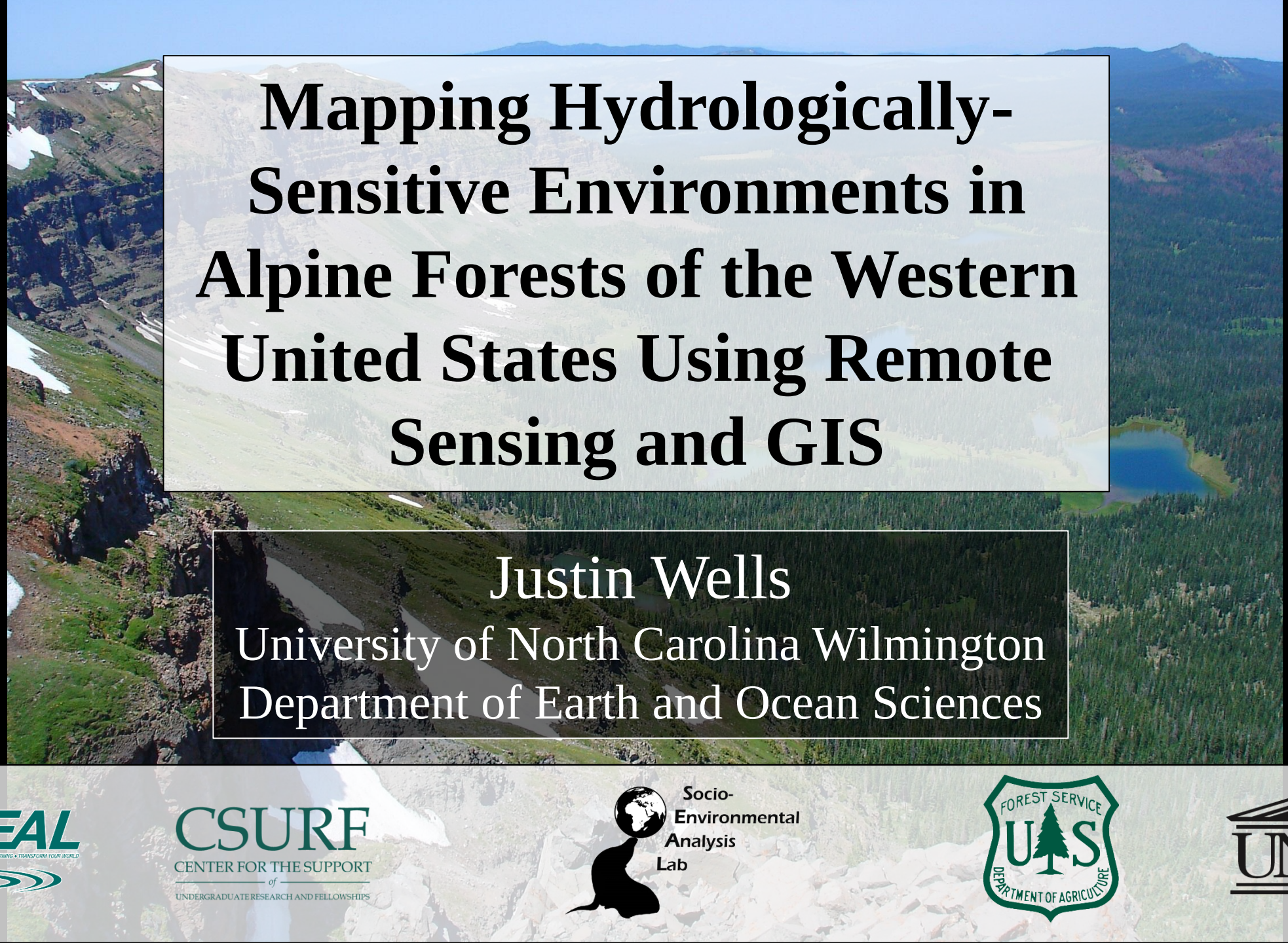

Mapping Hydrologically-Sensitive Environments in Alpine Forests of the Western United States Using Remote Sensing and GIS

