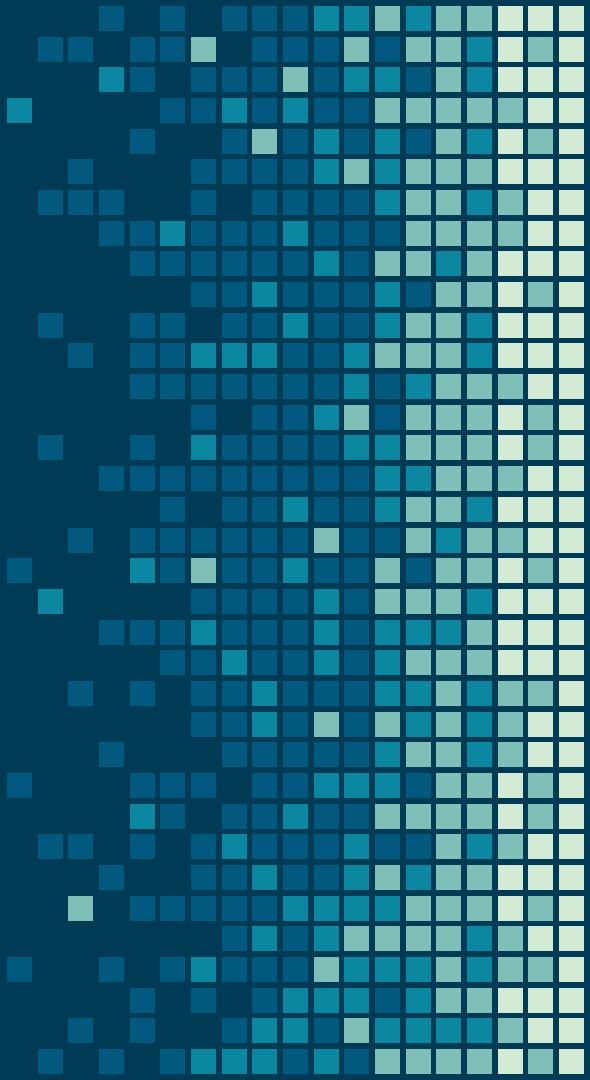
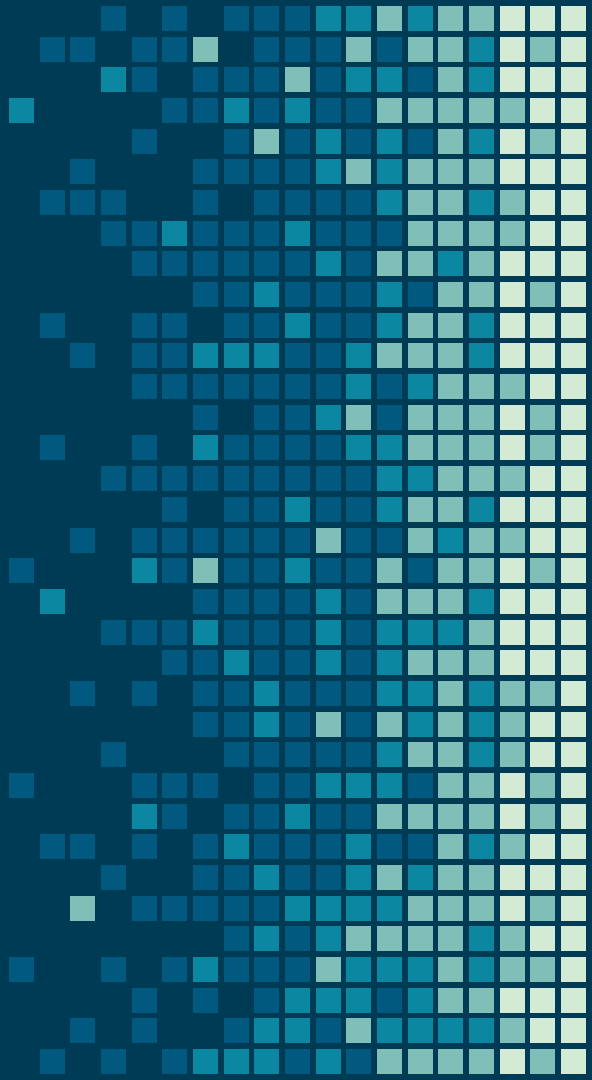
CHLORIS GEOSPATIAL:

reliable natural capital data



Outline:

1. Introduction: client
2. Goal:
    - Problem: client's request
    - Motivation: why are we doing this
3. Data: what are we working with
    - GeoTIFF, satellite images
4. Results
    - App Software
    - Expected results
        - Band graph
    - R package (optional): only if we have time
5. Next steps
    - The application create
    - Chloris leads to a better future



1.
INTRODUCTION

Our client


Chloris Geospatial
Access biomass data for any project, forest,
or land area anywhere on Earth

ABOUT CHLORIS GEOSPATIAL

- 2021 local startup consisting of experts in ecological science, machine learning, and sustainability strategy
- Provides data for companies taking action to practice forestry in their supply chains
- Measures carbon stock anywhere in the world
  - Def: amount of stored carbon
- Mission: accelerate global transition to a **net-zero**, **sustainable** economy

