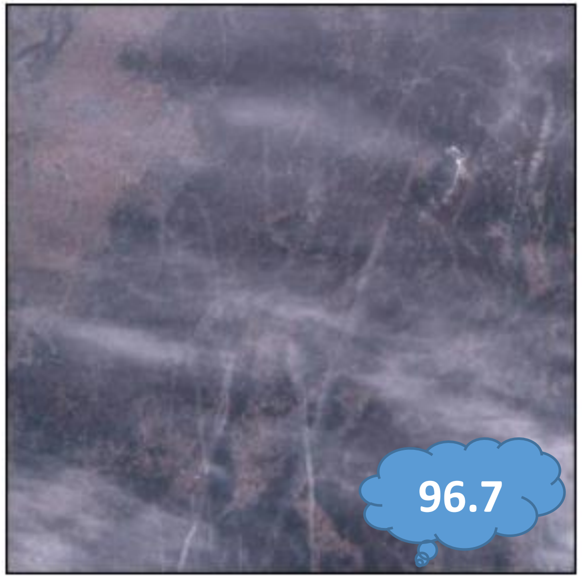
Sentinel 2A/2B image used in this study

	Cloud Cover Percentage
S2A_MSIL1C_20180217T021741_N0206_R003_T52SCE_20180217T064145.zip	6.640%
S2A_MSIL1C_20180408T021601_N0206_R003_T52SCE_20180408T041828.zip	0.216%
S2A_MSIL1C_20181025T021741_N0206_R003_T52SCE_20181025T051659.zip	1.970%
S2A_MSIL1C_20181214T022101_N0207_R003_T52SCE_20181214T055023.zip	0.221%
S2B_MSIL1C_20180602T021639_N0206_R003_T52SCE_20180602T040336.zip	0.163%
S2B_MSIL1C_20180801T021649_N0206_R003_T52SCE_20180801T040718.zip	1.138%

YearMMDD hhmmss
UTC

Scanning time

Korean Time : UTC + 9h, AM 11:16 – 11:21



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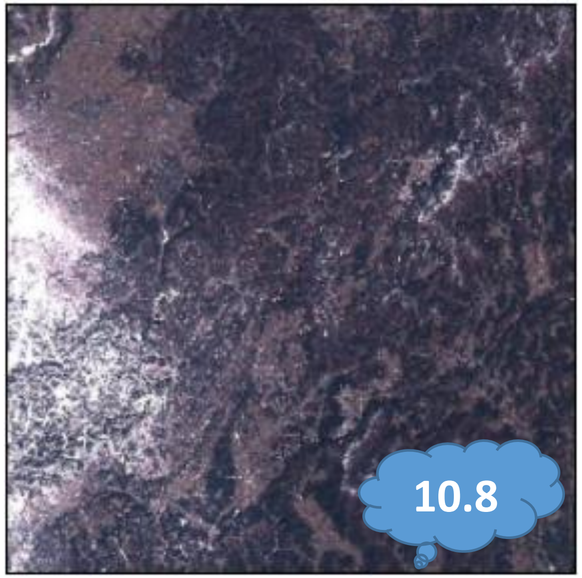
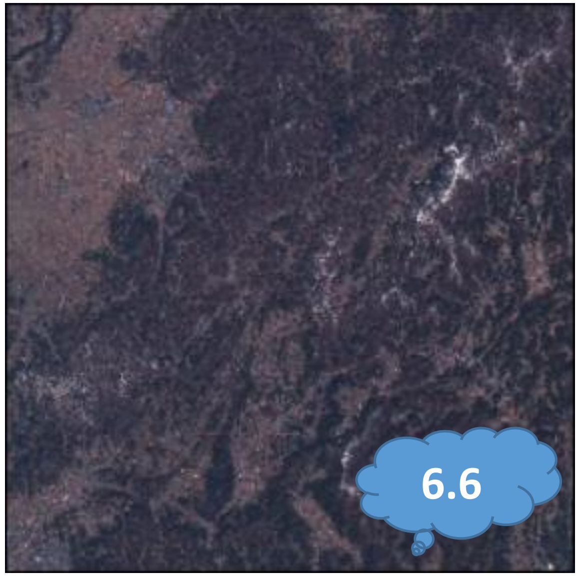
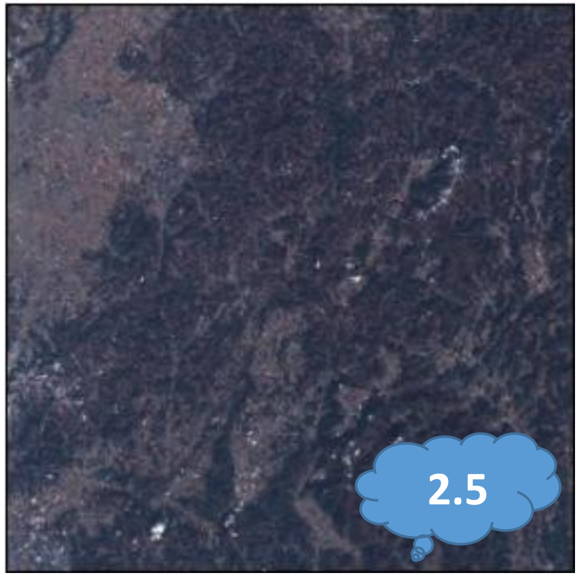


