

# Semi-supervised Classification of Images

In Python

And C++

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# Welcome to Python online and DS CoP!



- Everyone welcome
- Check out the code together session!
- Volunteer to do a presentation or demo?
- Please join the channels and participate in chats and events
- Door is always open.. Feedback / comments / input anytime pls.!
- Thanks for coming

# Overview



- **Some context**
  - Tools, FTL MVP project
- **ML Approach**
  - Keep it simple and accessible!
    - » As possible....
- **Try simple examples and iterate...**
  - Will need more detailed approach in future..
    - » Trade-off between accessibility and good results / performance!

# Tools



BC Wildfire  
Service

Choices can be subjective.. Build your own triangle! Where I like to play:

R project

Math & Stats

Scientists?

Computing science

Python

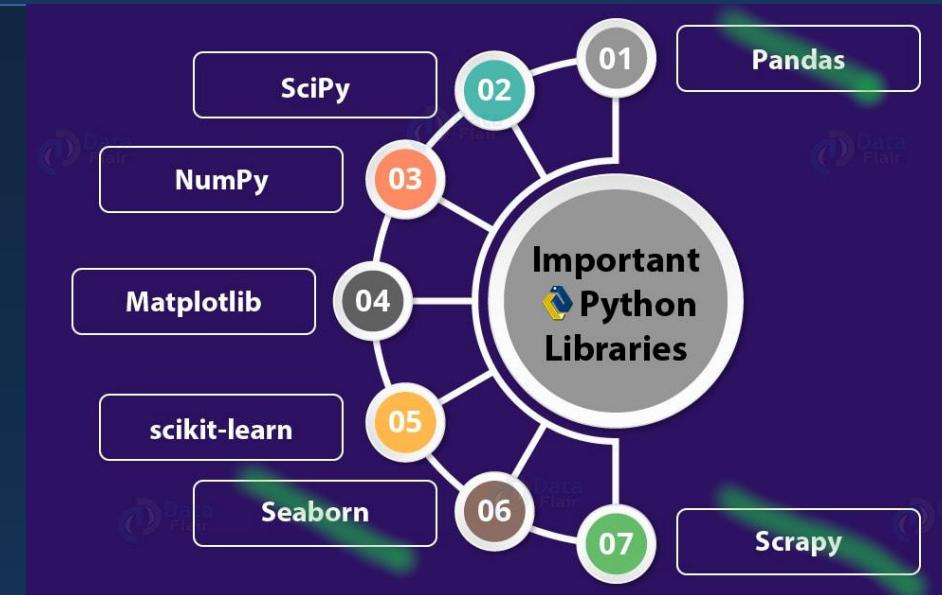
Engineers?

Business

C / C++

Math / stats used to be  
matlab / SPSS?

Comp Sci taught Java before..



Starting to use snappy as in  
ESA SNAP (for radar)..



# FTL MVP pilot project



- Satellite imagery collected for Telegraph Creek, BC
- Field data collected by Senior Fire Protection Officer
- New fuels information produced using in-house minimum viable product (MVP) software
- Fire simulations performed to assess impact of new info products, for operational decision making



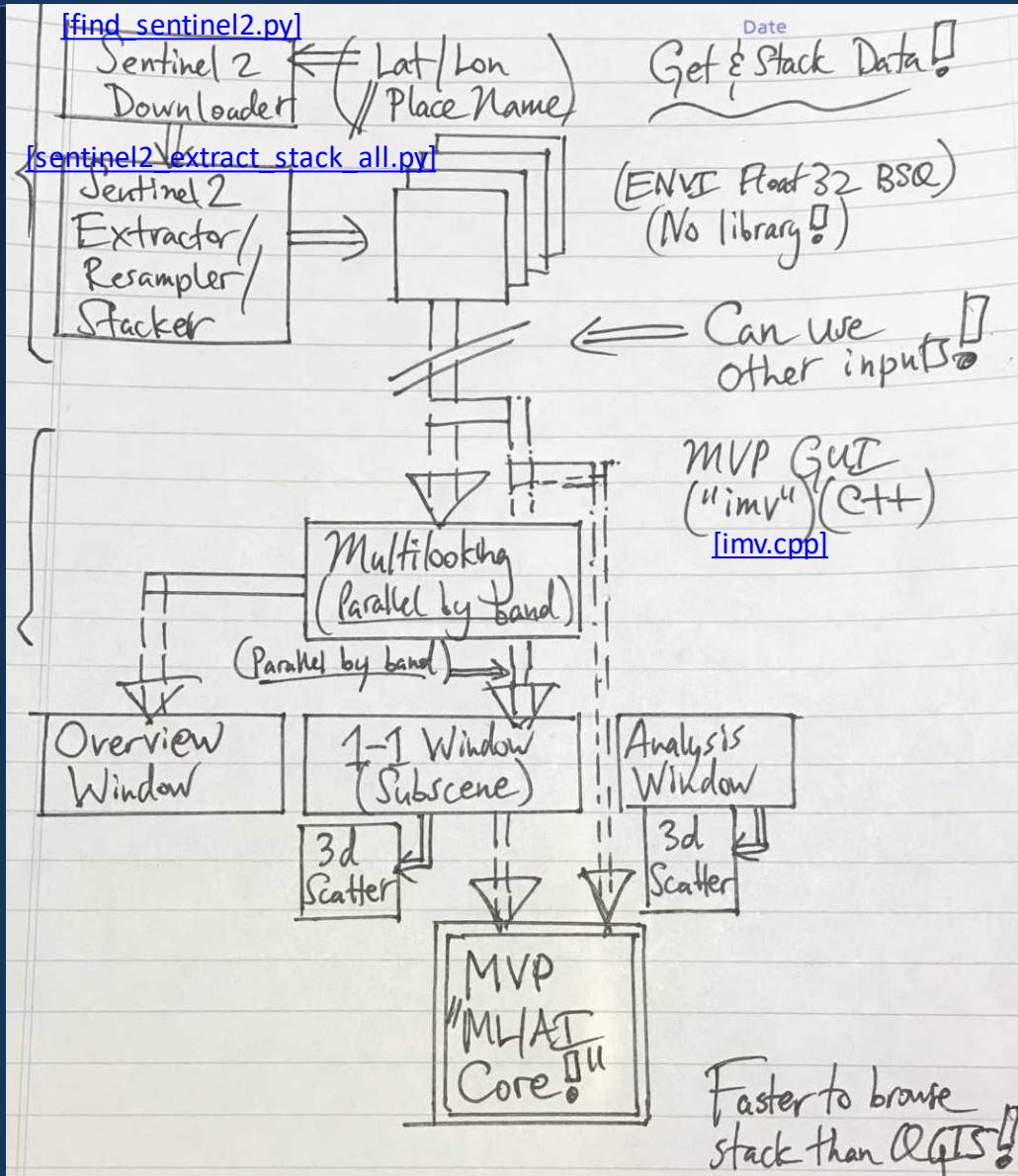
# MVP Software

To support:

- BC Wildfire Service staff to evaluate new satellite data sources in combination with observed field data
- Machine Learning methods to map wide areas of the Province
- Improved fire science understanding of landscape changes:
  - to inform enhanced planning and direction of fuel management activities, for years in advance



# MVP Software: GUI



[something is growing there now: telegraph creek]  
[seeing the unseen with multispectral: telegraph creek]  
[Sentinel-2 10m RGB: telegraph creek]