Justin Wells

University of North Carolina Wilmington

Department of Earth and Ocean Sciences

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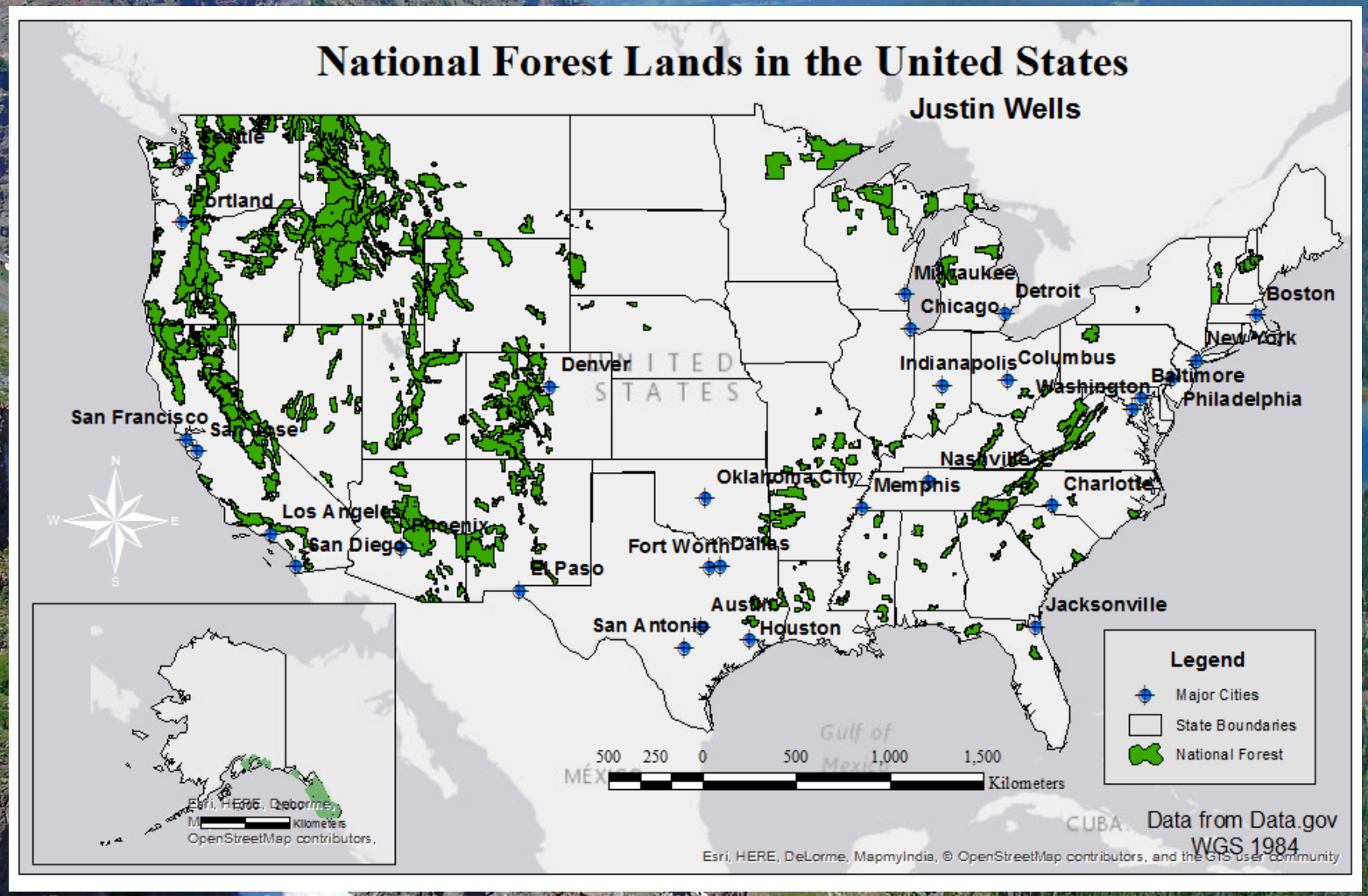
Study Area



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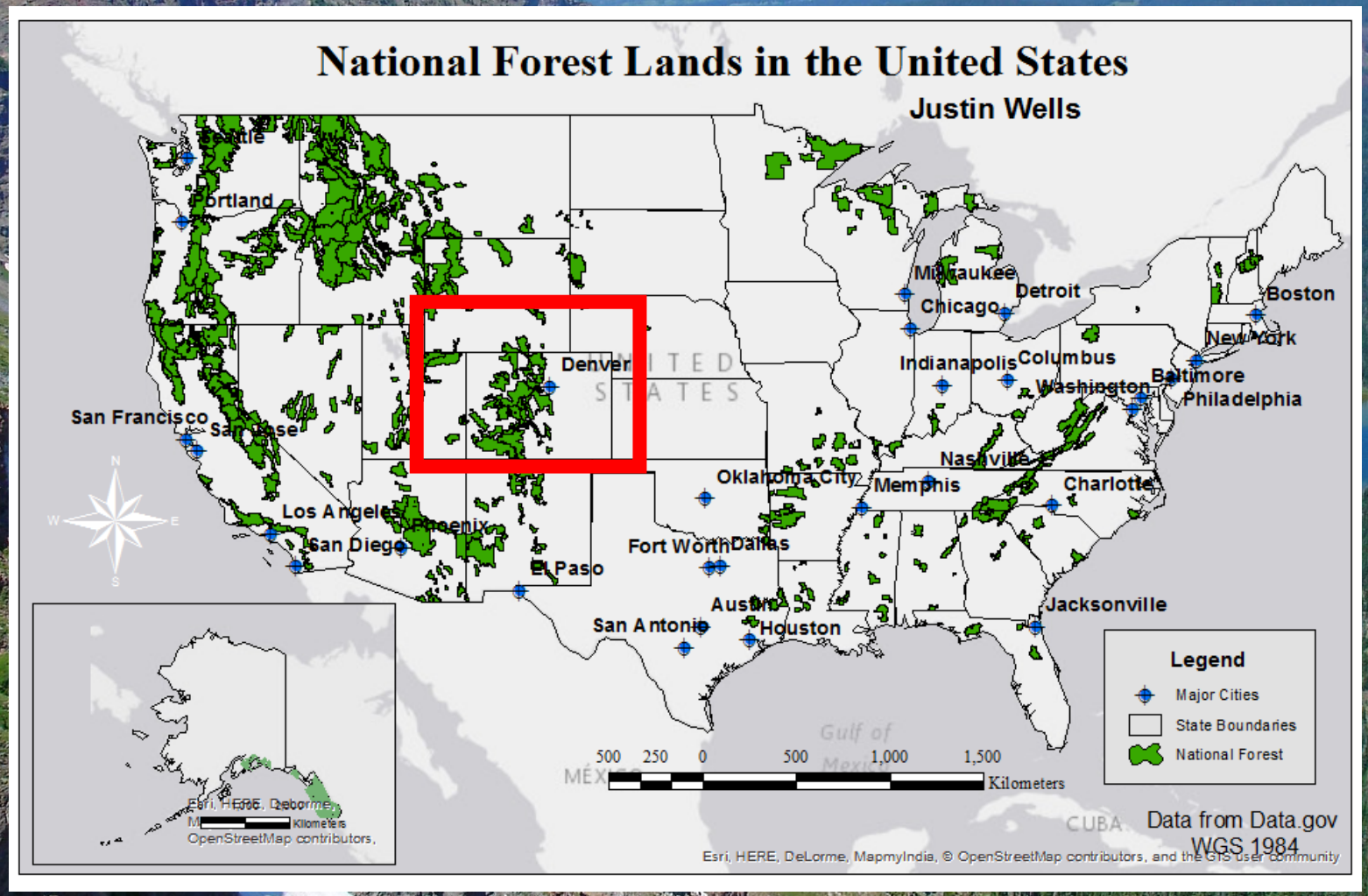
Study Area