S2A_MSIL1C_20180207T02184

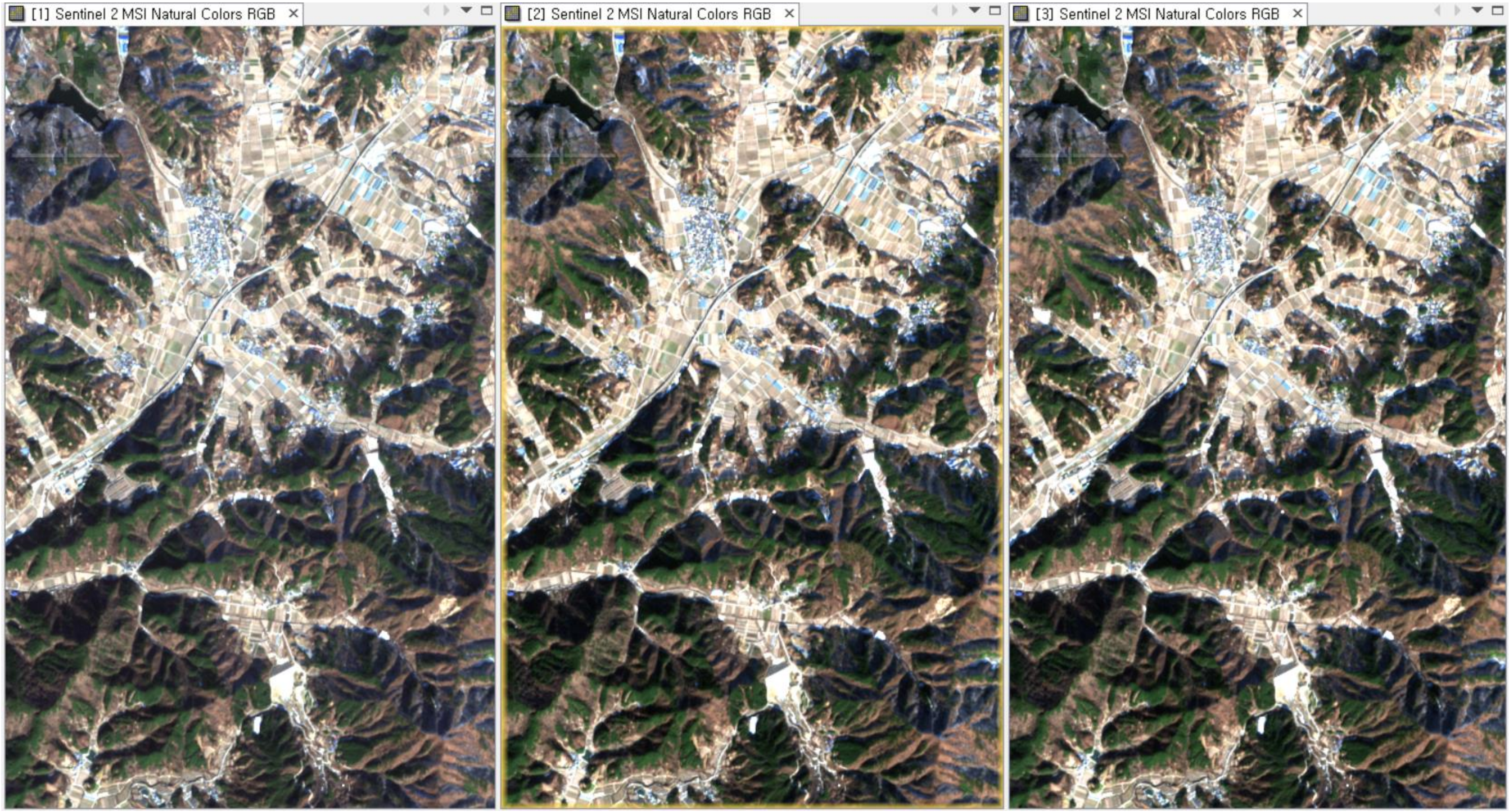
The cloud content of each images



S2A_MSIL1C_20180217T02174



S2B_MSIL1C_20181229T022109



TOA input image L1C

Atmospheric corrected BOA simulated L2A from L1C image

BOA L2A image from Hub (Results from ESA)

Figure TOA Level-1C image(left), associated Level-2A BOA image(center) generated using Sen2cor toolbox, and Level-2A BOA image(right) download from data Hub

(3rd January, 2019, Natural color, Cloud cover percentage 1.23%)

Methodology

Natural vegetation cover and agricultural crops are frequently the subjects of remote sensing studies. The information obtained in this way is a source of knowledge used **for monitoring and evaluating the Earth's vegetative cover**.

Using by **QGIS-SCP plugin and SNAP toolbox** explores classification using

The selected bands combination(SBc : specific bands combinations based classification)

Table 3 summarizes the individual characteristics of each of the 12 types of band combinations. In this paper, six types of band combinations were selected and used for vegetation analysis.

Explores classification based on vegetation indices

(VIs : vegetation indices based classification).