OUR CLIENT

Dr. Alessandro Baccini

Co-Founder and CSO

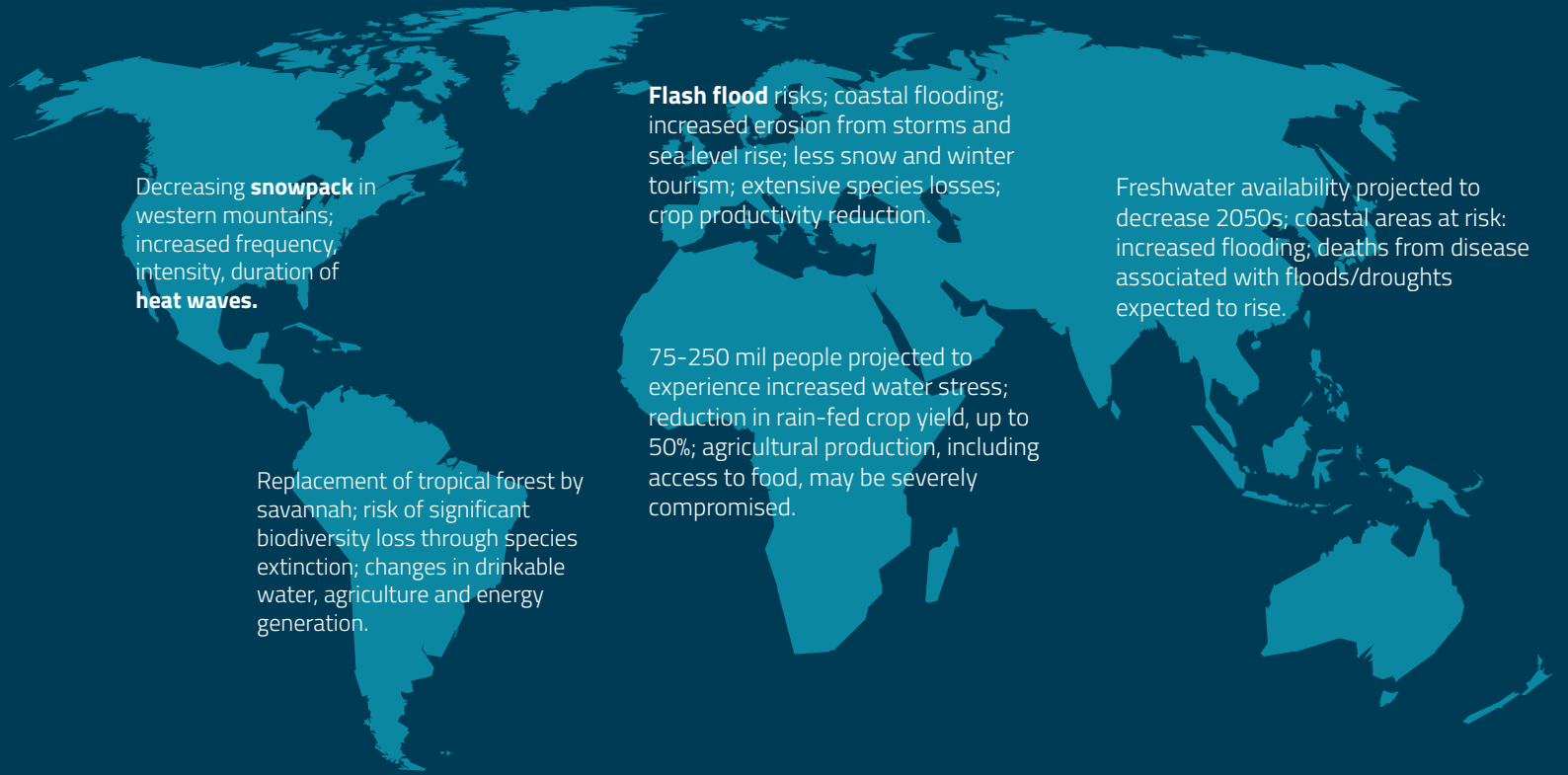
Research Professor at the Center for Remote Sensing, Boston University. Member of the NASA Carbon Monitoring System Science Team.

2.
THE ULTIMATE GOAL

CLIENT'S REQUEST

- Application software for visualizing progression of forests over time
  - Pixel by pixel
- Band Values vs. time
  - Band graph combines QA value
- Quality Assessment Graph
  - Analyze pixels to distinguish the type of landform

LONG-TERM CLIMATE CHANGE EFFECTS



Decreasing **snowpack** in western mountains; increased frequency, intensity, duration of **heat waves.**

Flash flood risks; coastal flooding; increased erosion from storms and sea level rise; less snow and winter tourism; extensive species losses; crop productivity reduction.

Freshwater availability projected to decrease 2050s; coastal areas at risk: increased flooding; deaths from disease associated with floods/droughts expected to rise.

75-250 mil people projected to experience increased water stress; reduction in rain-fed crop yield, up to 50%; agricultural production, including access to food, may be severely compromised.

Replacement of tropical forest by savannah; risk of significant biodiversity loss through species extinction; changes in drinkable water, agriculture and energy generation.