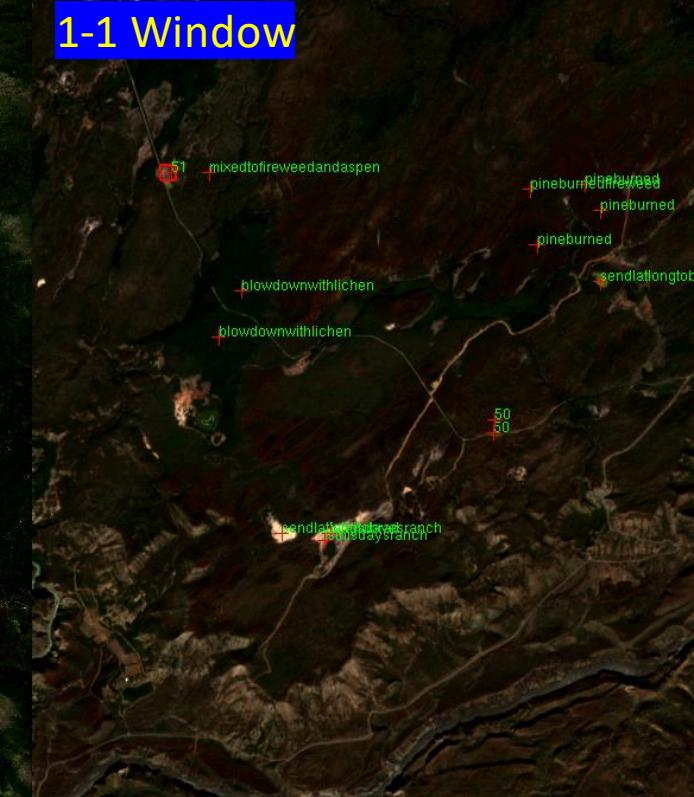


BC Wildfire Service

Overview Window



1-1 Window



Analysis Window



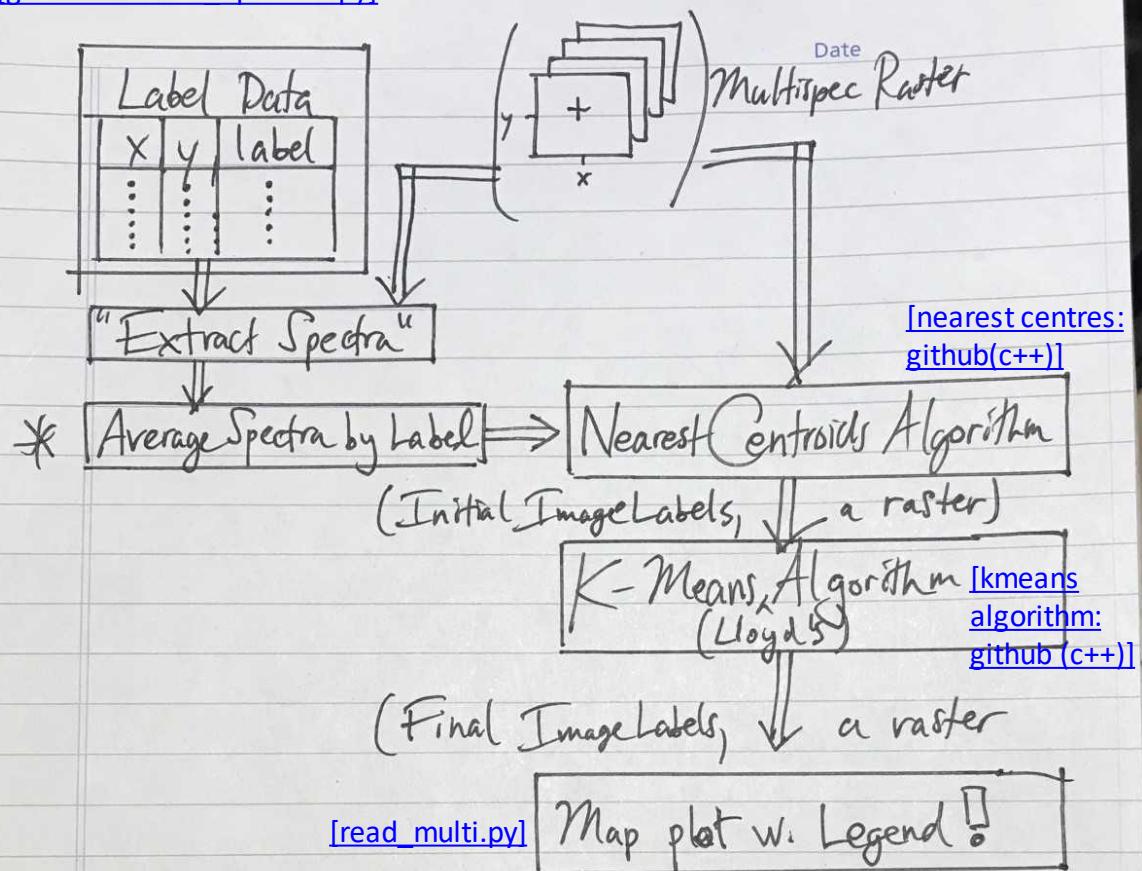
Analysis 3d Scatter

# MVP Software: "ML/AL core"



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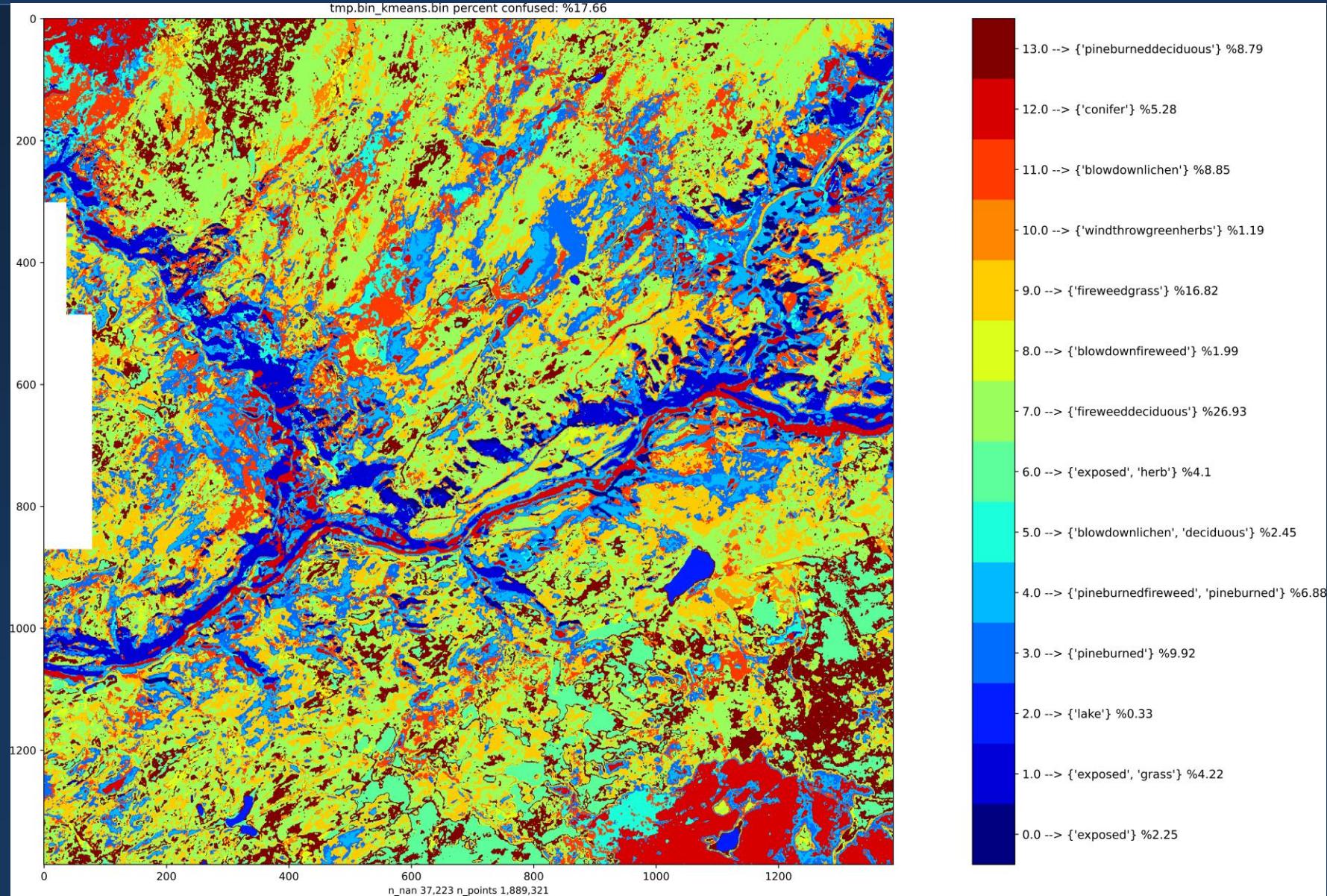
[github: kmeans\_optimize.py]



# Results: Telegraph Creek Study



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20210303 DMBID  
20210209 FBCOP

# Fire Simulation: VRI-based FTL



Image © 2021 Maxar Technologies  
© 2021 Google  
Image Landsat / Copernicus

Google Earth

58°04'31.60" N 130°59'15.61" W elev 639 m eye alt 4.79 km

# Fire Simulation: FTL project



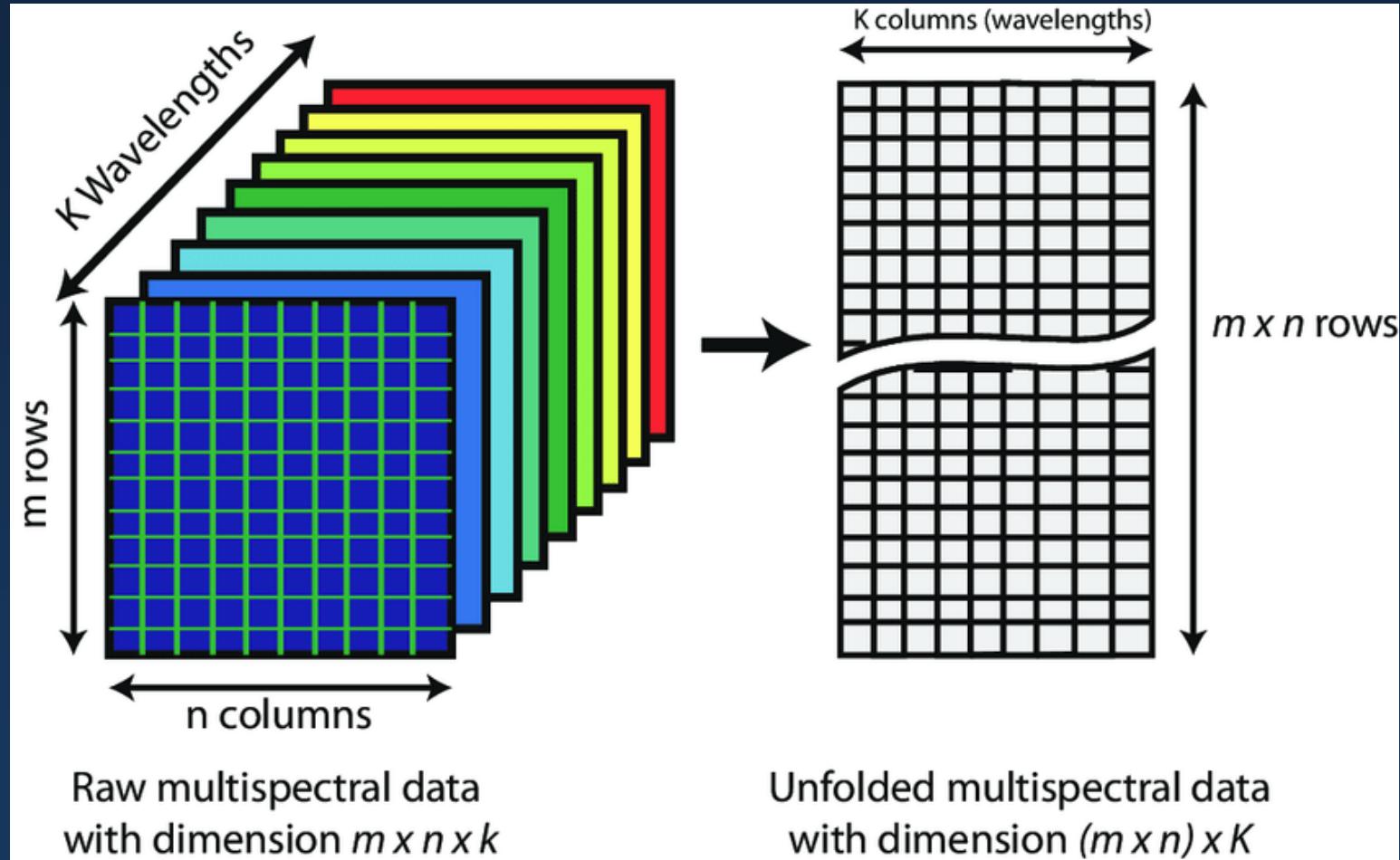
Image © 2021 Maxar Technologies  
© 2021 Google  
Image Landsat / Copernicus