Twelve types of band combinations and it’s characteristics

R band	G band	B band	Characteristics
4	3	2	Natural Colors
8	4	3	False color Infrared
7	3	2	
12	11	4	False color (Urban)
7	3	10	
11	8	2	Agriculture
12	11	8a	Atmospheric penetration
8	11	2	Healthy vegetation
8	11	4	Land/Water
12	8	3	Natural Colors with Atmospheric Removal
12	8	4	Shortwave Infrared
11	8	4	Vegetation Analysis

Normalized Difference Vegetation Index : NDVI

$$NDVI = \frac{NIR - VIR}{NIR + VIR} = \frac{B8 - B4}{B8 + B4}$$

Equation for SENTINEL-2 NDVI

- > Water, 0<= Soil < 0.1, Vegetation > 0.1

Green Chlorophyll Index for Senescing Vegetation

$$CI_{green} = \frac{NIR}{Green} - 1 = \frac{B_8}{B_3} - 1$$

Equation for SENTINEL-2 CIgreen

This index eliminates **highly reflective senescing vegetation** using filtering tests on band 8/band 3 reflectance ratio. **Senescing vegetation** is highly reflective in NIR and more highly reflective in the green than green vegetation. **The band 8/band 3 reflectance ratio is higher for vegetation than for cloud** or other scene features.

https://sentinel.esa.int/web/sentinel/technical-guides/sentinel-2-msi/level-2a/algorithm

Results and Discussion

Specific Bands Combinations based Classification Comparison

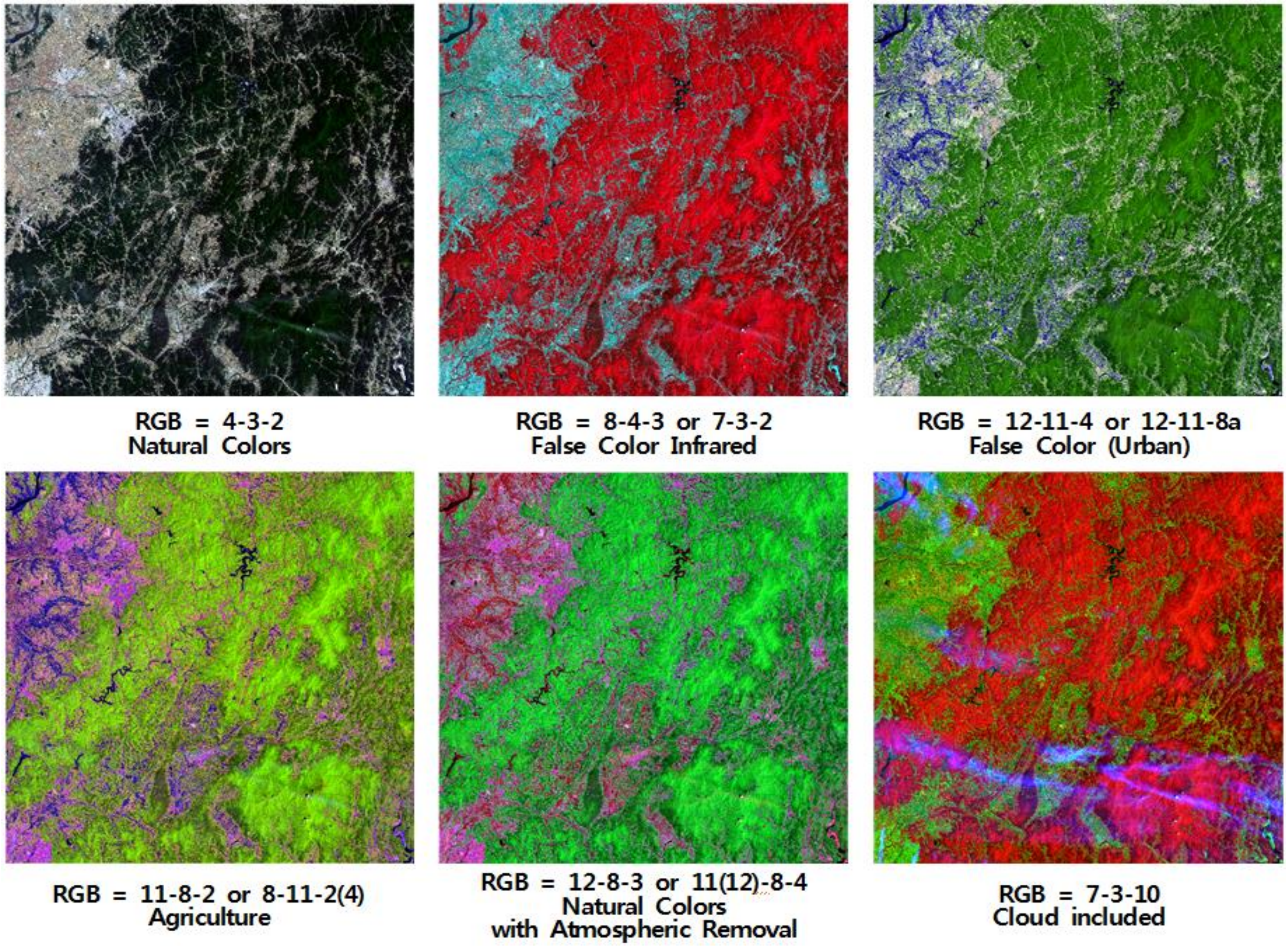
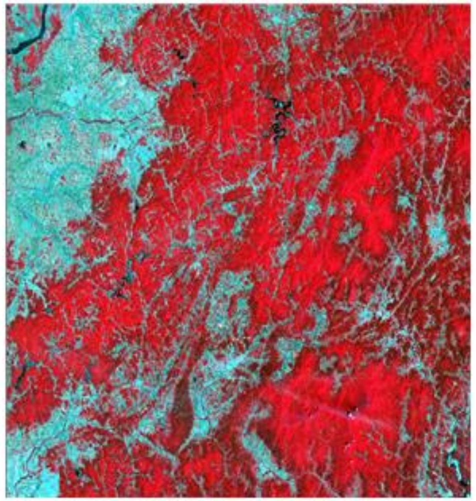


Figure 2.