PARIS AGREEMENT

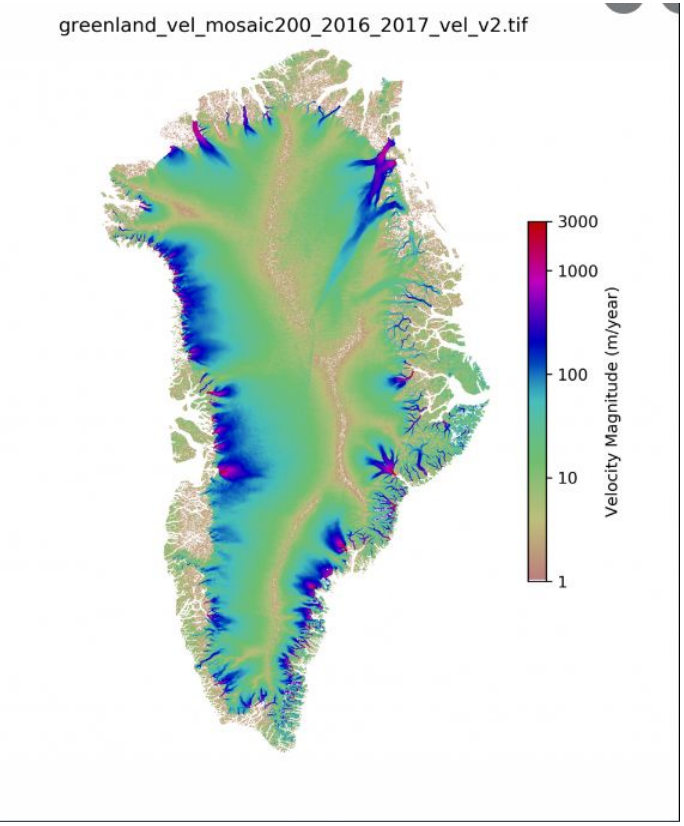
The goal to reach net zero by 2050

3.
DATA DESCRIPTION

Landsat 8, GeoTIFF and QA bits

SOME BACKGROUND: landsat 8

Landsat 8 was launched on an Atlas-V rocket on February 11, 2013. The satellite carries the Operational Land Imager (OLI, 9 spectral bands) and the Thermal Infrared Sensor (TIRS, 2 spectral bands) instruments. In Landsat 8 Full Scenes data in MTL format, each band will have a GeoTIFF file and metadata



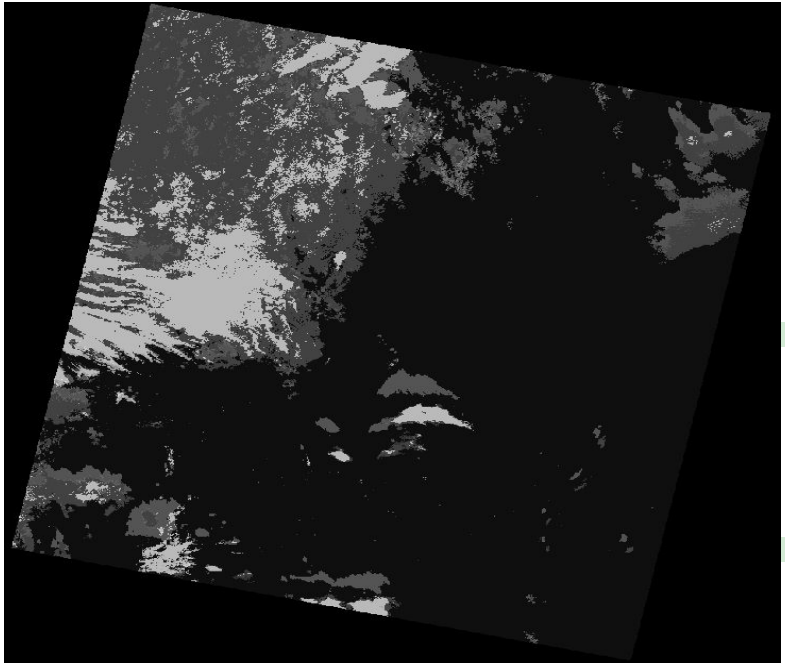
Geotiff example

What is Geotiff

GeoTIFF is a public domain metadata standard which has the georeferencing information embedded within the image file. The georeferencing information is included by way of tiff tags that contains spatial information about the image file such as map projection and coordinate systems.

Quality Assessment

Quality Assessment (QA) bands help to evaluate the overall usefulness of a Landsat pixel. Each pixel in the QA band contains an integer value that represents bit-packed combinations of surface, atmospheric, and sensor conditions that can affect the individual pixel quality.



This is an example of a Quality Assessment (QA) Band image.

Landsat 8 OLI/TIRS Collection 1 Level-1 Quality Assessment Band Attribute and Pixel Value Possibilities	
Attribute	**Pixel Value**
Fill	1
Terrain Occlusion	2, 2722
Clear	2720, 2724, 2728, 2732
Radiometric Saturation - 1-2 bands	2724, 2756, 2804, 2980, 3012, 3748, 3780, 6820, 6852, 6900, 7076, 7108, 7844, 7876
Radiometric Saturation - 3-4 bands	2728, 2760, 2808, 2984, 3016, 3752, 3784, 6824, 6856, 6904, 7080, 7112, 7848, 7880
Radiometric Saturation - 5+ bands	2732, 2764, 2812, 2988, 3020, 3756, 3788, 6828, 6860, 6908, 7084, 7116, 7852, 7884
Cloud	2800, 2804, 2808, 2812, 6896, 6900, 6904, 6908
Cloud Confidence - Low	2720, 2722, 2724, 2728, 2732, 2976, 2980, 2984, 2988, 3744, 3748, 3752, 3756, 6816, 6820, 6824, 6828, 7072, 7076, 7080, 7084, 7840, 7844, 7848, 7852
Cloud Confidence - Medium	2752, 2756, 2760, 2764, 3008, 3012, 3016, 3020, 3776, 3780, 3784, 3788, 6848, 6852, 6856, 6860, 7104, 7108, 7112, 7116, 7872, 7876, 7880, 7884
Cloud Confidence - High	2800, 2804, 2808, 2812, 6896, 6900, 6904, 6908
Cloud Shadow - High	2976, 2980, 2984, 2988, 3008, 3012, 3016, 3020, 7072, 7076, 7080, 7084, 7104, 7108, 7112, 7116
Snow/Ice - High	3744, 3748, 3752, 3756, 3776, 3780, 3784, 3788, 7840, 7844, 7848, 7852, 7872, 7876, 7880, 7884
Cirrus Confidence - Low	2720, 2722, 2724, 2728, 2732, 2752, 2756, 2760, 2764, 2800, 2804, 2804, 2808, 2812, 2976, 2980, 2984, 2988, 3008, 3012, 3016, 3020, 3744, 3748, 3752, 3756, 3780, 3784, 3788