58°04'26.36" N 130°59'19.76" W elev 631 m eye alt 4.79 km

# Multispectral data



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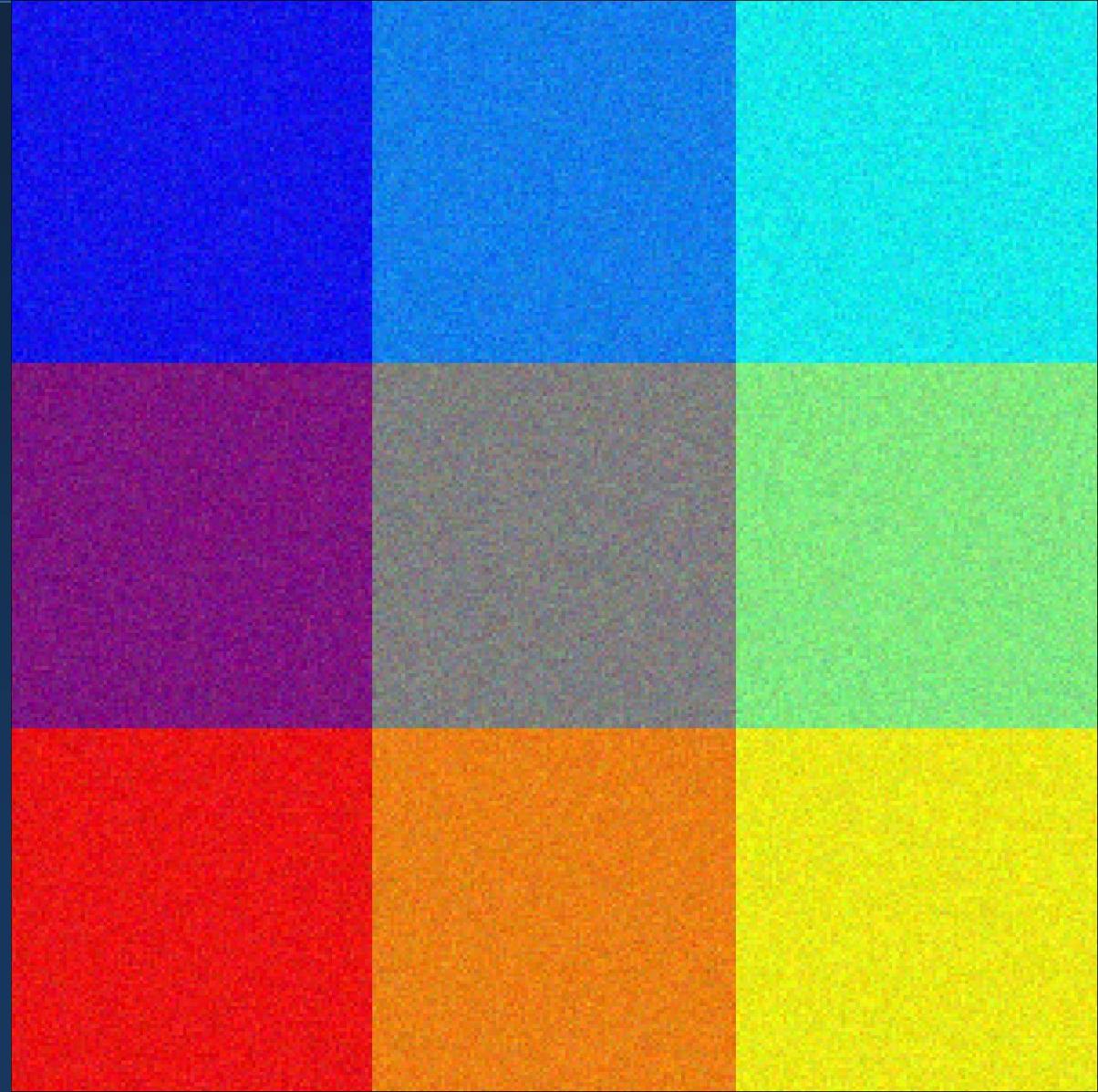
# Synthetic Data



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[raster synthetic data.py]

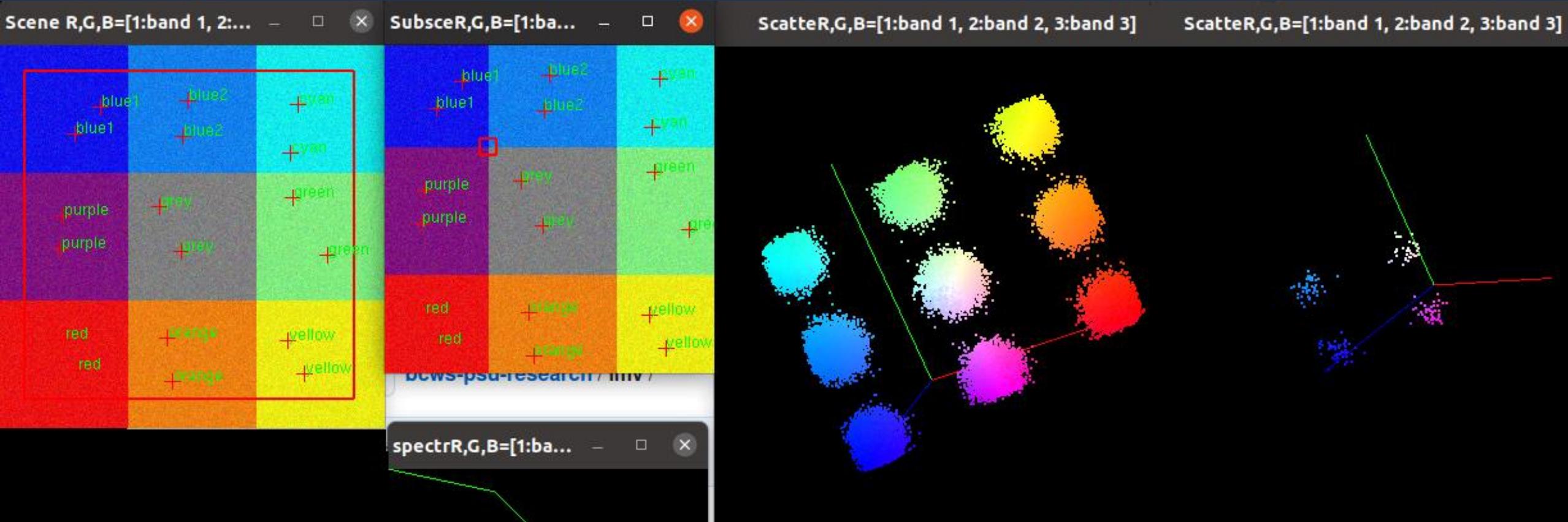
```
25 # simulate the multi/hyperspectral data bands
26 for k in range(0, nb):
27     for i in range(0, L):
28         for j in range(0, L):
29             bi = math.floor(i / nwin)
30             if((k % nsq) == 1): bi = math.floor(j / nwin)
31             if((k % nsq) == 2): bi = math.floor((L - i - 1) / nwin)
32             d[ci] = np.random.normal((bi -.5 / n_class), sigma)
33             ci += 1
34
35 for k in range(0, n_class):
36     for i in range(0, L):
37         for j in range(0, L):
38             class_i = (math.floor(i / nwin) * nsq) + math.floor(j / nwin)
39             d[ci] = (1. if (class_i == float(k)) else 0.)
40             ci += 1
41
```



# Synthetic Data



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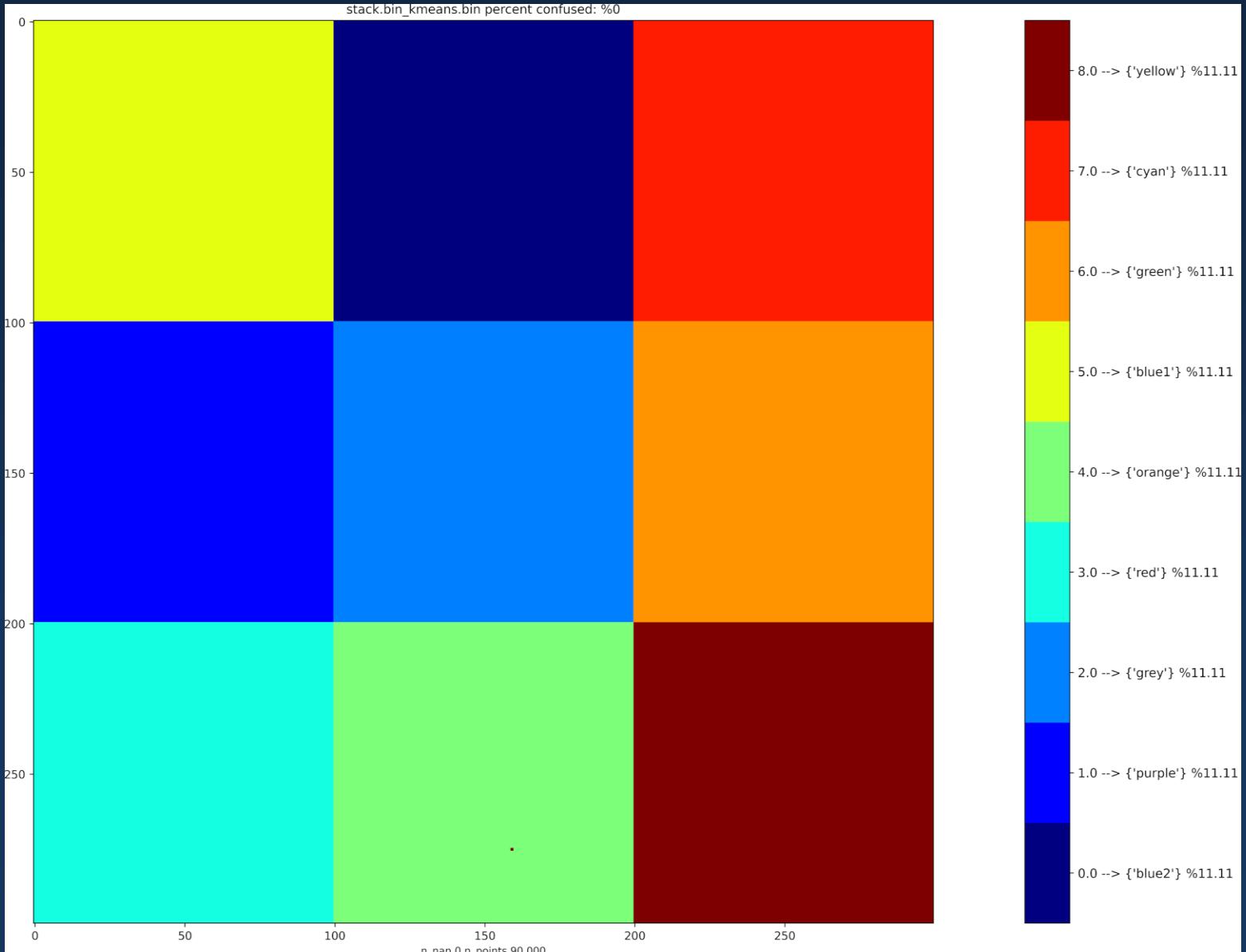


1. Click on subscene window at location.
2. type a [label] <return> to add a label
3. type k to classify on subscene, or kk to classify on full scene

# Synthetic Data



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Ok the robot can stand  
up...  
..Let's make it fall over!