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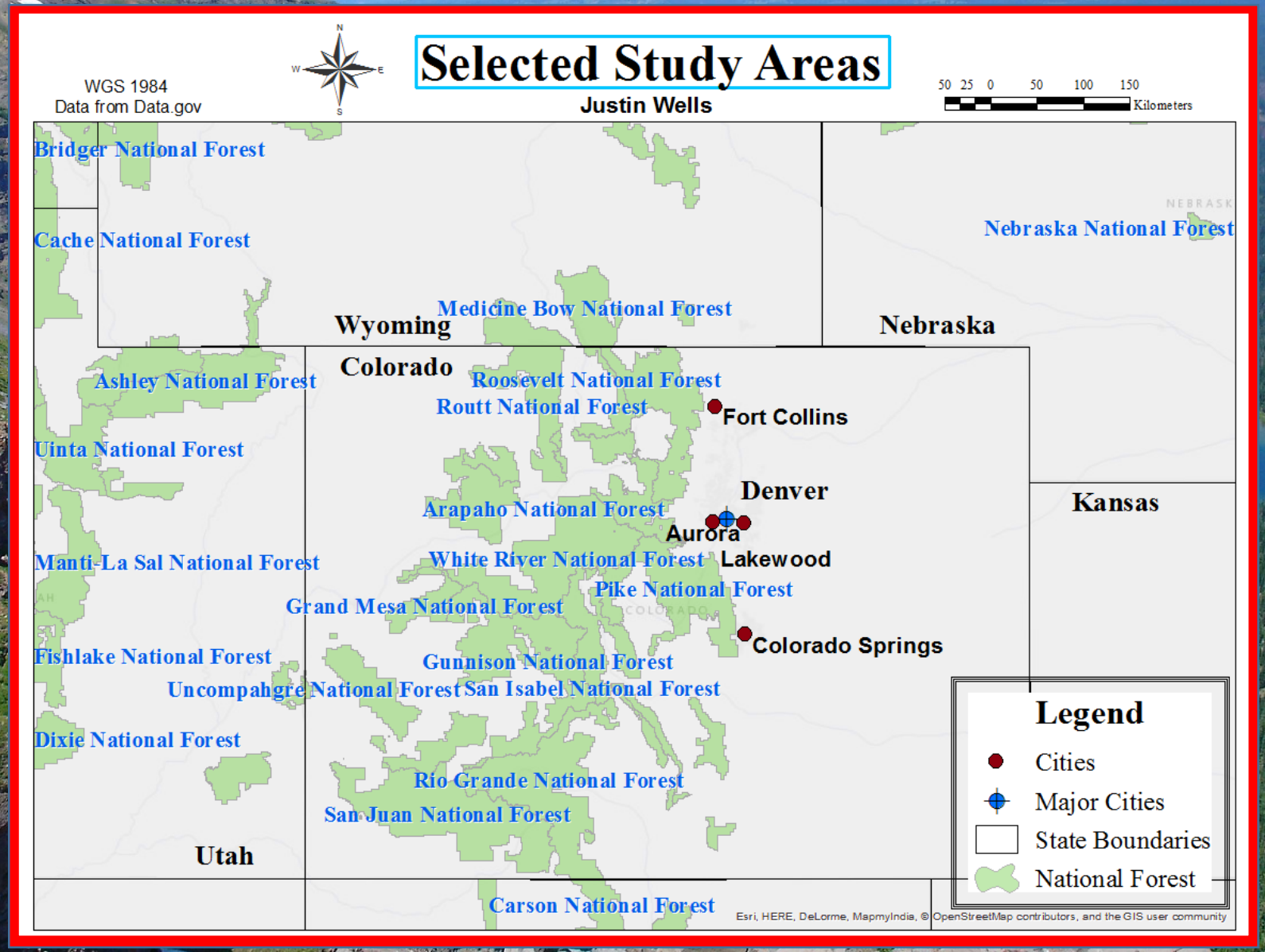
Study Area