What are QA Bits

The bit-packed information in the QA bands is a translation of binary strings.Used effectively, QA bits help improve the integrity of Landsat-derived science investigations by indicating which pixels might be affected by surface conditions, cloud contamination, or sensor conditions.

Landsat Collection 1 LandsatLook 8-bit Quality Images Designations						
Landsat 8 OLI/TIRS		Landsat 7 ETM+, Landsat 4-5 TM		Landsat 1-5 MSS		Color
Bit	Description	Bit	Description	Bit	Description	
0	Designated Fill	0	Designated Fill	0	Designated Fill	
1	Terrain Occlusion	1	Dropped Pixel	1	Dropped Pixel	
2	Radiometric Saturation	2	Radiometric Saturation	2	Radiometric Saturation	
3	Cloud	3	Cloud	3	Cloud	
4	Cloud Shadow	4	Cloud Shadow	4	Unused	
5	Snow/Ice	5	Snow/Ice	5	Unused	
6	Cirrus	6	Unused	6	Unused	
7	Unused	7	Unused	7	Unused	Unused

Landsat 8 OLI, OLI/TIRS Collection 1 QA band bits; Read from RIGHT to LEFT, starting with Bit 0																
Cumulative Sum																
	65553	32767	16383	8191	4095	2047	1023	511	255	127	63	31	15	7	3	1
BIT	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Description				Cirrus Confidence		Snow/Ice Confidence		Cloud Shadow Confidence		Cloud Confidence		Cloud	Radiometric Saturation		Terrain Occlusion	Designated Fill

The pixel values in the Level-1 QA band must be translated into 16-bit binary form to be used effectively.

For the single bits (0, 1, and 4):

0 = "No" = This condition does not exist

1 = "Yes" = This condition exists

For radiometric saturation bits (2-3), represent how many bands contain saturation:

00 - No bands contain saturation

01 - 1-2 bands contain saturation

10 - 3-4 bands contain saturation

11 - 5 or more bands contain saturation

For the remaining double bits (5-6, 7-8, 9-10, 11-12), represent levels of confidence that a condition exists:

00 = “Not Determined”

01 = “Low”

10 = “Medium”

11 = “High”

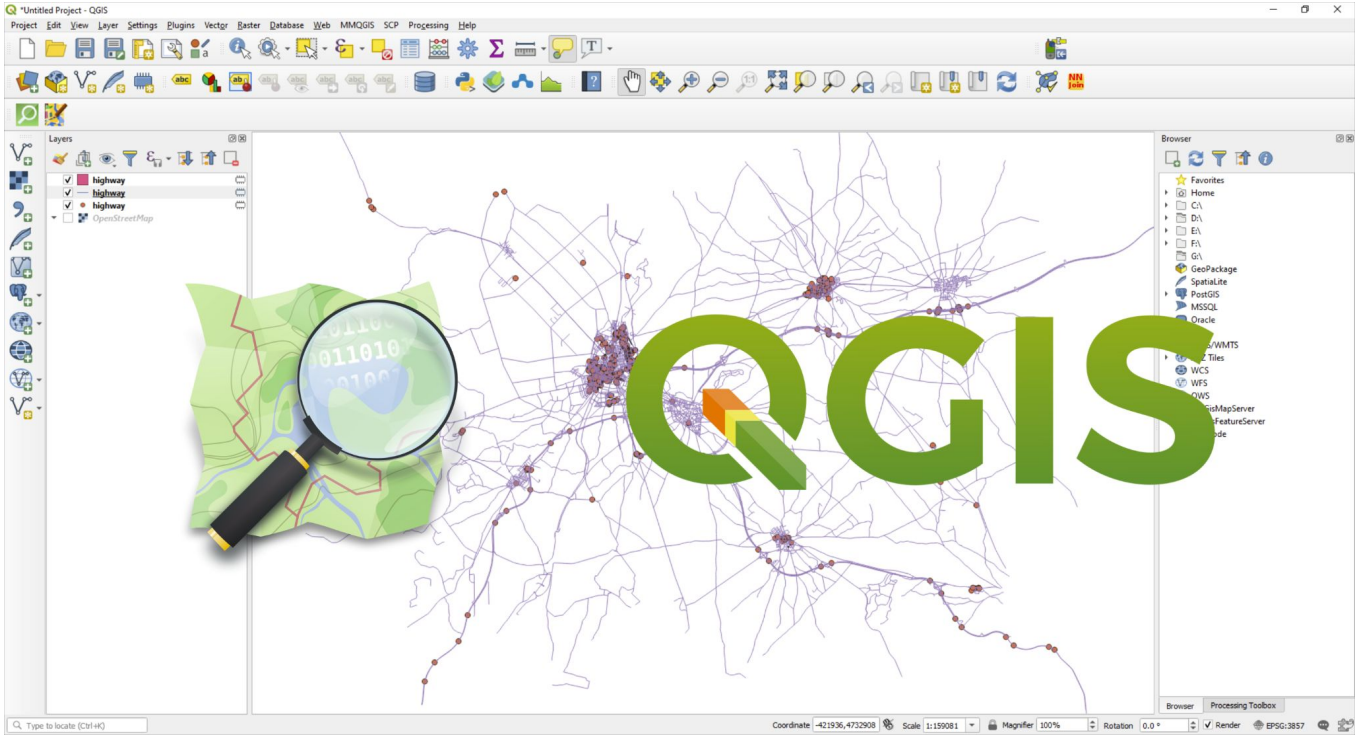
Landsat 8 OLI, OLI/TIRS Collection 1 QA band bits; Read from RIGHT to LEFT, starting with Bit 0															
Cumulative Sum	65553	32767	16383	8191	4095	2047	1023	511	255	127	63	31	15	7	3	1
BIT	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Description				Cirrus Confidence		Snow/Ice Confidence		Cloud Shadow Confidence		Cloud Confidence		Cloud	Radiometric Saturation		Terrain Occlusion	Designated Fill