# Chess example



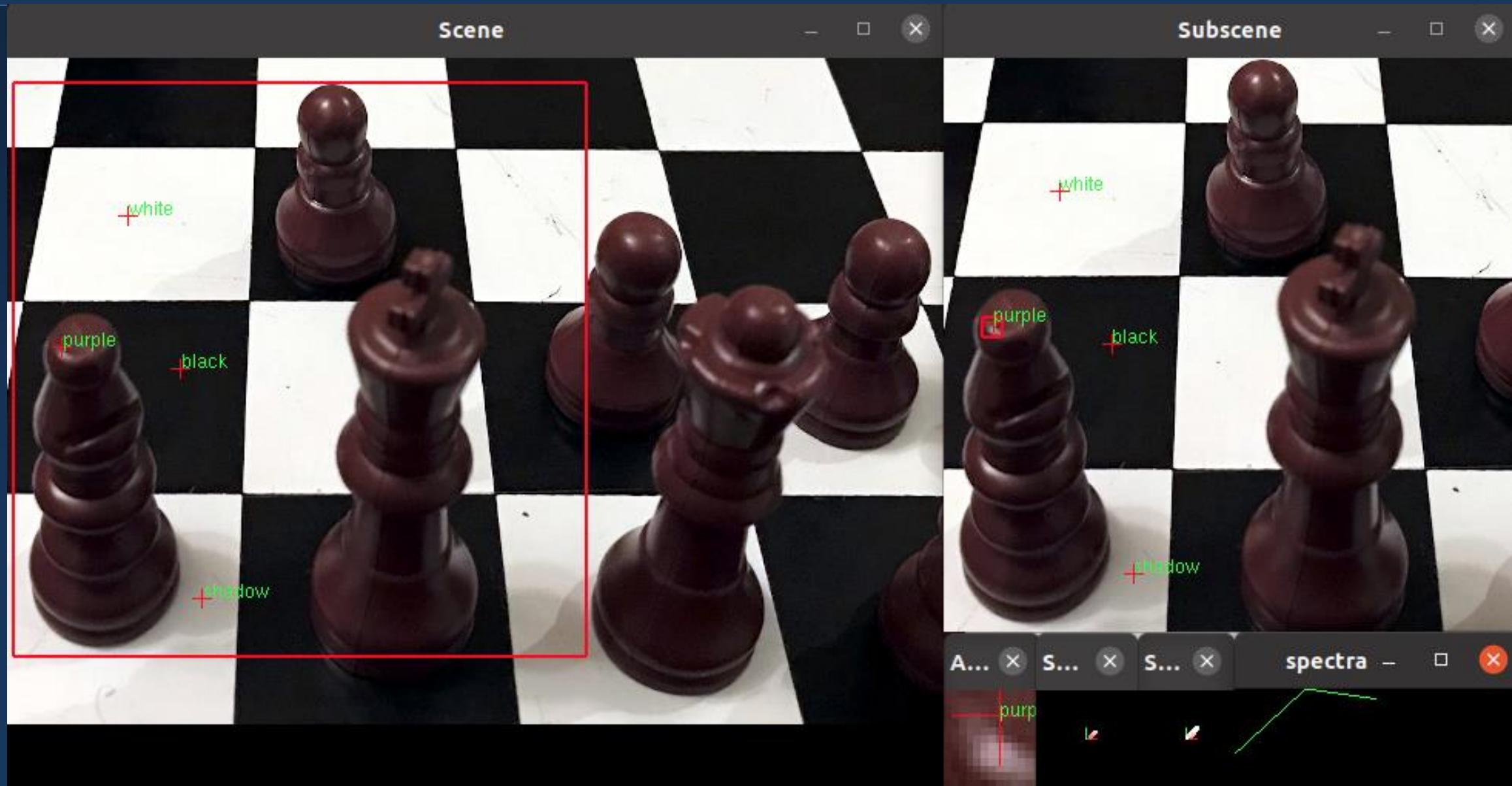
BC Wildfire  
Service



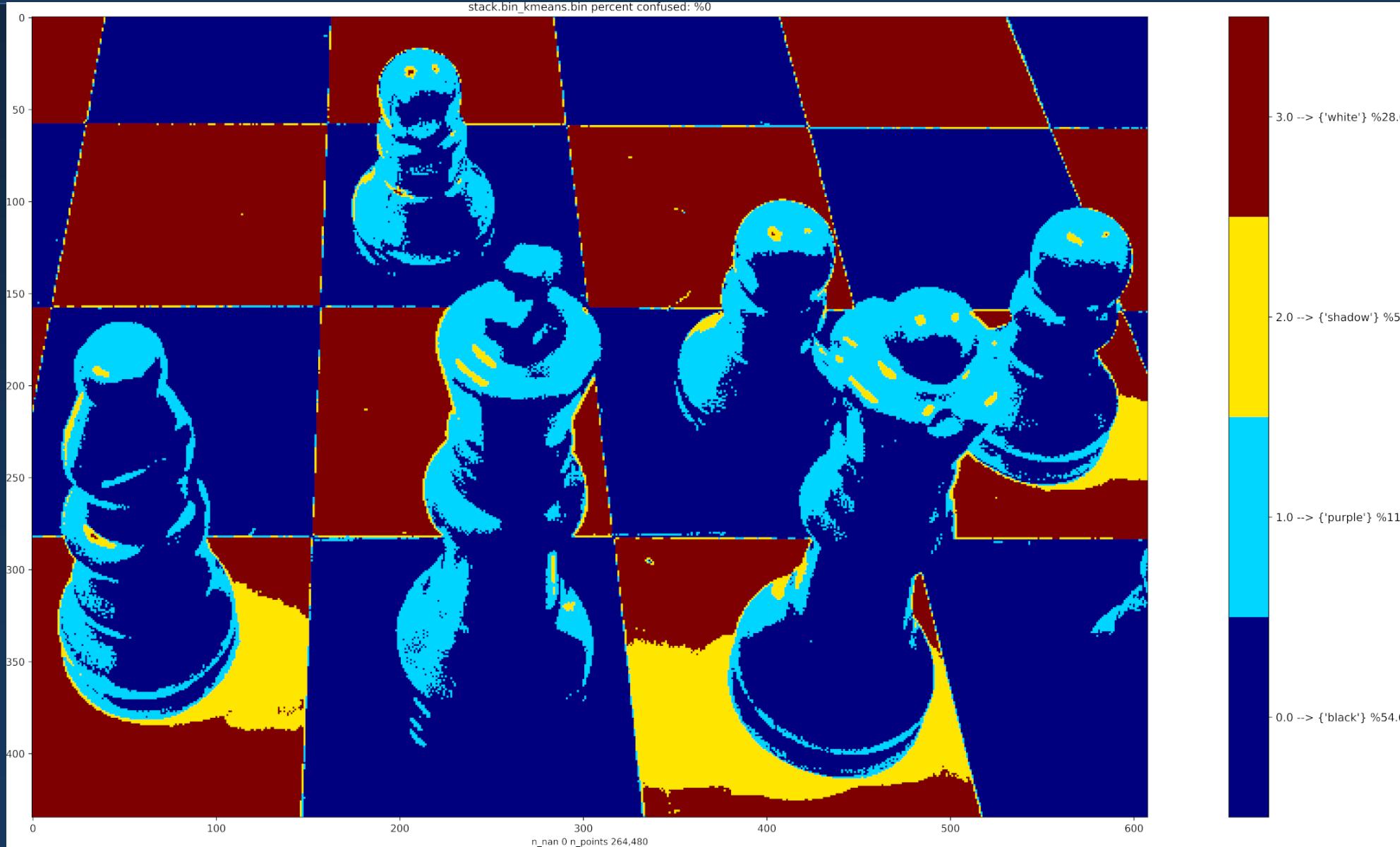
[Big-dog Beta \(early  
big dog quadruped  
robot testing\)](#)

Shadow, lighting, reflection  
issues..

# Chess example



# Chess example



Pixel based k-means  
is simplistic..

..Lacks context

Approaches to help  
add context:

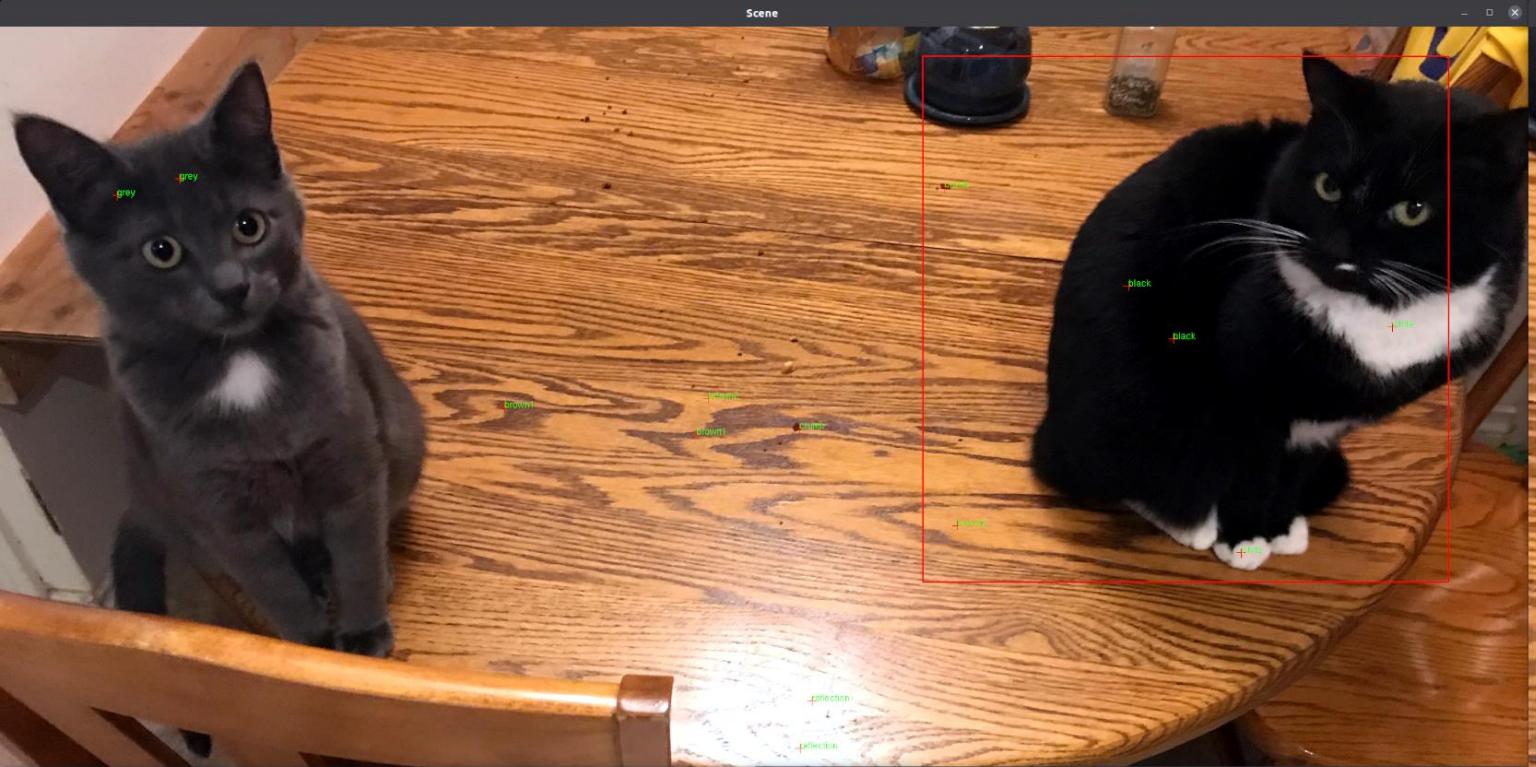
- More bands
- More reference  
labels
- region-based  
(algorithm and  
reference data)
- Neural network