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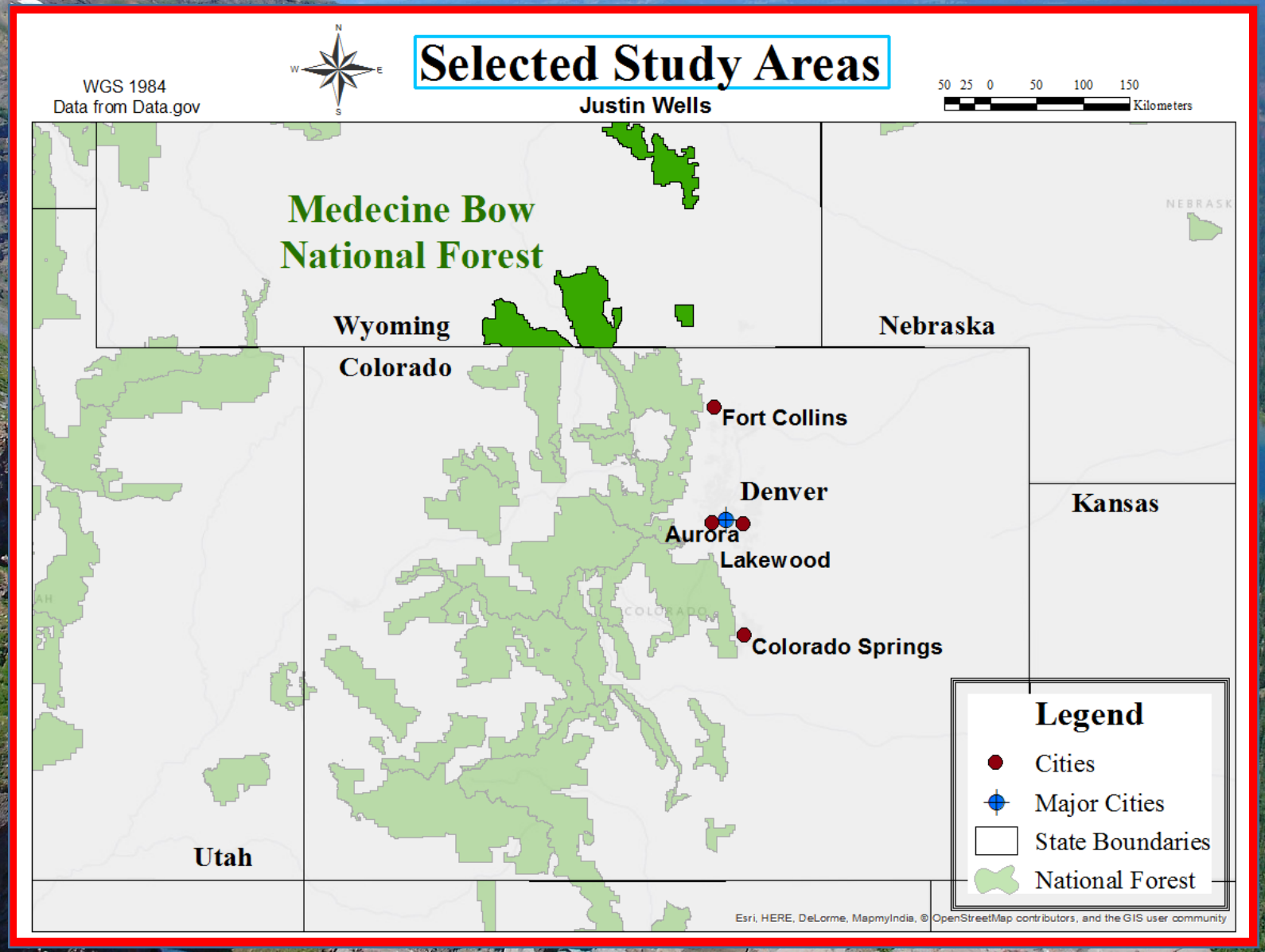
Study Area



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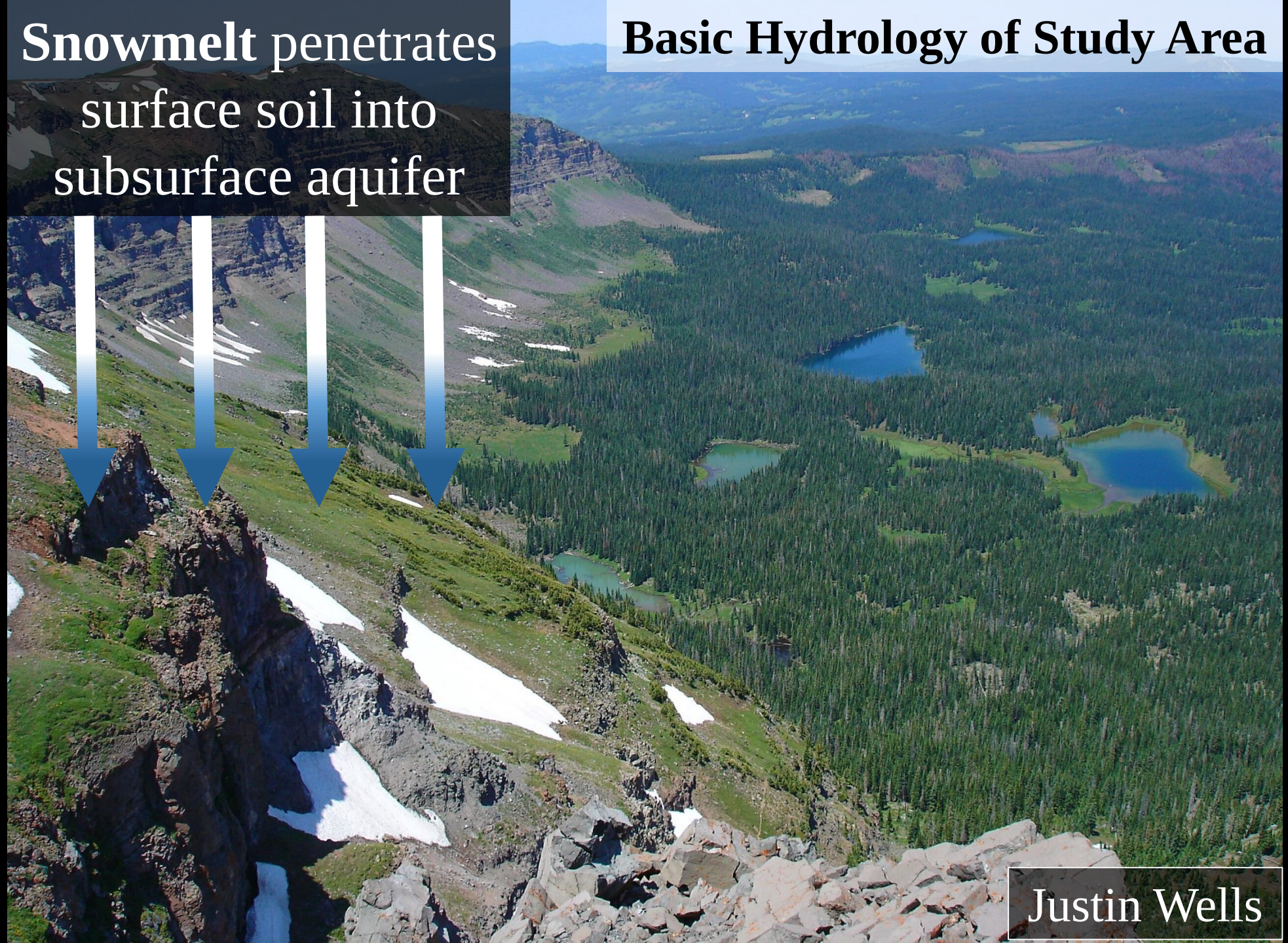
Basic Hydrology of Study Area