4.
EXPECTED RESULTS

Software

OUR PROCESS

QGIS

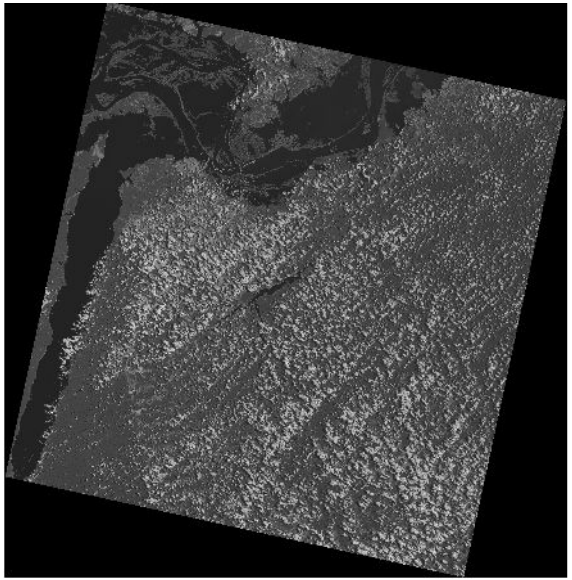

*Untitled Project - QGIS
Project Edit View Layer Settings Plugins Vector Raster Database Web MMQGIS SCP Processing Help
Layers
highway
highway
highway
OpenStreetMap
Browser
Favorites
Home
GeoPackage
SpatiaLite
PostGIS
MSSQL
Oracle
WCS
WFS
Browser
Processing Toolbox
QGIS

Band Picture

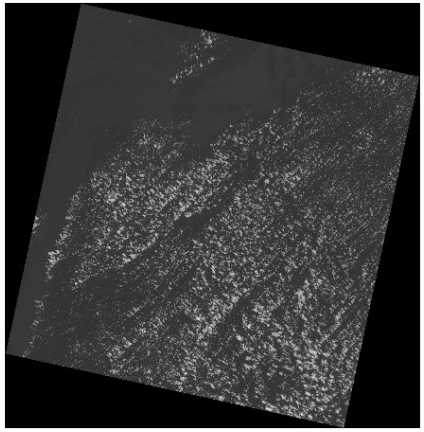
ONE DAY (e.g. 2021.09.15)

ONE PLACE (path 227, row 62)

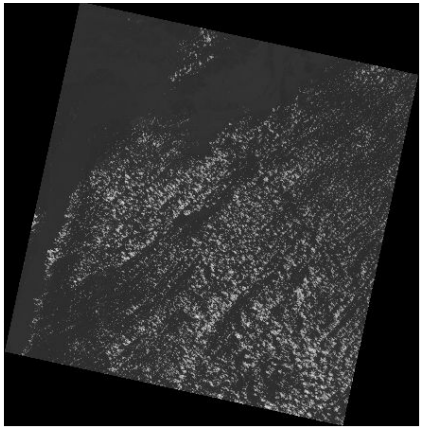
BAND 1 —--- BAND 7
(Automatic identification by QGIS for Landsat 8 data)