Six kinds of Sentinel-2 images **bands combination** map calculated in **QGIS-SCP plugin**
(Cloud percentage = 1.97%, *results for 2nd June 2018*)

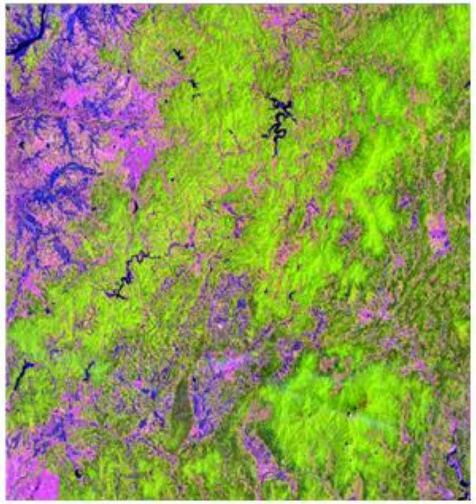
Specific Bands Combinations based Classification Comparison

RGB = 4-3-2 Natural Colors
by SNAP

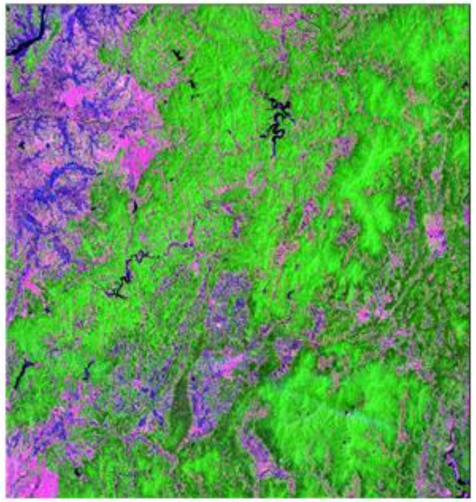


RGB = 8-4-3
False Color Infrared

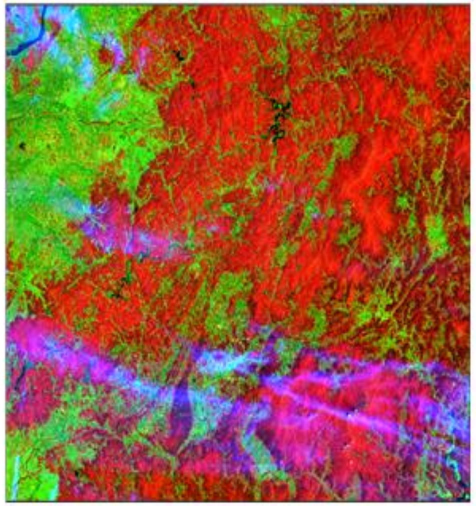
RGB = 12-11-4
False Color (Urban)



RGB = 11-8-2 or 8-11-2(4)
Agriculture



RGB = 12-8-3 or 11(12)-8-4
Natural Colors
with Atmospheric Removal



RGB = 7-3-10
Cloud included

Figure 3.

Six kinds of Sentinel-2 images **bands combination** maps calculated in **SNAP scientific toolbox.**
(Cloud percentage = 1.97%,
Results for 2nd June 2018)