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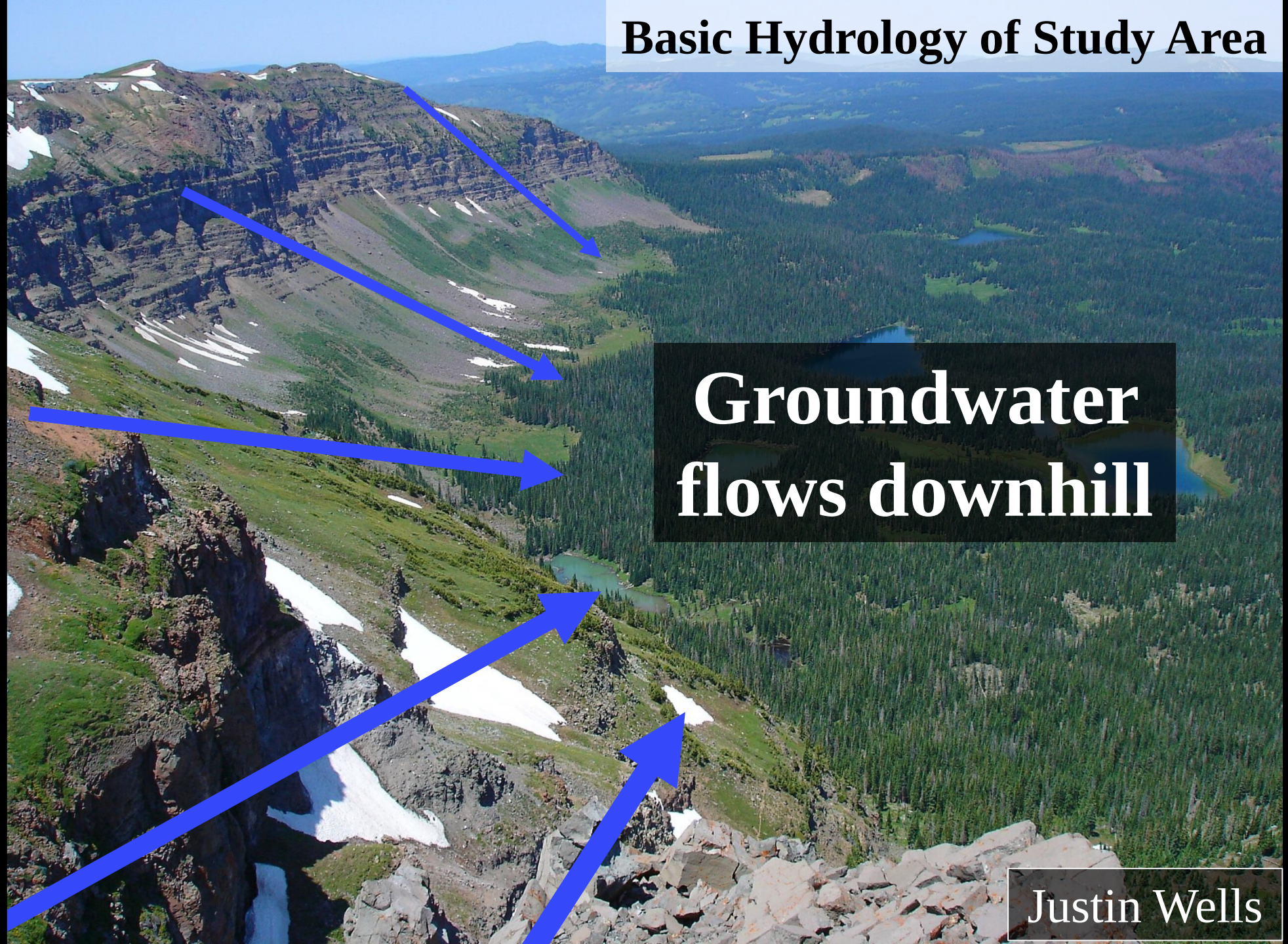
Basic Hydrology of Study Area