# Cats

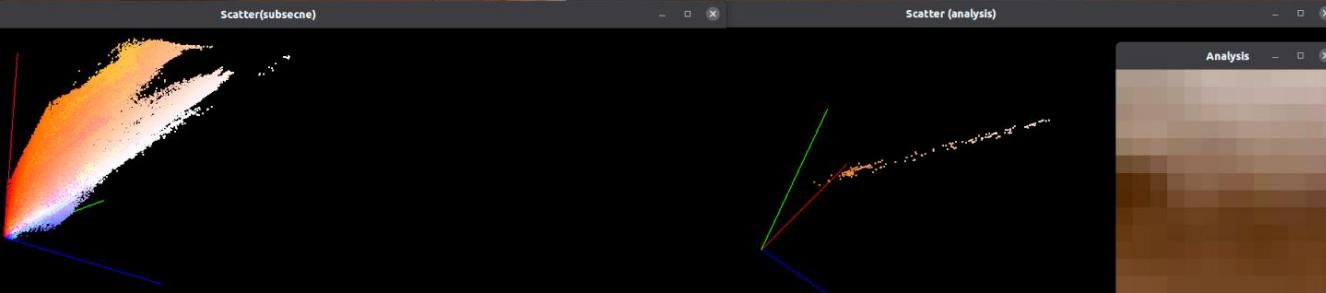
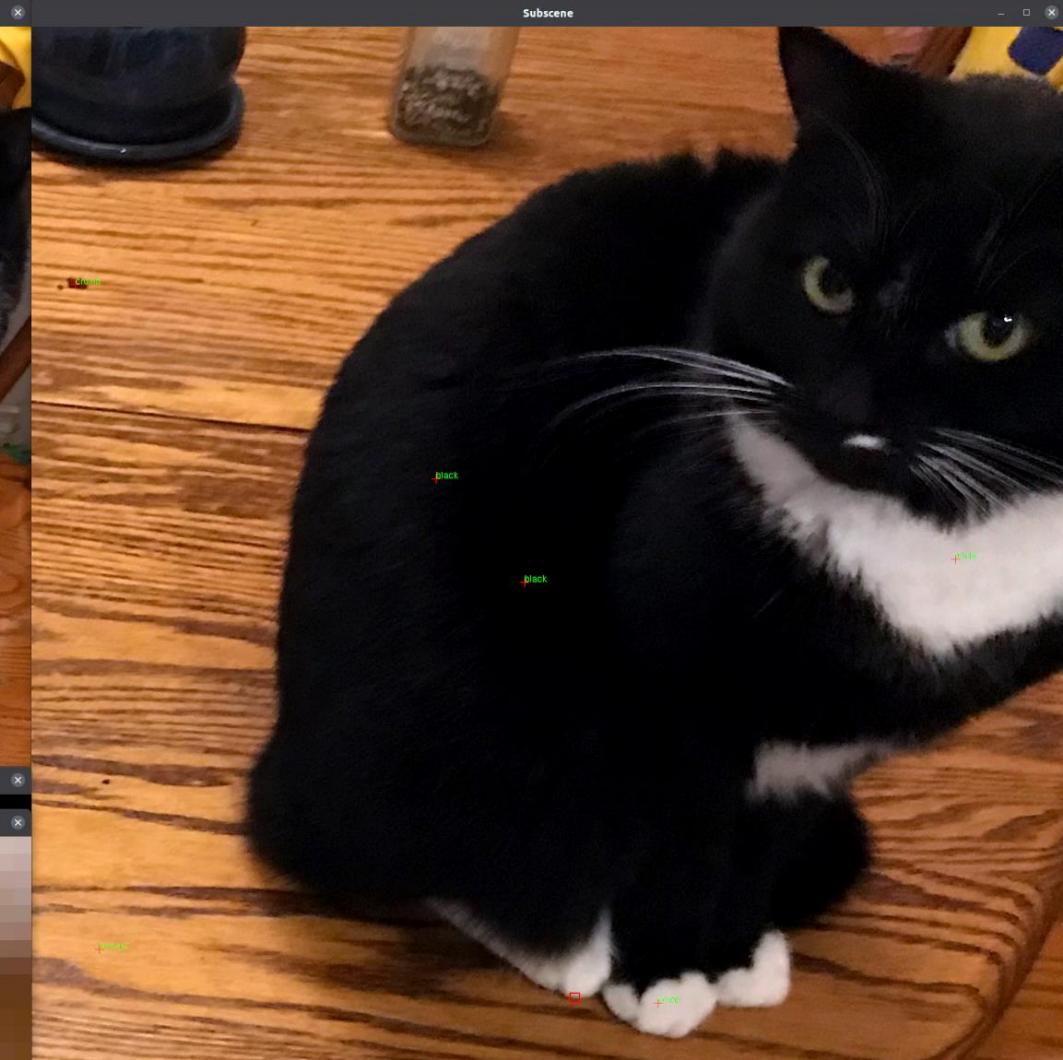