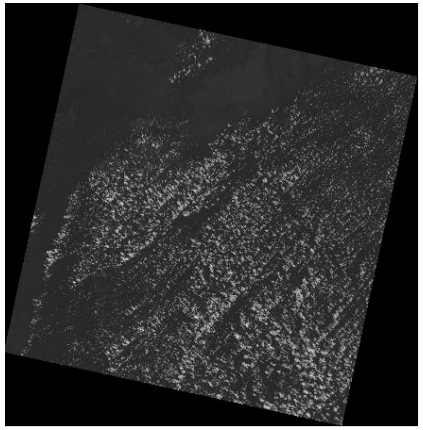
Band 6



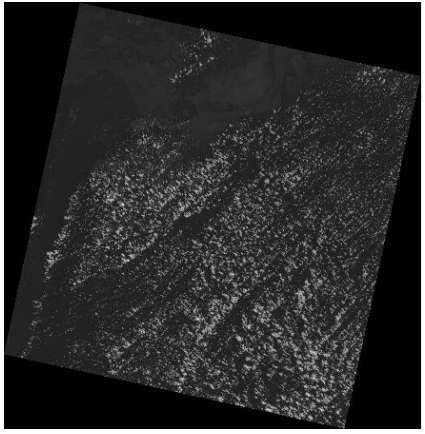
Band 1



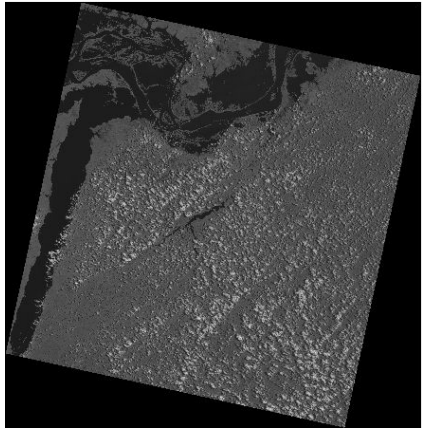
Band 2



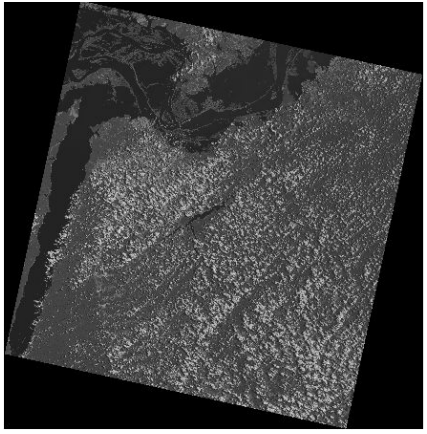
Band 3



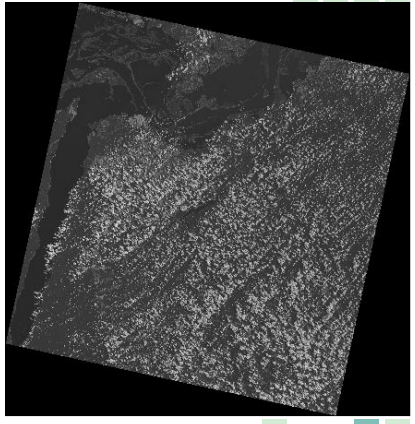
Band 4



Band 5



Band 6



Band 7

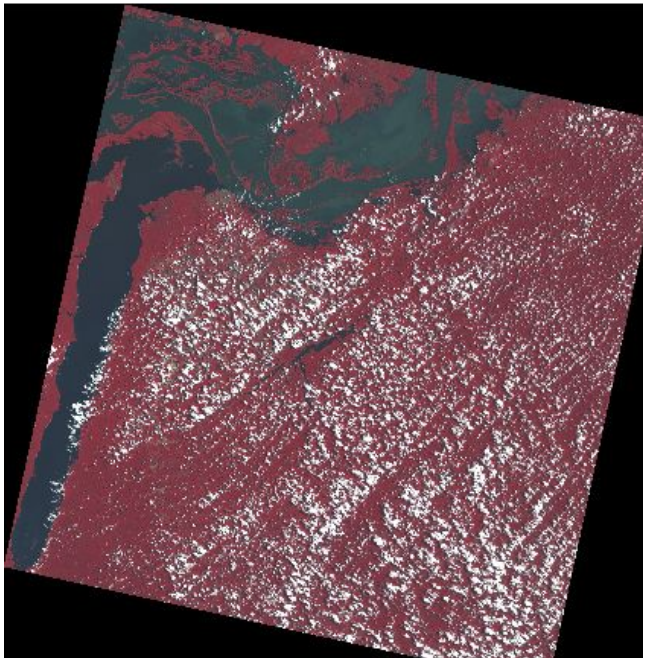
multispectral image(MS)