Vegetation Indices based Classification Comparison

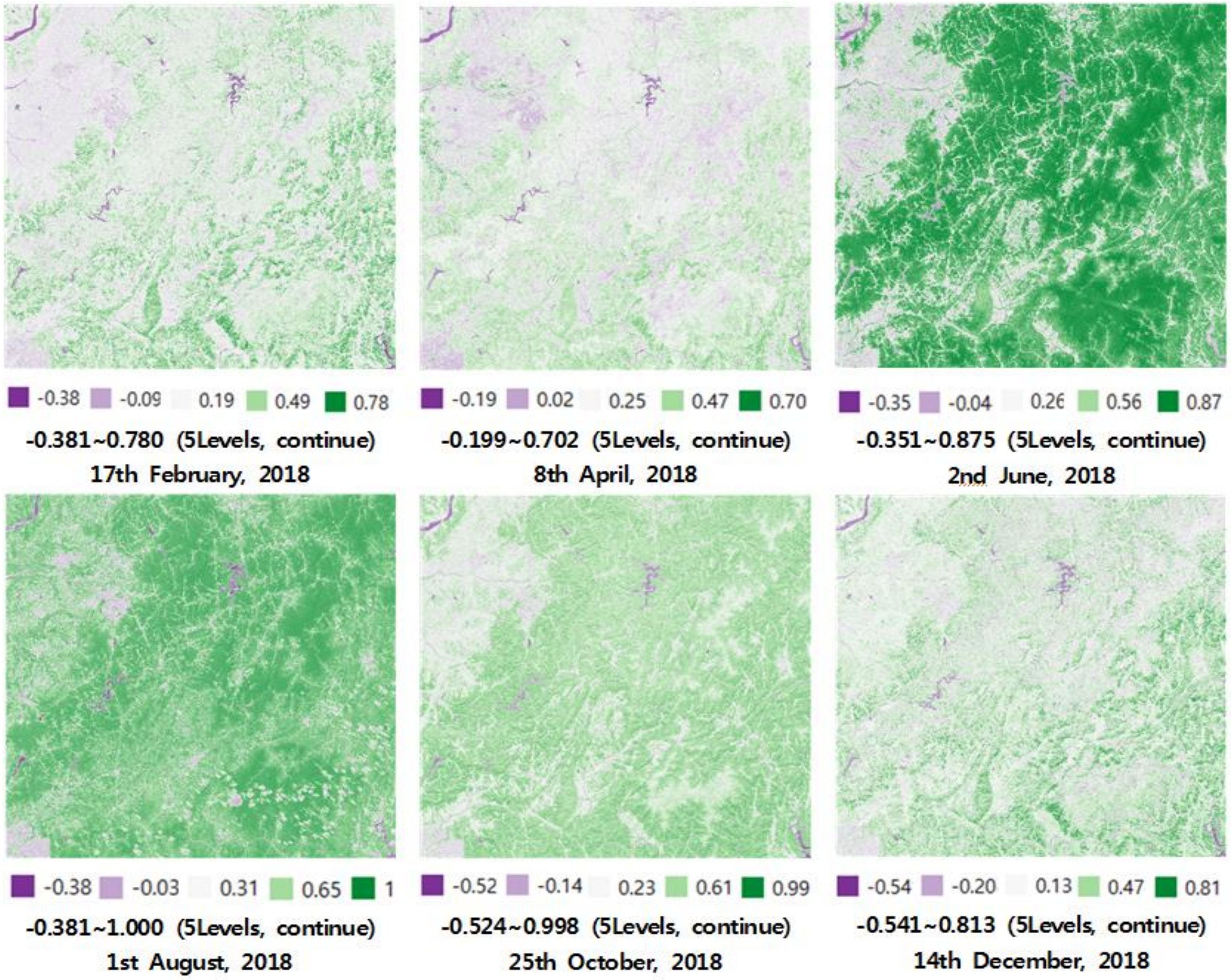


Figure 4.

Four-season time-series **NDVI** map distribution **calculated by QGIS-SCP plugin** in 2018 year

The distribution of the NDVI index in June **ranges from -0.351 to 0.875**, while the vegetation index in August **ranges from -0.381 to 1.000**, indicating improved vegetation vitality.