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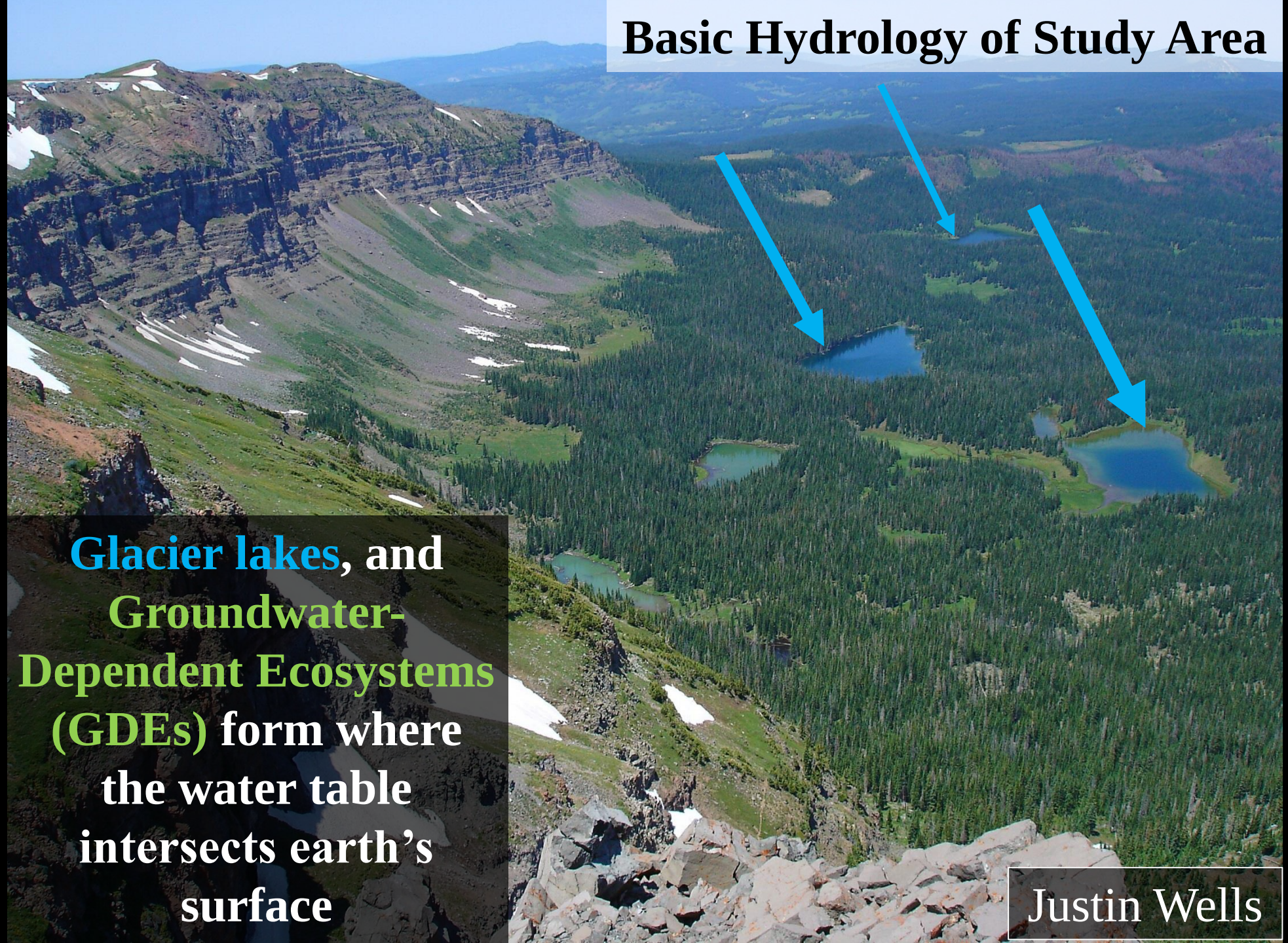
Basic Hydrology of Study Area



Glacier lakes, and Groundwater-Dependent Ecosystems (GDEs) form where the water table intersects earth's surface