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Service

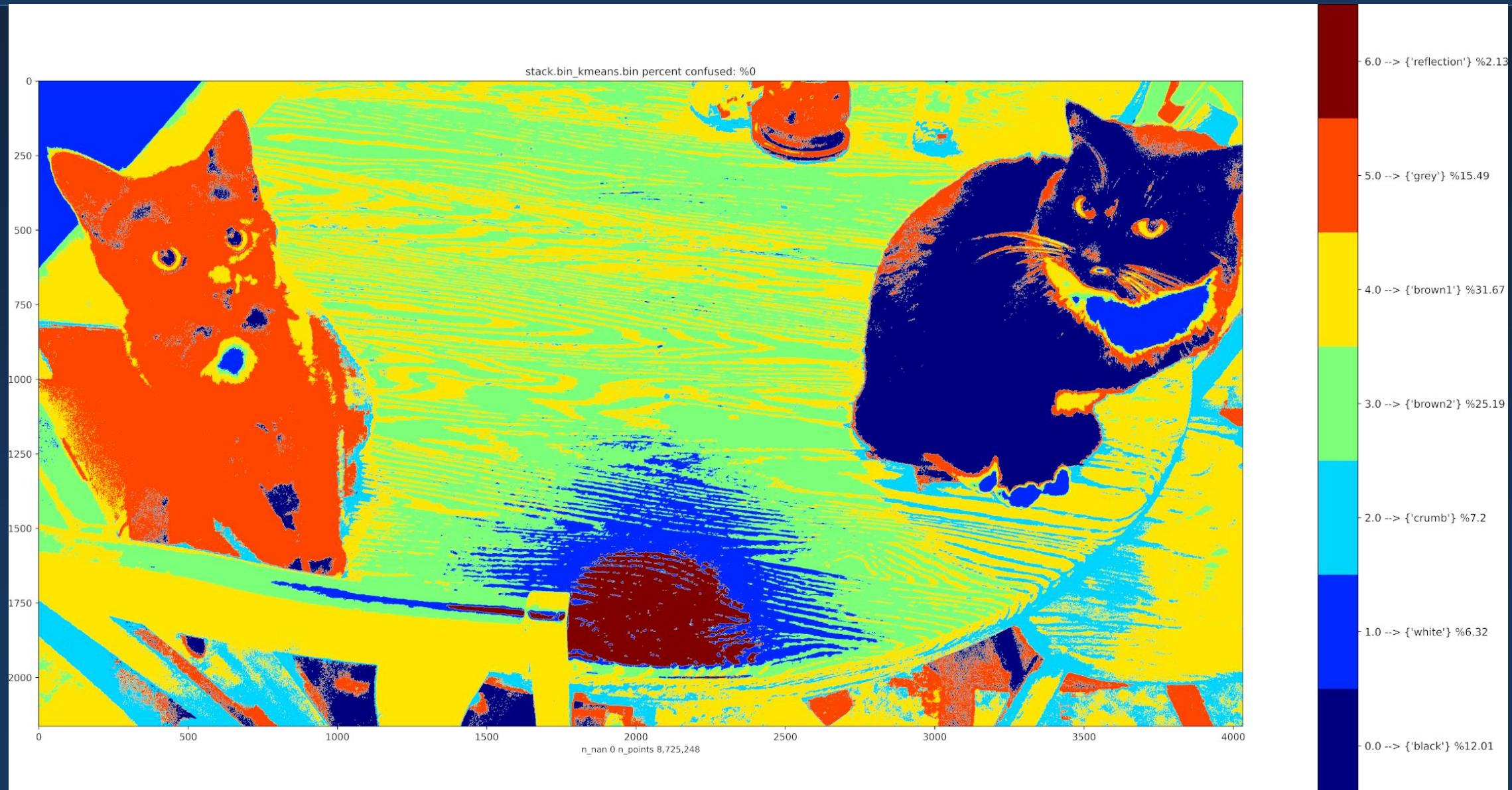
Smoky cat



Jazzy cat



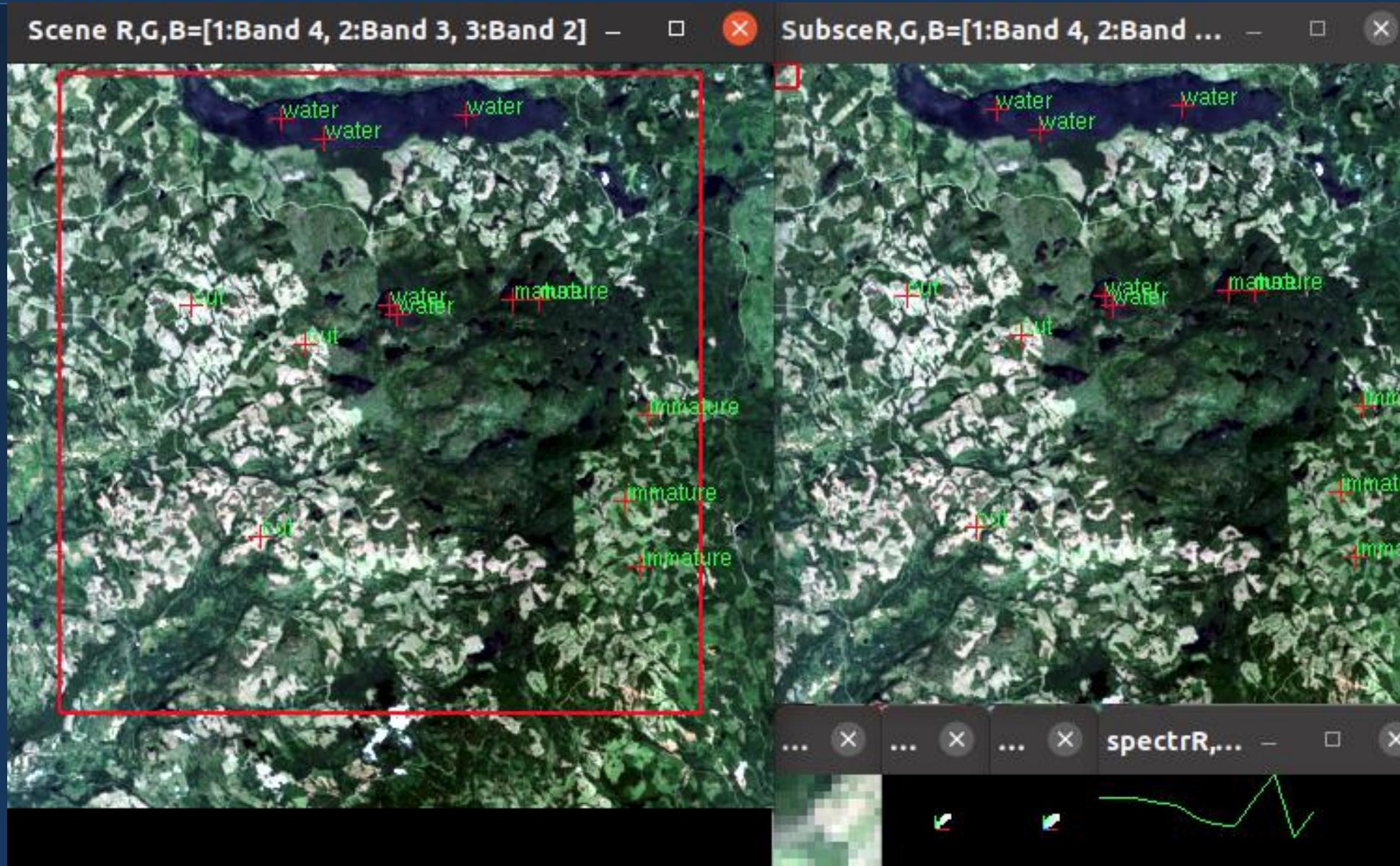
# Cat Example



# Lake Bonaparte



BC Wildfire  
Service

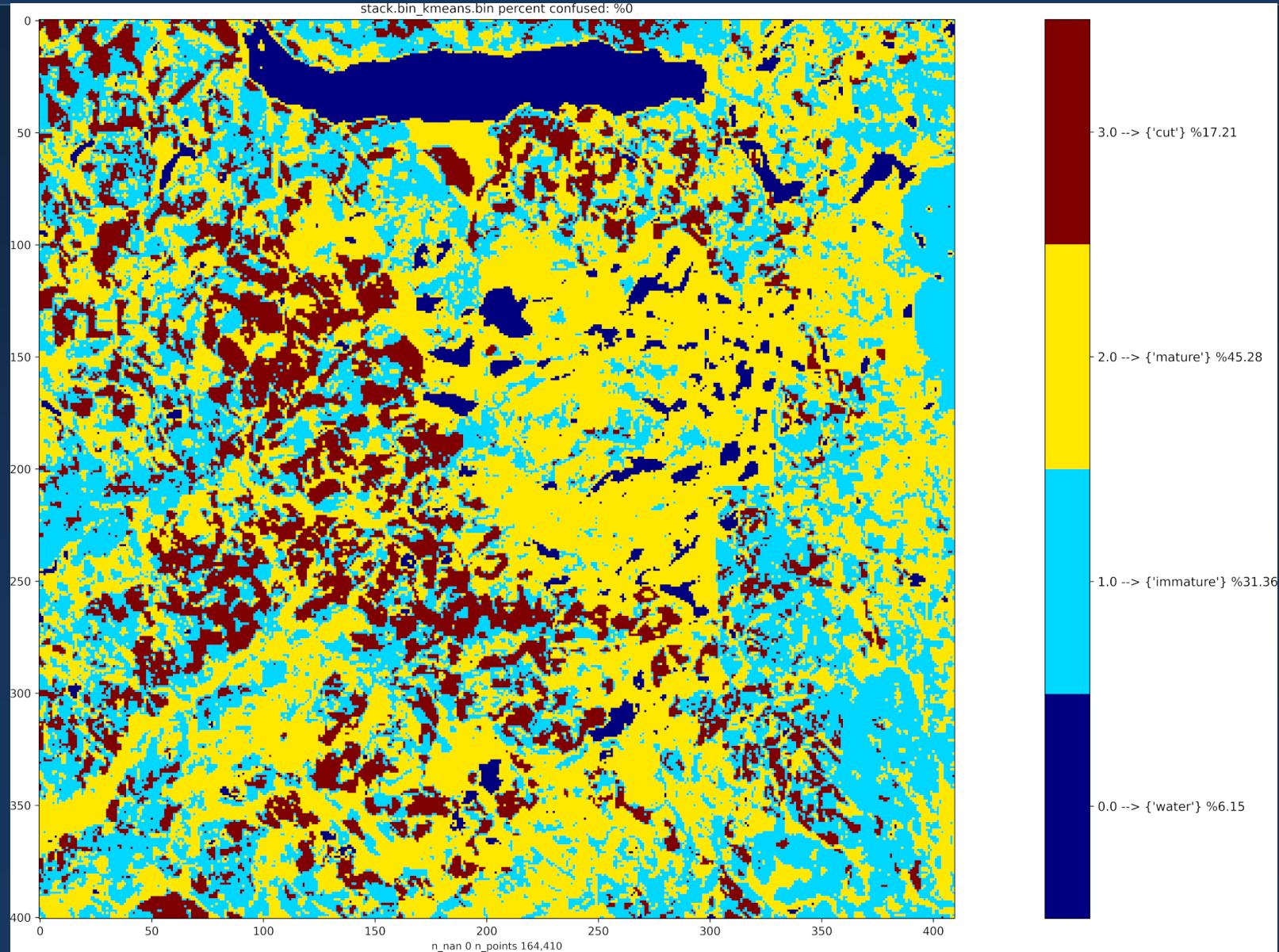


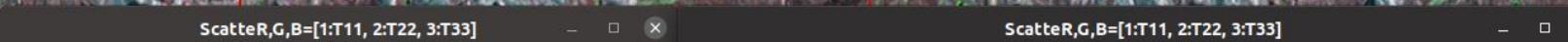
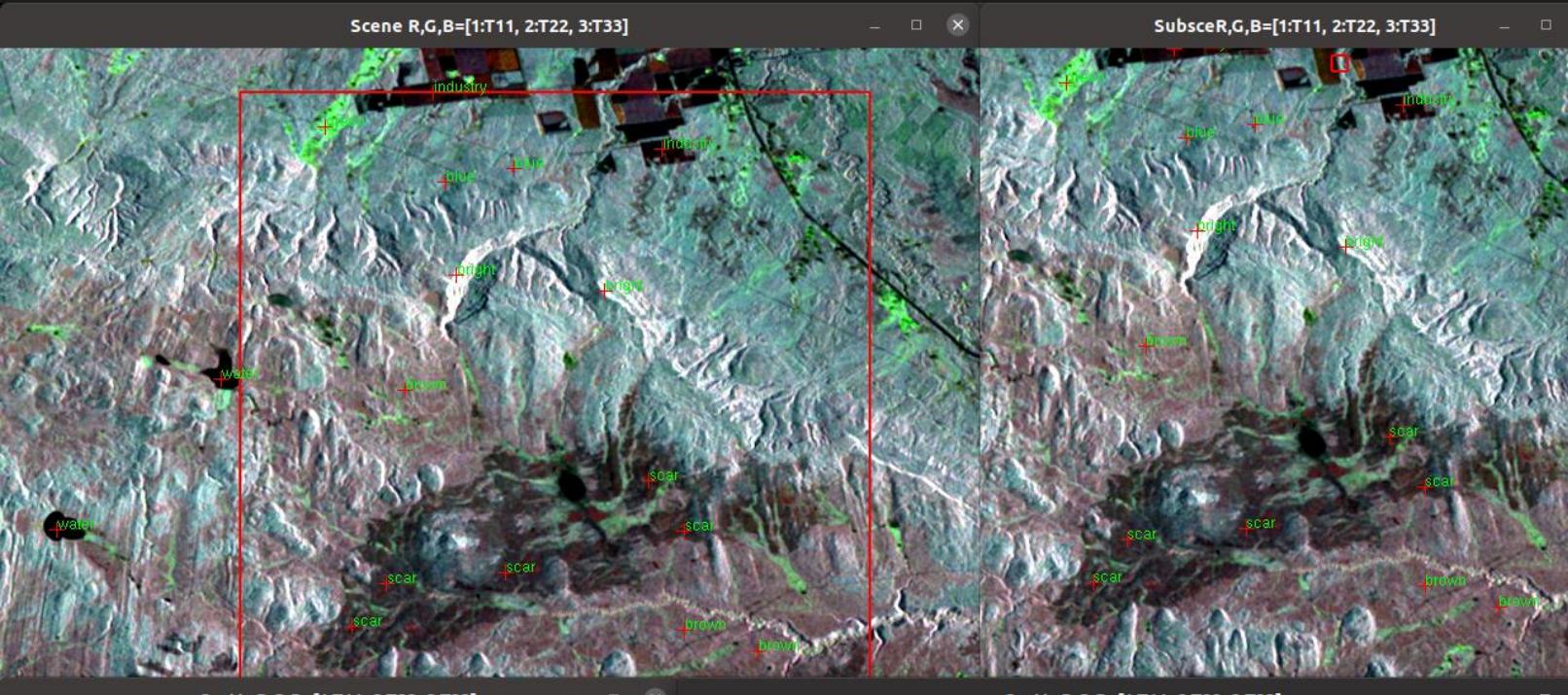
Poor label  
choices, I should  
have checked  
VRI