Vegetation Indices based Classification Comparison

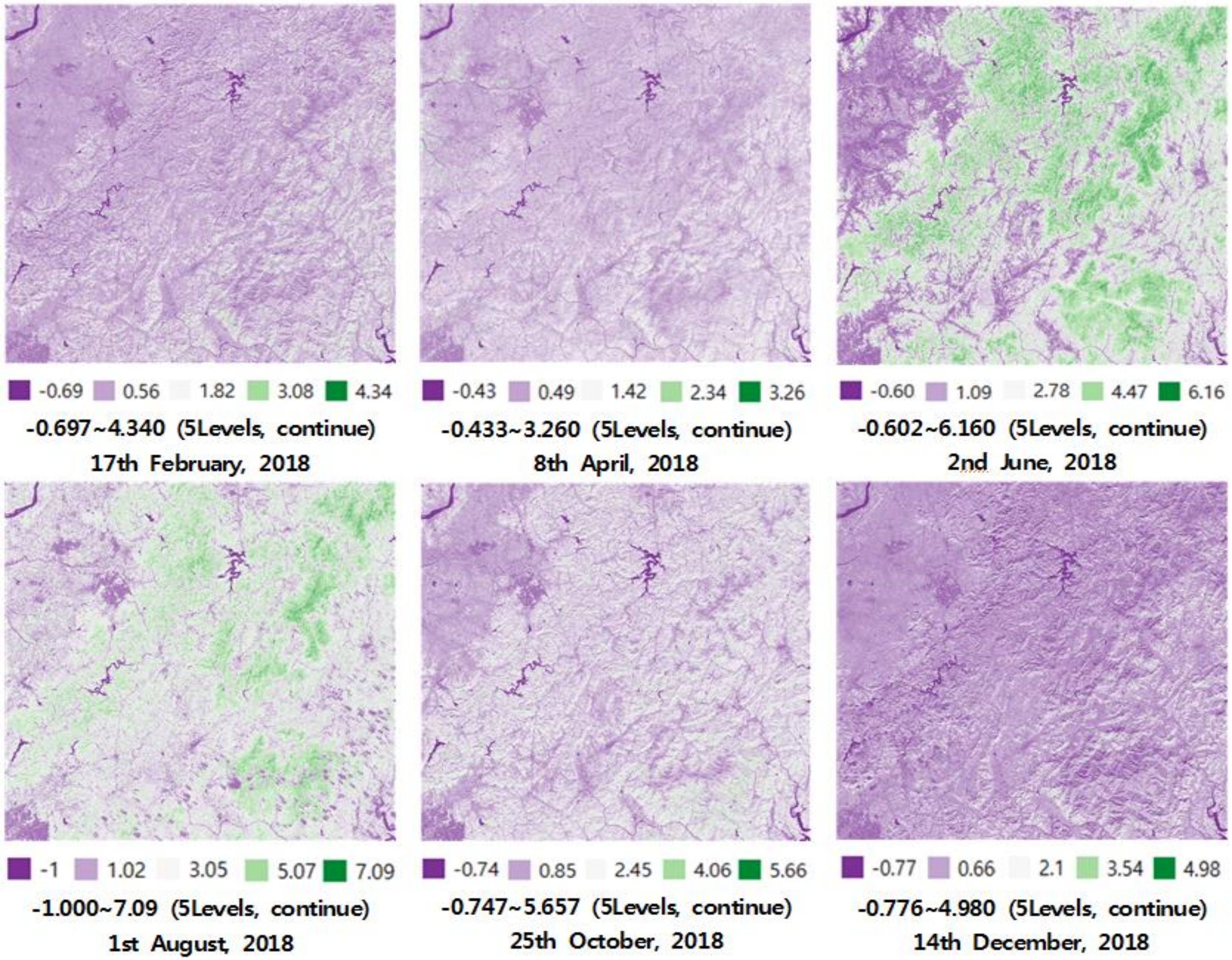


Figure 5.

Four-season time-series **CIgreen index** map distribution calculated by **QGIS-SCP plugin** in 2018 year

The following figure 5 shows **CIgreen vegetation index map by QGIS-SCP** analysis.

Although the seasonal classification status is less than the NDVI vegetation index described above, but **the overall trend is similar to the NDVI vegetation distribution**.

Vegetation Indices based Classification Comparison

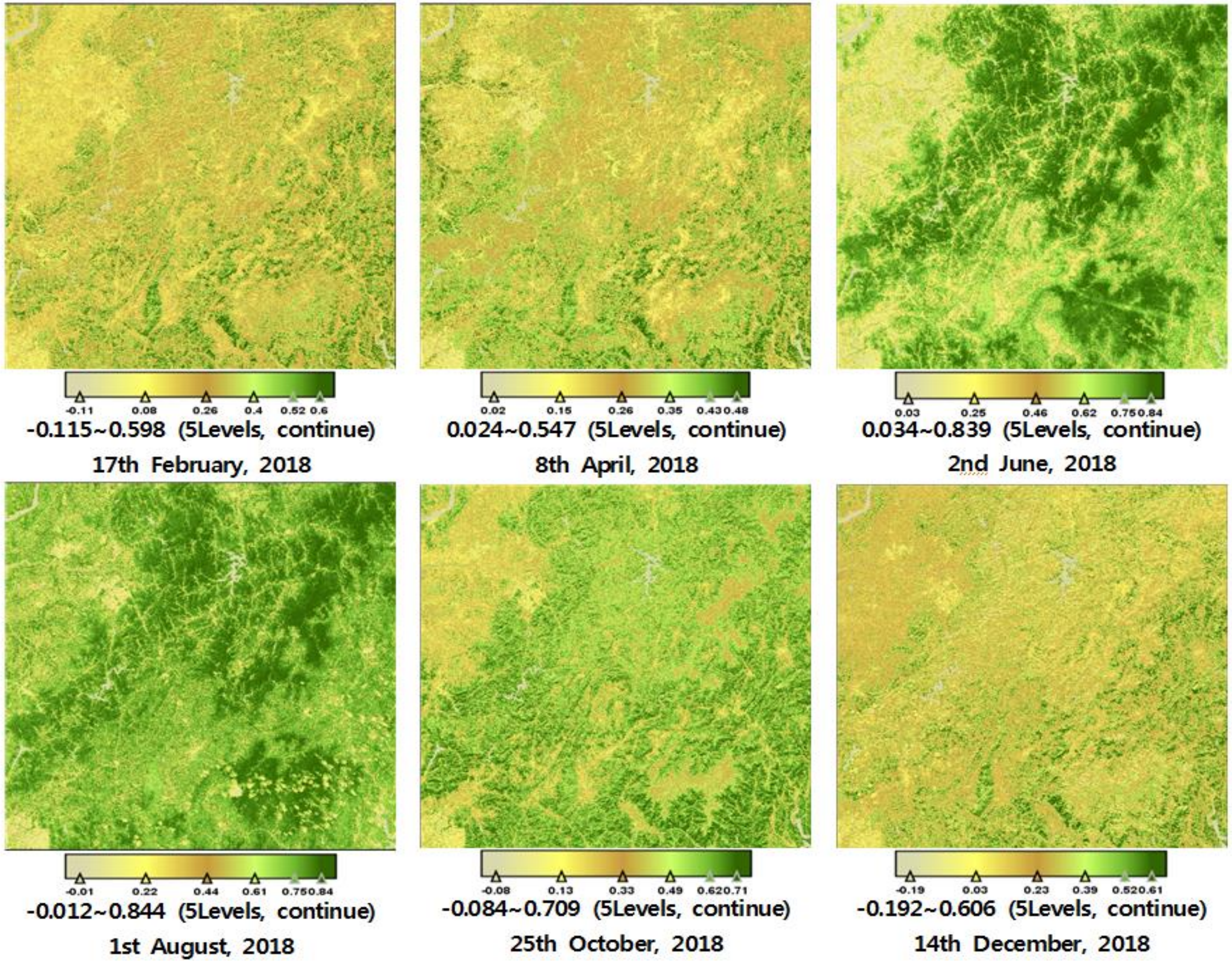


Figure 6.