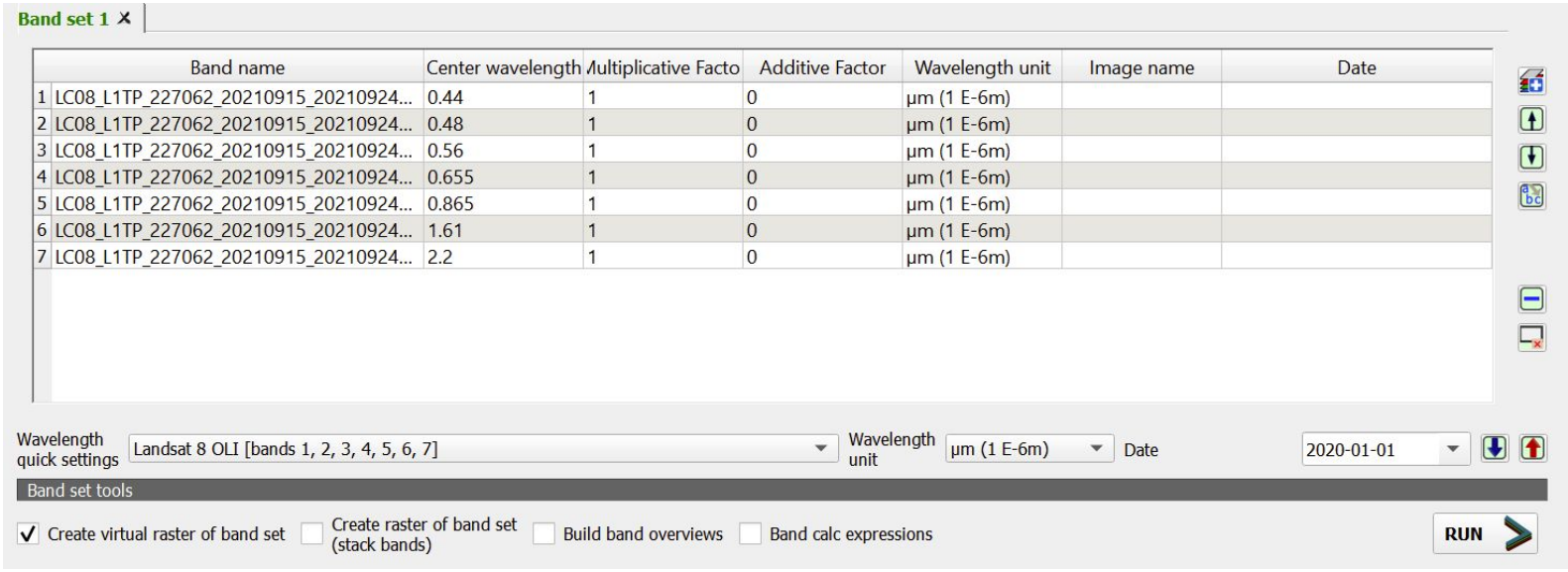
BLUE BAND(B) 0.45 - 0.52 um

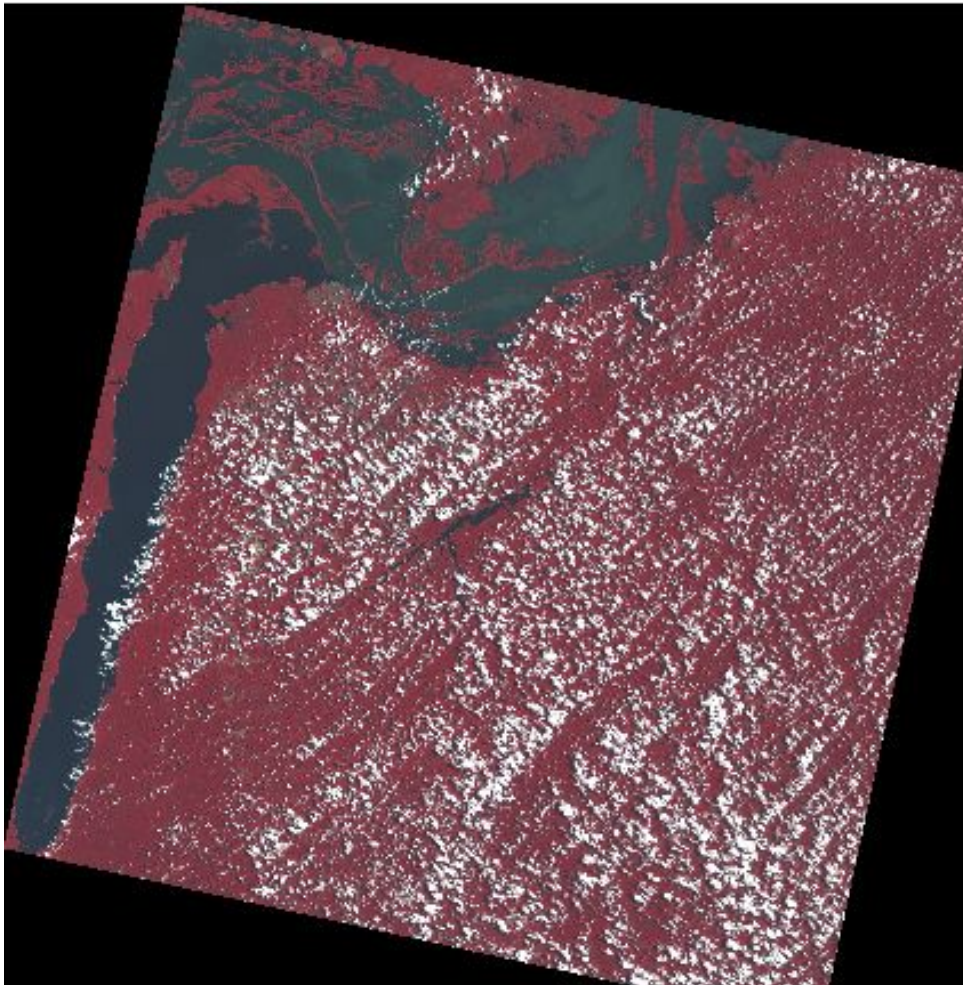
GREEN BAND(G) 0.52 - 0.60 um

RED BAND(R) 0.63 - 0.69 um

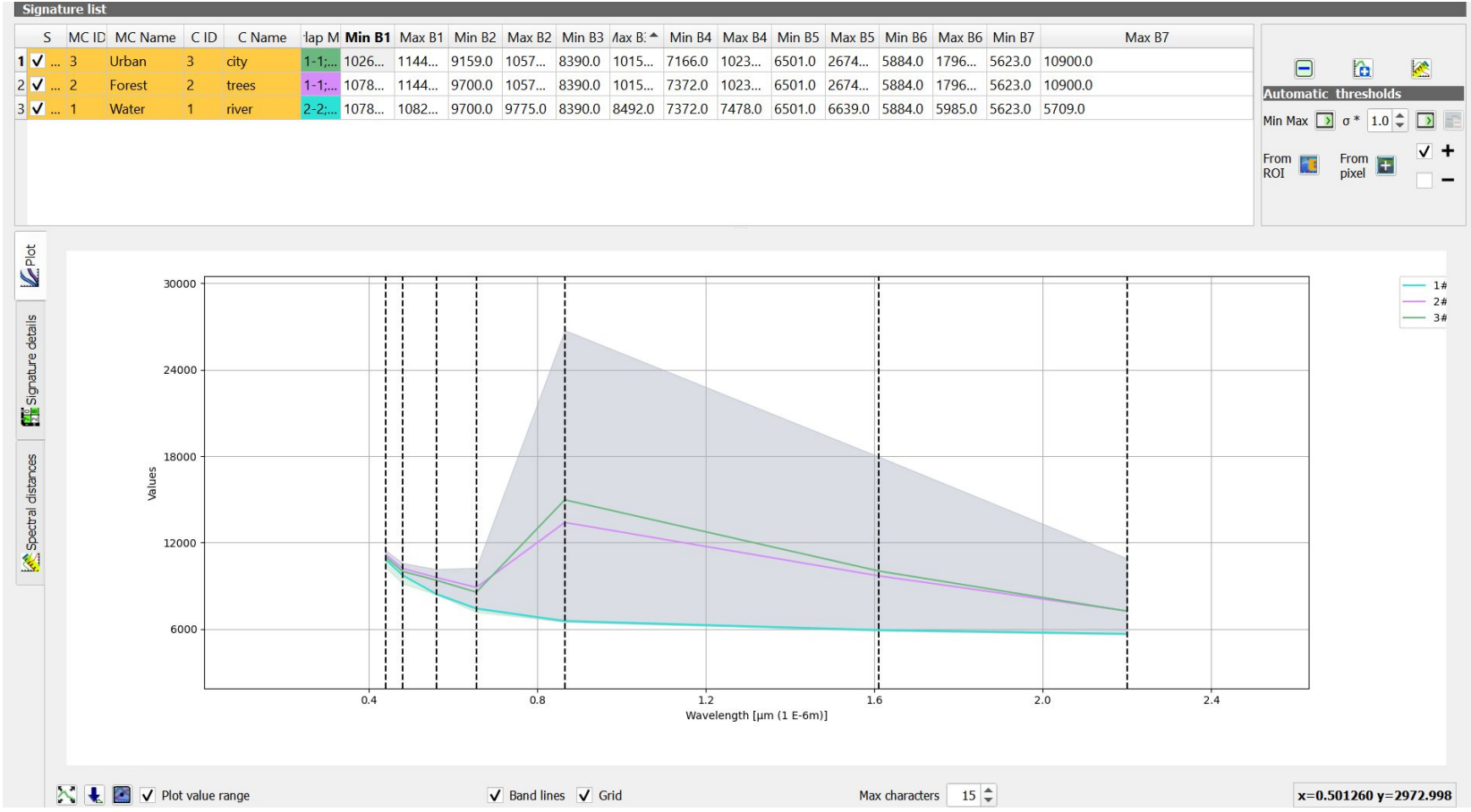
NEAR-INFRARED BAND (IR) 0.76 - 0.90 um




Band set 1
Band name
Center wavelength
Multiplicative Facto
Additive Factor
Wavelength unit
Image name
Date
1 LC08_L1TP_227062_20210915_20210924... 0.44 1 0 µm (1 E-6m)
2 LC08_L1TP_227062_20210915_20210924... 0.48 1 0 µm (1 E-6m)
3 LC08_L1TP_227062_20210915_20210924... 0.56 1 0 µm (1 E-6m)
4 LC08_L1TP_227062_20210915_20210924... 0.655 1 0 µm (1 E-6m)
5 LC08_L1TP_227062_20210915_20210924... 0.865 1 0 µm (1 E-6m)
6 LC08_L1TP_227062_20210915_20210924... 1.61 1 0 µm (1 E-6m)
7 LC08_L1TP_227062_20210915_20210924... 2.2 1 0 µm (1 E-6m)
Wavelength quick settings
Landsat 8 OLI [bands 1, 2, 3, 4, 5, 6, 7]
Wavelength unit
µm (1 E-6m)
Date
2020-01-01
Band set tools
Create virtual raster of band set
Create raster of band set (stack bands)
Build band overviews
Band calc expressions
RUN



BAND PLOT


Signature list
S
MC ID
MC Name
C ID
C Name
Min B1
Max B1
Min B2
Max B2
Min B3
Min B4
Max B4
Min B5
Max B5
Min B6
Max B6