# Lake Bonaparte



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BRITISH  
COLUMBIA

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# Keg River 2002 fire scar

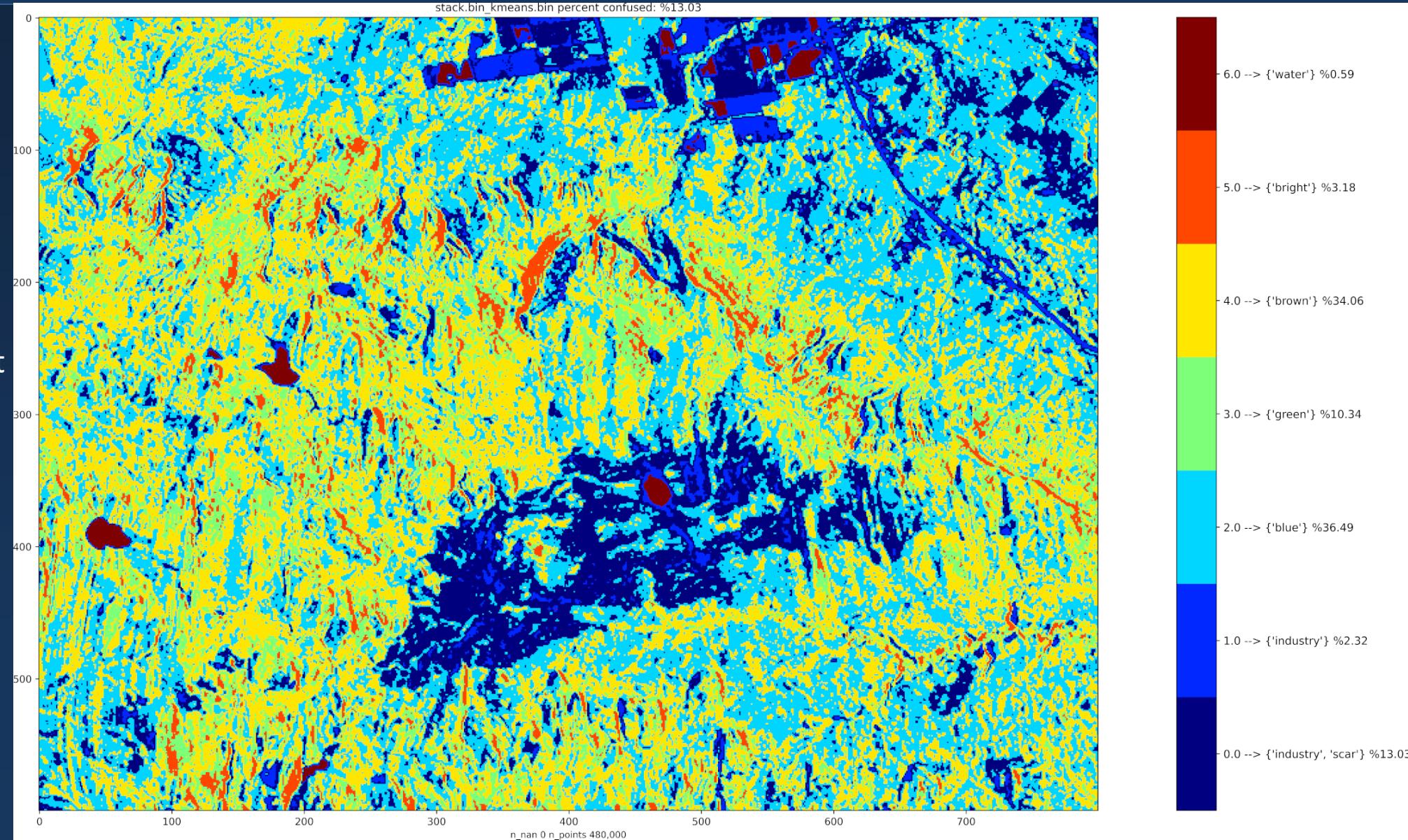
Radarsat2 QP 2013-14



# Keg River 2002 fire scar (3 bands T11, T22, T33)



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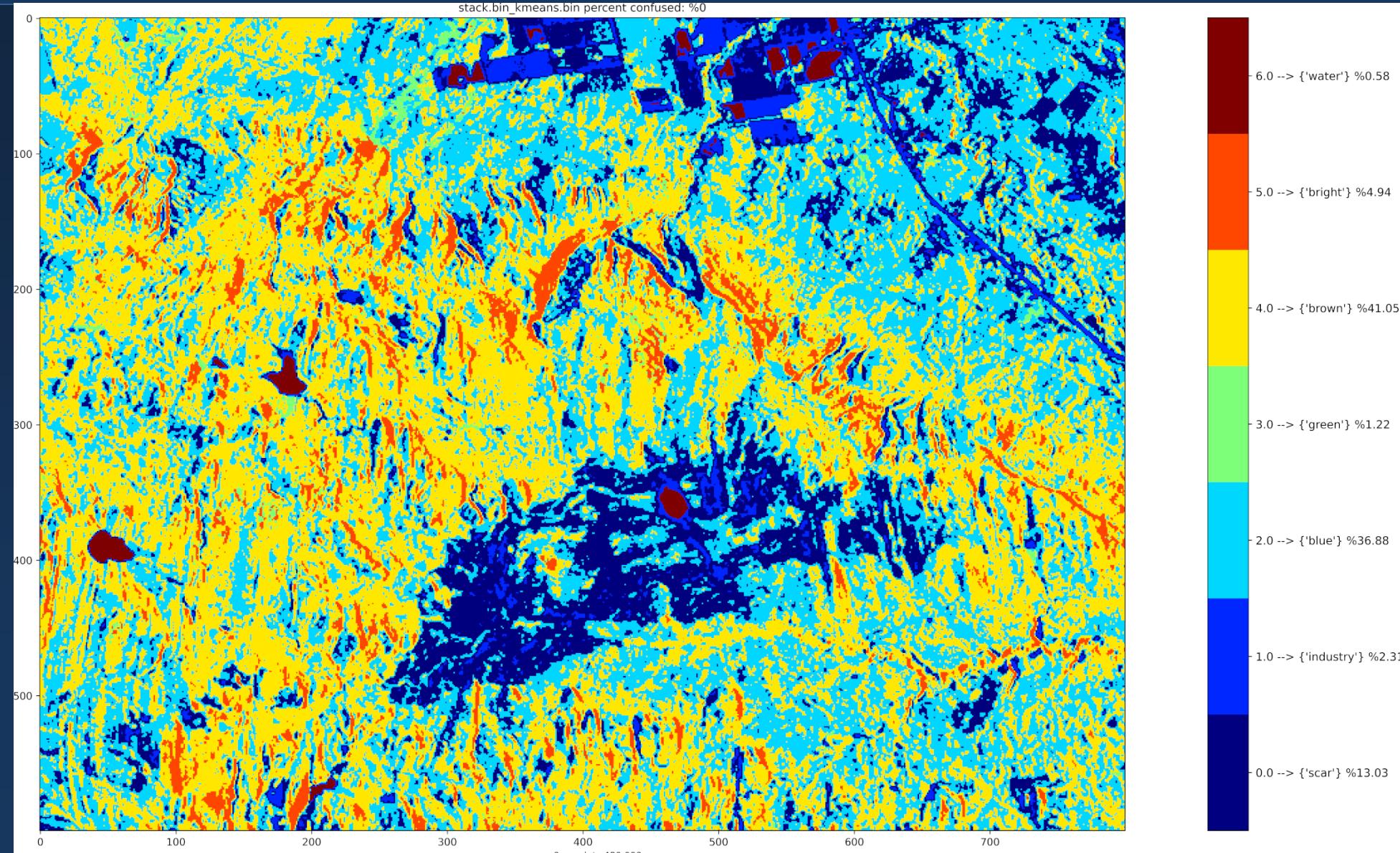
The stuff we  
labeled  
green, didn't  
seem to be  
picked up  
very well..

..Need  
smarter  
approach!

# Keg River 2002 fire scar 16 bands (T4 matrix)



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Green  
Is back!..

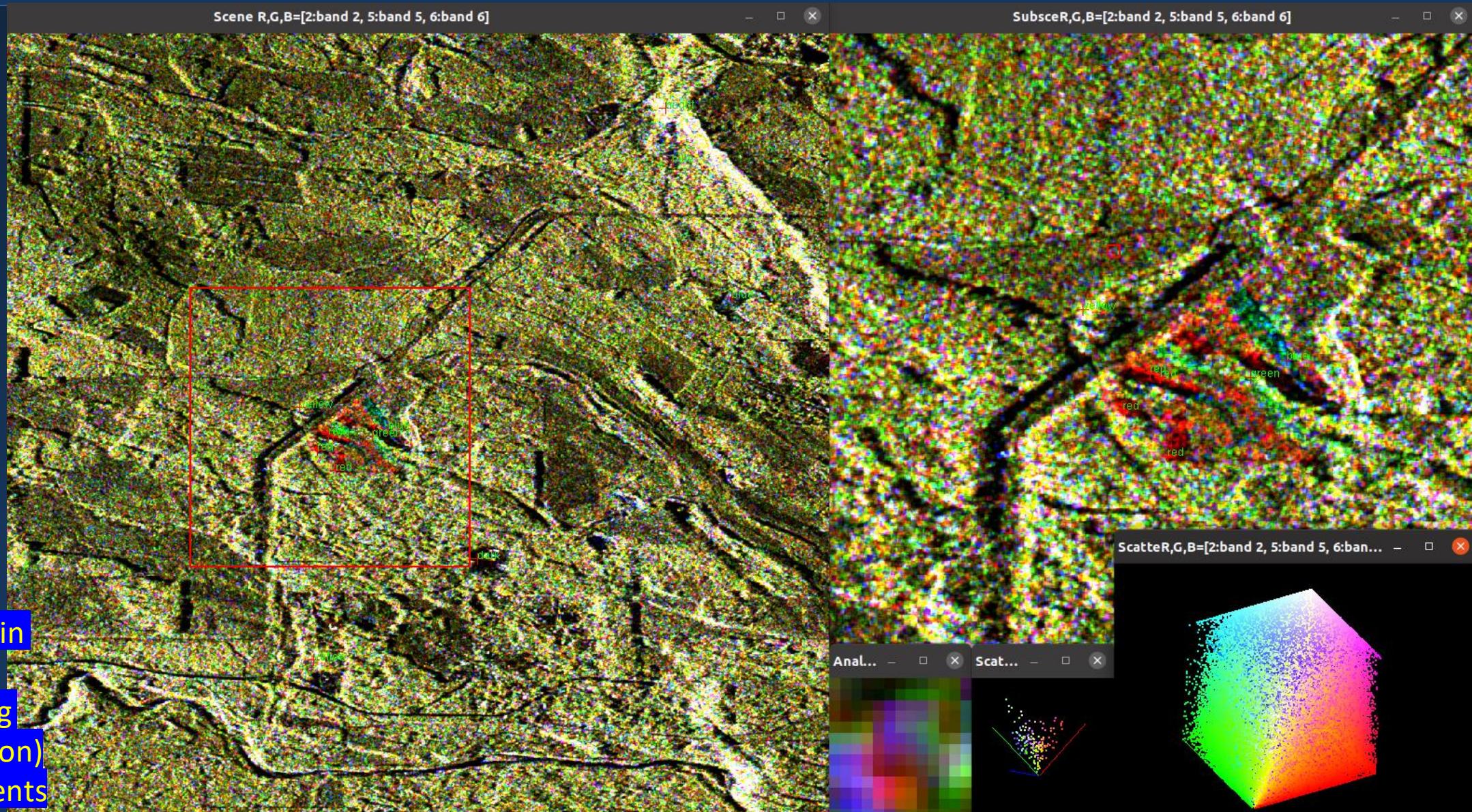
..by adding  
more data!

Could still  
use a  
smarter  
approach,  
though..