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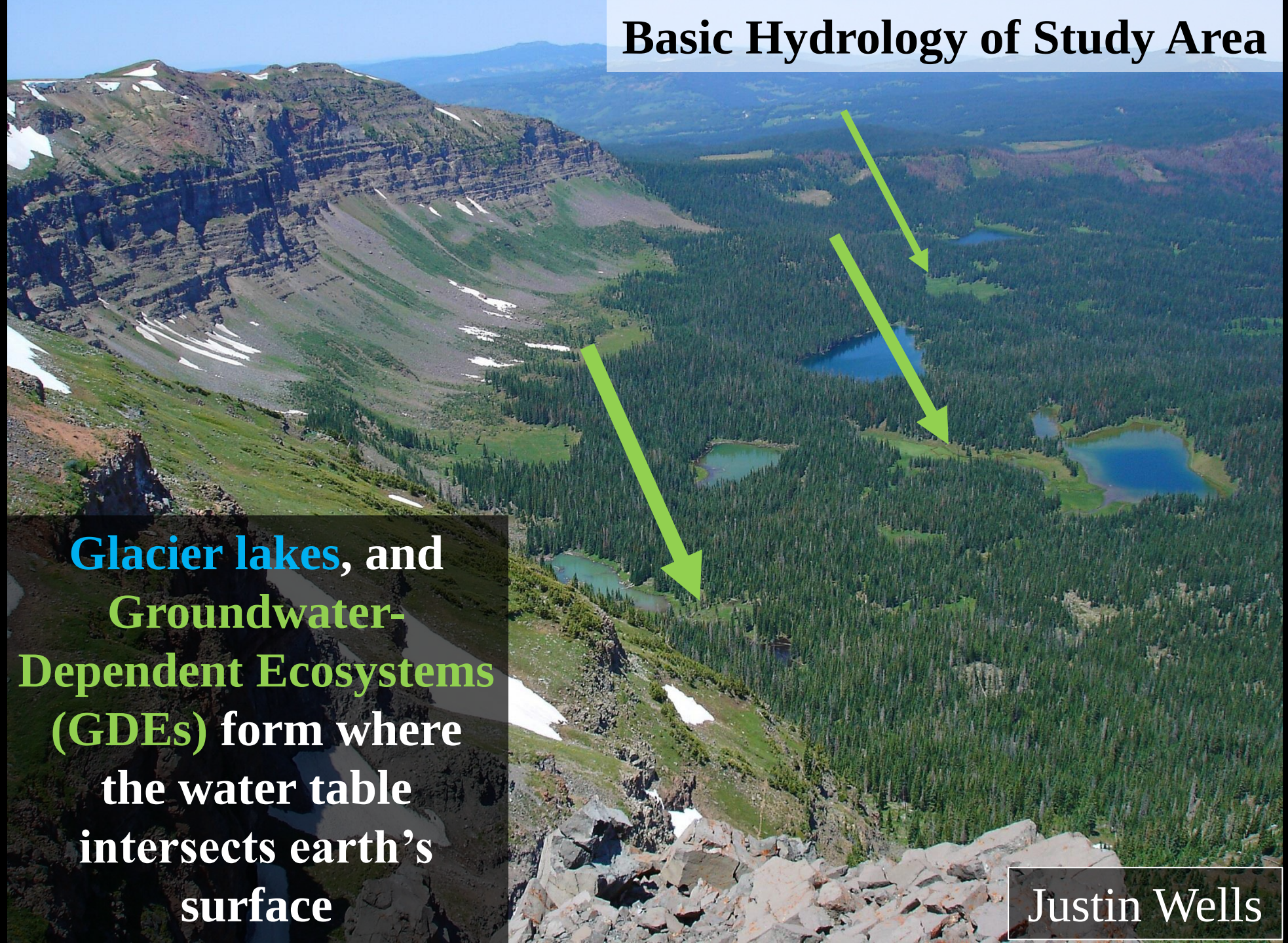
Basic Hydrology of Study Area



Glacier lakes, and Groundwater-Dependent Ecosystems (GDEs) form where the water table intersects earth's surface

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Groundwater-Dependent Ecosystems

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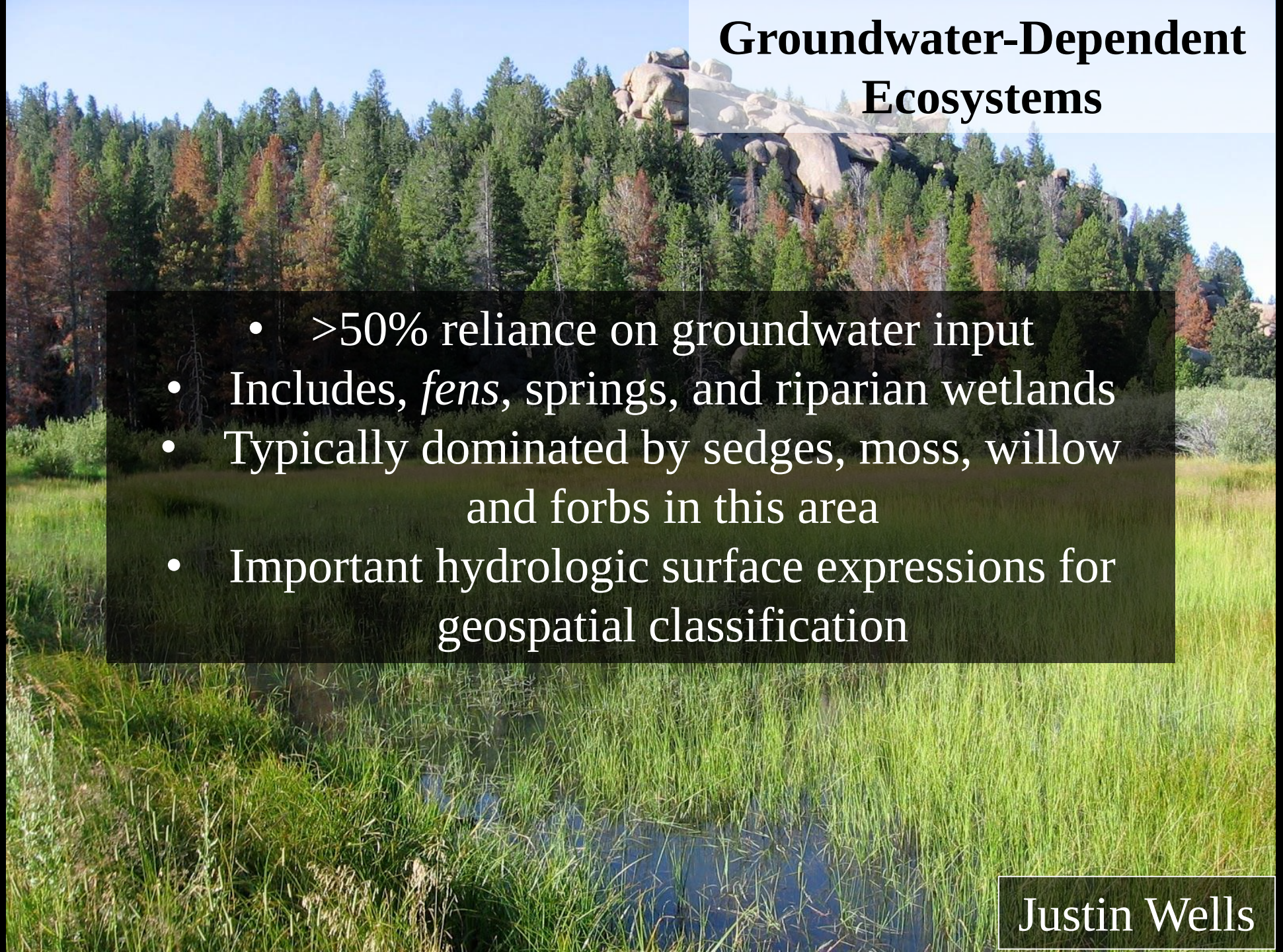
Groundwater-Dependent Ecosystems