Min B7
Max B7
1 ... 3 Urban 3 city 1026... 1144... 9159.0 1057... 8390.0 1015... 7166.0 1023... 6501.0 2674... 5884.0 1796... 5623.0 10900.0
2 ... 2 Forest 2 trees 1078... 1144... 9700.0 1057... 8390.0 1015... 7372.0 1023... 6501.0 2674... 5884.0 1796... 5623.0 10900.0
3 ... 1 Water 1 river 1078... 1082... 9700.0 9775.0 8390.0 8492.0 7372.0 7478.0 6501.0 6639.0 5884.0 5985.0 5623.0 5709.0
Automatic thresholds
Min Max
σ *
1.0
From ROI
From pixel
Plot
Signature details
Spectral distances
30000
24000
18000
12000
6000
Values
0.4
0.8
1.2
1.6
2.0
2.4
Wavelength [µm (1 E-6m)]
1#
2#
3#
Plot value range
Band lines
Grid
Max characters
15
x=0.501260 y=2972.998

5.
NEXT STEPS

Further development

- **shiny** in R/implement the data create an interactive **application**
- users select **location**, **time**, **band**/show ts graph of the **land features**
- provide the **organization**/come up with the efficient **strategy**/climate change effects.

US EPA ❌

Government ❌

politicians ❌

super hero ❌

TEAM CHLORIS ✅

THANKS!

Any questions?

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Team 3: Cathy Feng, Christine Liu, Qihan Su, Lucy Wang, Kelly Xu, Tong Sun