Four-season time-series Sentinel-2 images **NDVI** map calculated by **SNAP** in 2018 year

The distribution of the NDVI index in June **ranges from 0.034 to 0.839**, while the vegetation index in August **ranges from -0.012 to 0.844**, indicating improved vegetation vitality.

Vegetation Indices based Classification Comparison

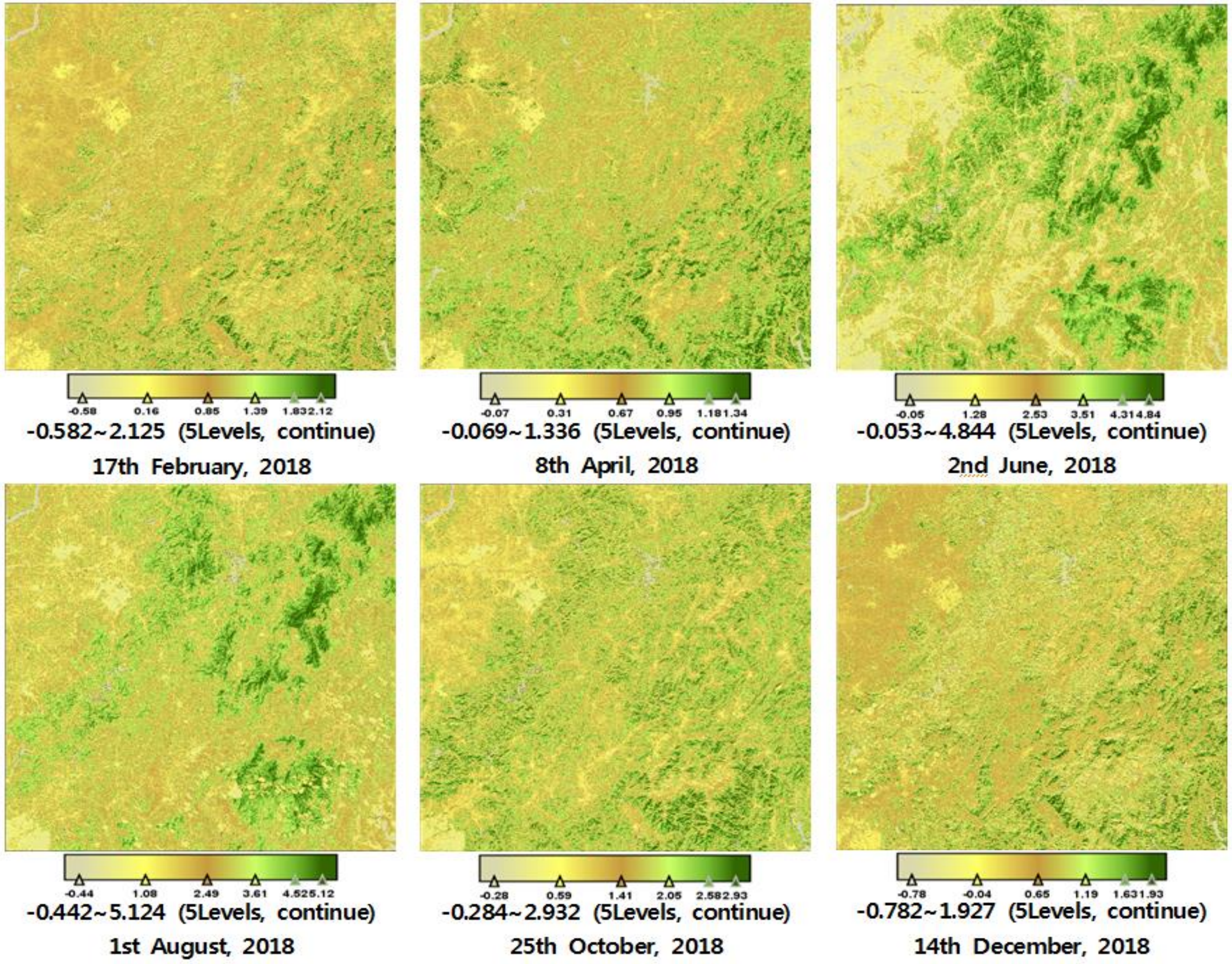
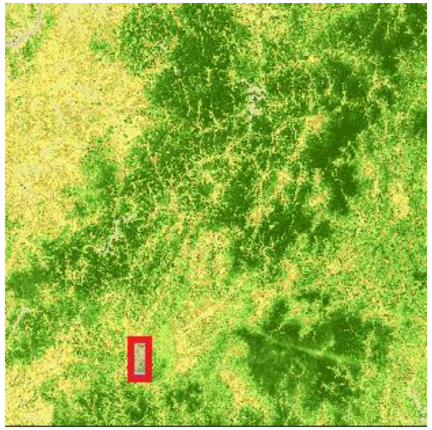
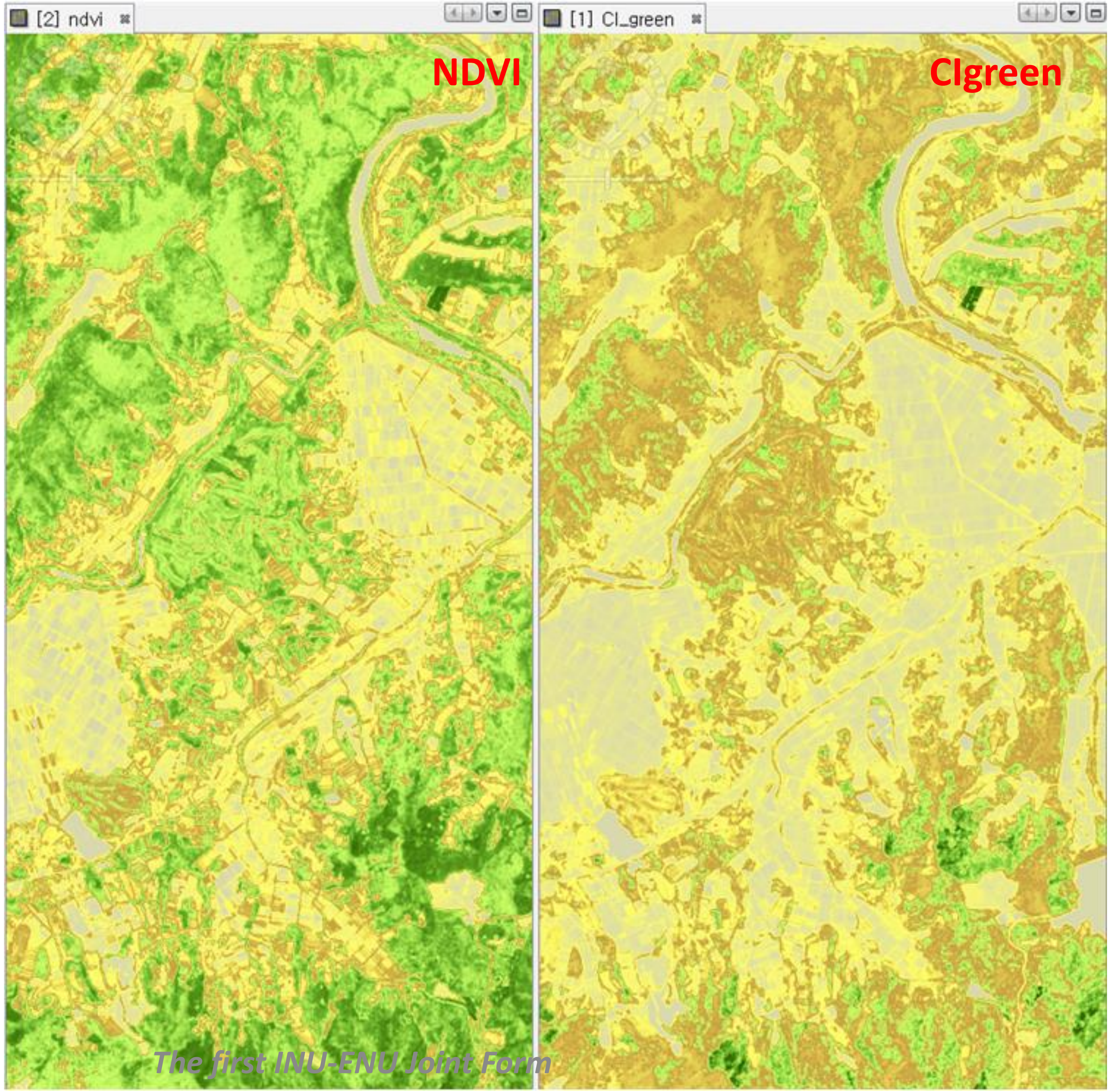