# RCM Nanaimo 3-comp : 2020: 0815, 0831, 0831-0815



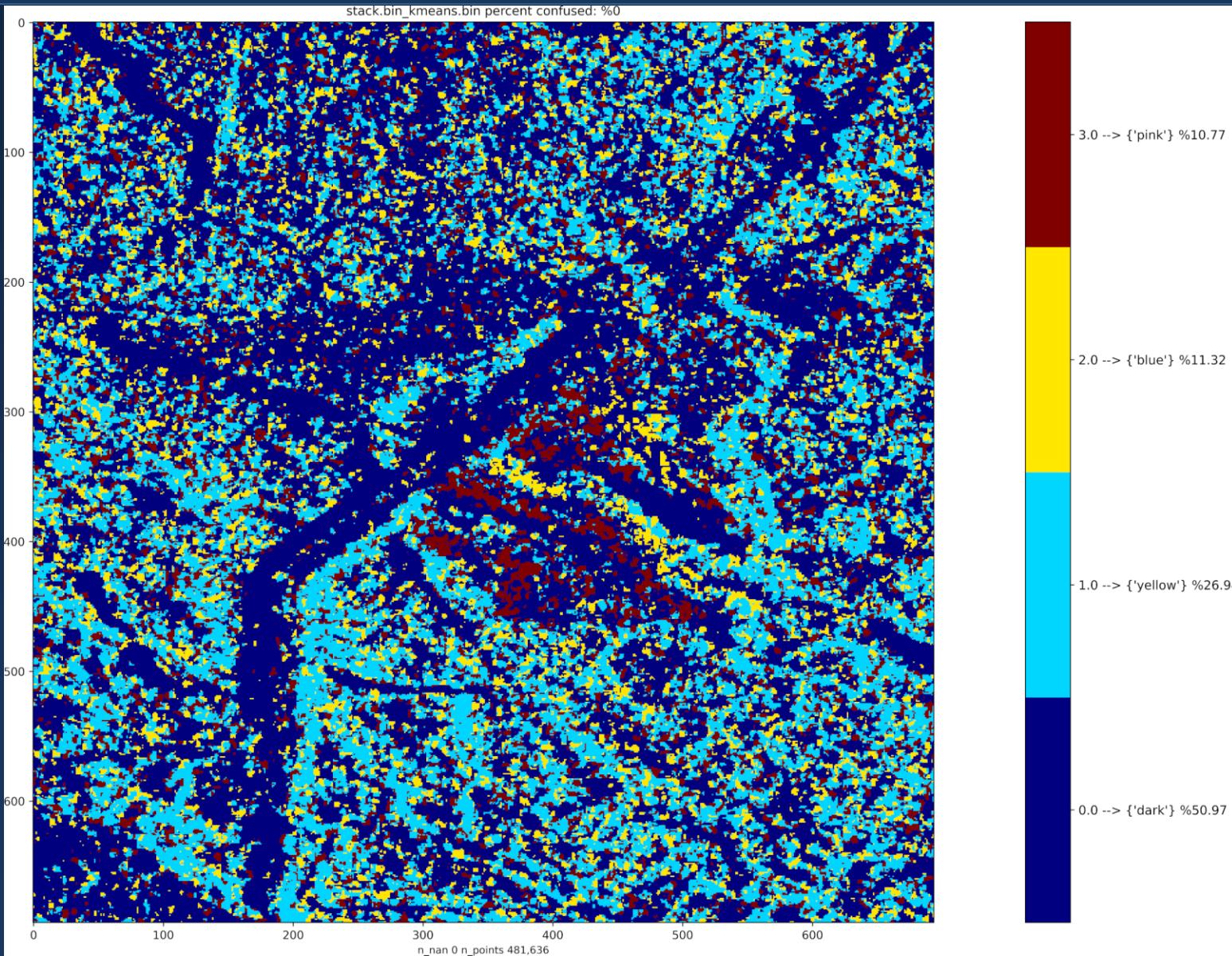
BC Wildfire  
Service



# RCM Nanaimo 3-comp : 2020: 0815, 0831, 0831-0815



BC Wildfire  
Service



S2



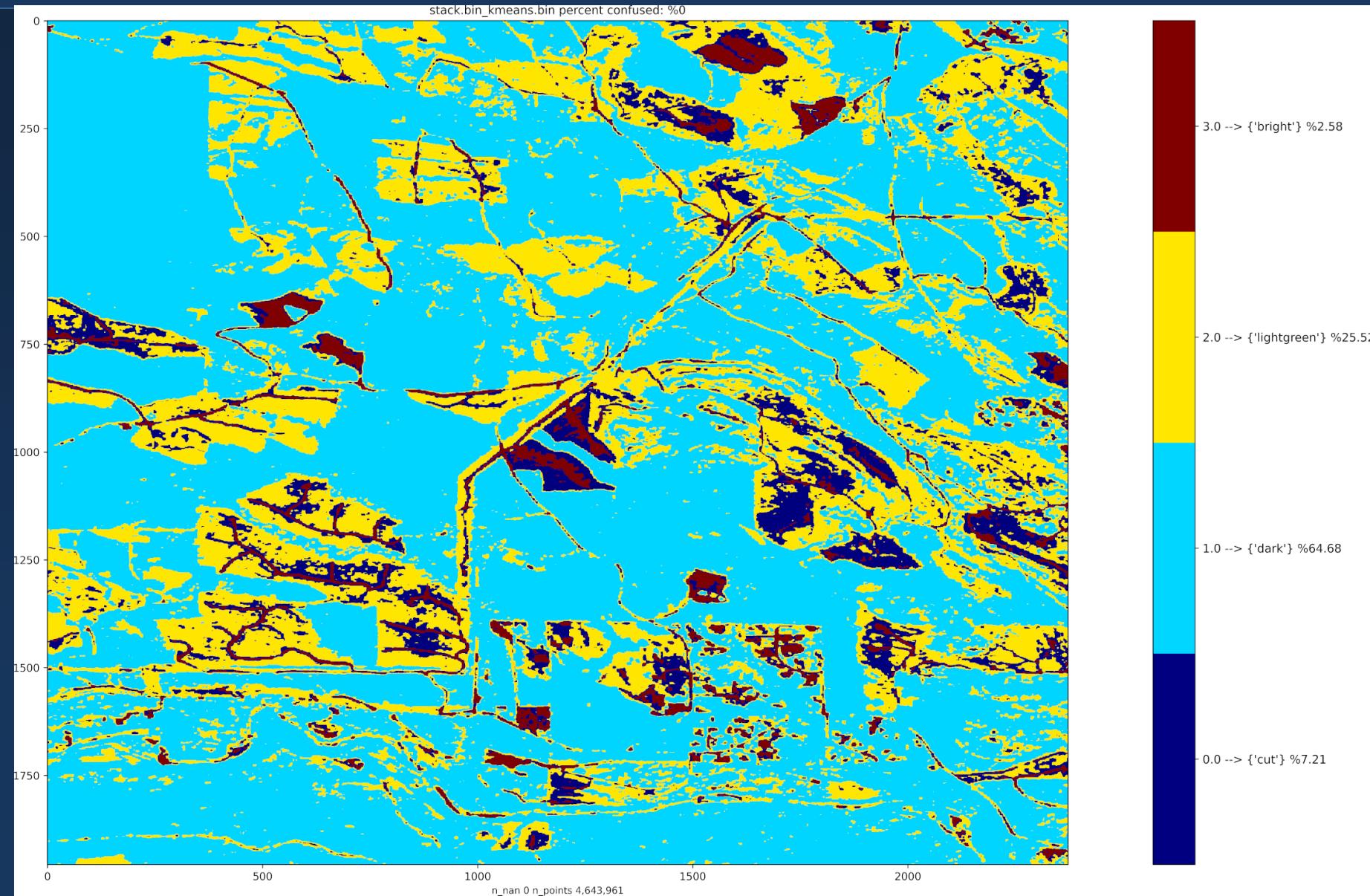
BC Wildfire  
Service



S2



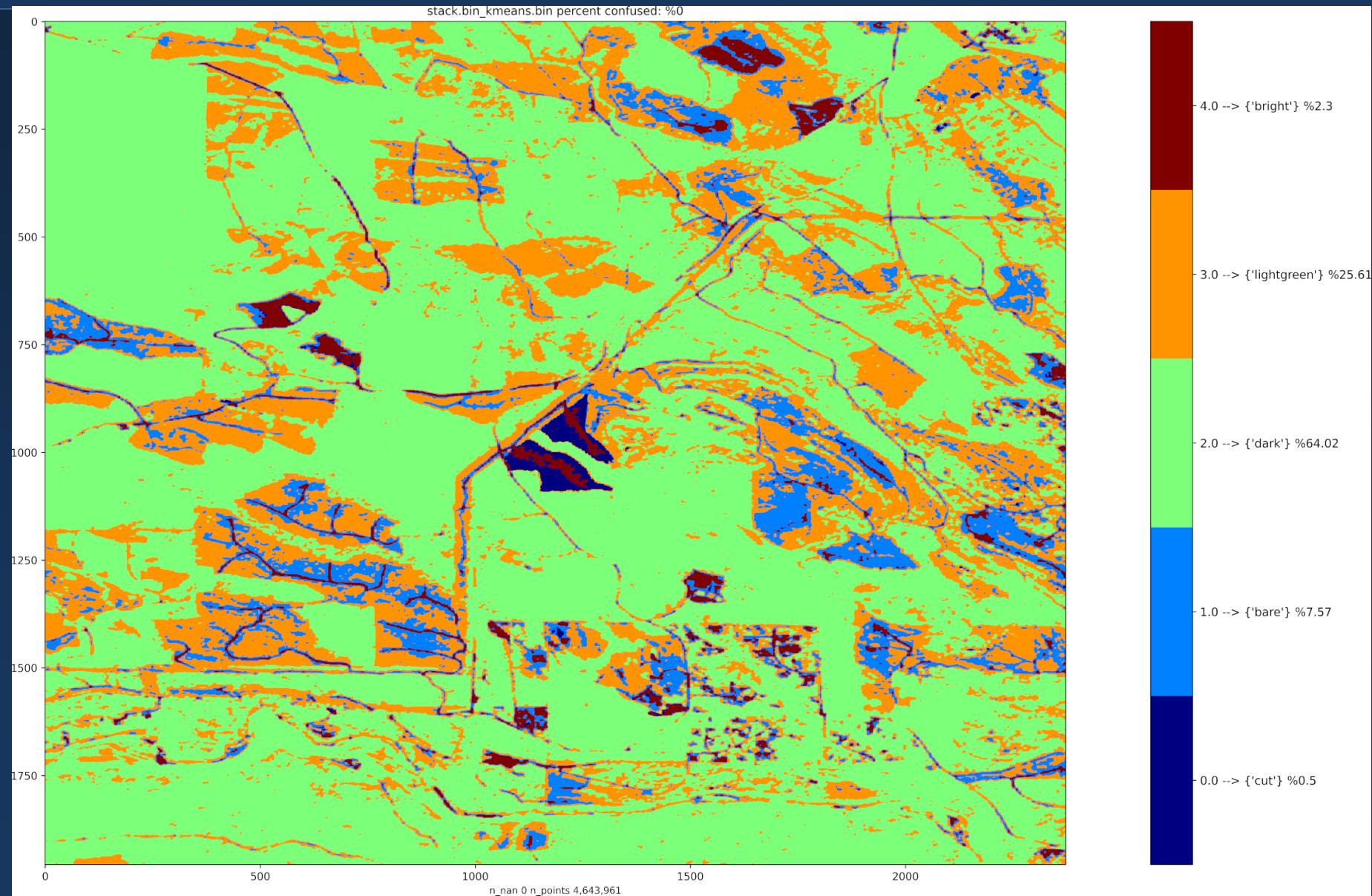
BC Wildfire  
Service



S2



BC Wildfire  
Service



# BCWS FTL Next Steps



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- Data sharing agreements, human capacity and modest IT infrastructure needed, to scale up to province-wide solution
- Expand BCWS data-collection activities using our mobile FTL Survey123 App
- Invest in in-house tech capacity (people and machines) to extract value for BC from rapidly expanding high-quality, satellite data options
  - Plus cloud/smoke - penetrating tech
- Continue R&D collaboration with research partners to leverage advances in satellite, LiDAR, drone data and methods



Questions?

[Ashlin.Richardson@gov.bc.ca](mailto:Ashlin.Richardson@gov.bc.ca)



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# Dimensions of BCWS FTL system



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**Space:** full provincial coverage at high resolution\*\*\*

**Colour:** use all available spectral bands from imagery

**Time:** multitemporal for detailed phenology, succession

**Sensor type:** pivot to new sources w transferrable algorithms

**Vegetation type:** adapt to new ground reference data on the fly

**People:** prioritize human feedback by making decision support systems responsive, visual and interactive\*\*

\*\*\* Use the spatial information

\*\* A.I. = decision support system

**Law of Requisite Variety:** viable solution of complex problem must have sufficient flexibility and sophistication to handle the problem's complexity

# Questions?

Ashlin.Richardson@gov.bc.ca



# Data Science Partnerships Program

We help government connect data with outcomes using data science.



## Support Data-Driven Outcomes

Support ministries with data science resources and expertise to understand and address policy and service challenges



## Build Data Science Capacity

Increase the technical capacity of government by supporting development and attracting new talent



## Catalyze Cross-Government Collaboration

Promote evaluation initiatives that build understanding of cross-program outcomes for citizens at a population level



## Enable Use of the Data Innovation Program

Support ministries and partnerships in use of cross-ministry integrated data in the Data Innovation Program

CITZ: DPDD

Partnerships and Capacity Branch

Data Science Partnerships

FLNRORD

BC Wildfire Service

Wildfire Operations

Predictive Services