Figure 7.

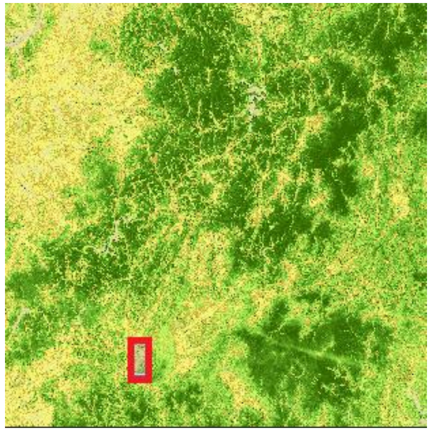
Four-season time-series Sentinel-2 images **CIgreen** index map calculated by **SNAP** in 2018 year

Figure 7 shows CIgreen vegetation index map by SNAP toolbox analysis. Although there are some factors depending on the type of color template and the number of grade intervals, but the overall trend is similar to the NDVI vegetation distribution by SNAP.





Enlarged map of
NDVI (left) and
CIgreen(right)
vegetation indices
distribution
by SNAP toolbox
at the red square area
of study site
on June 2, 2018



Enlarged map of **NDVI (left) and CIgreen(right)** vegetation indices distribution **by QGIS SCP** at the red square area of study site on June 2, 2018

Conclusions and Recommendation

This study **presents an evaluation of the application to the national agricultural policy and the utilization of smart scientific farming for farmer** from consideration of the time series distribution of the vegetation index at the field test for the western part of South Korea with the open source toolkits.

As shown in the various vegetation analysis, **the distribution of NDVI and CIgreen vegetation index and the seasonal fluctuation trends of indices by QGIS** **showed similar results to that of SNAP**, **could confirmed the availability of the QGIS open-source image analysis tool.**

Therefore, QGIS and Sentinel satellite images are **expected to be utilized as effective public interpretation tools and as information to confirm the status of vegetation in terms of both national and private farmers.**

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