- >50% reliance on groundwater input
- Includes, *fens*, springs, and riparian wetlands
- Typically dominated by sedges, moss, willow and forbs in this area
- Important hydrologic surface expressions for geospatial classification



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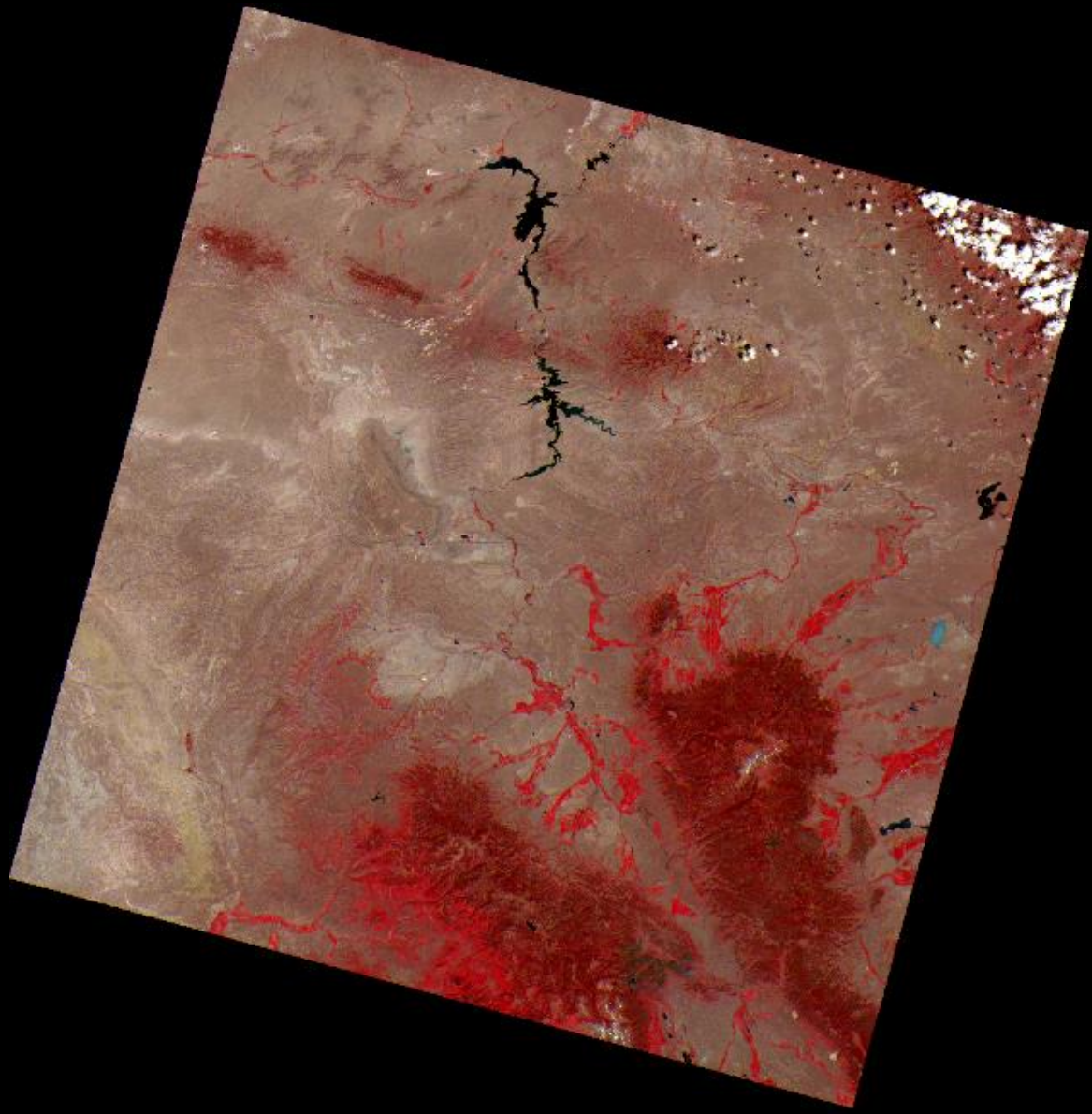
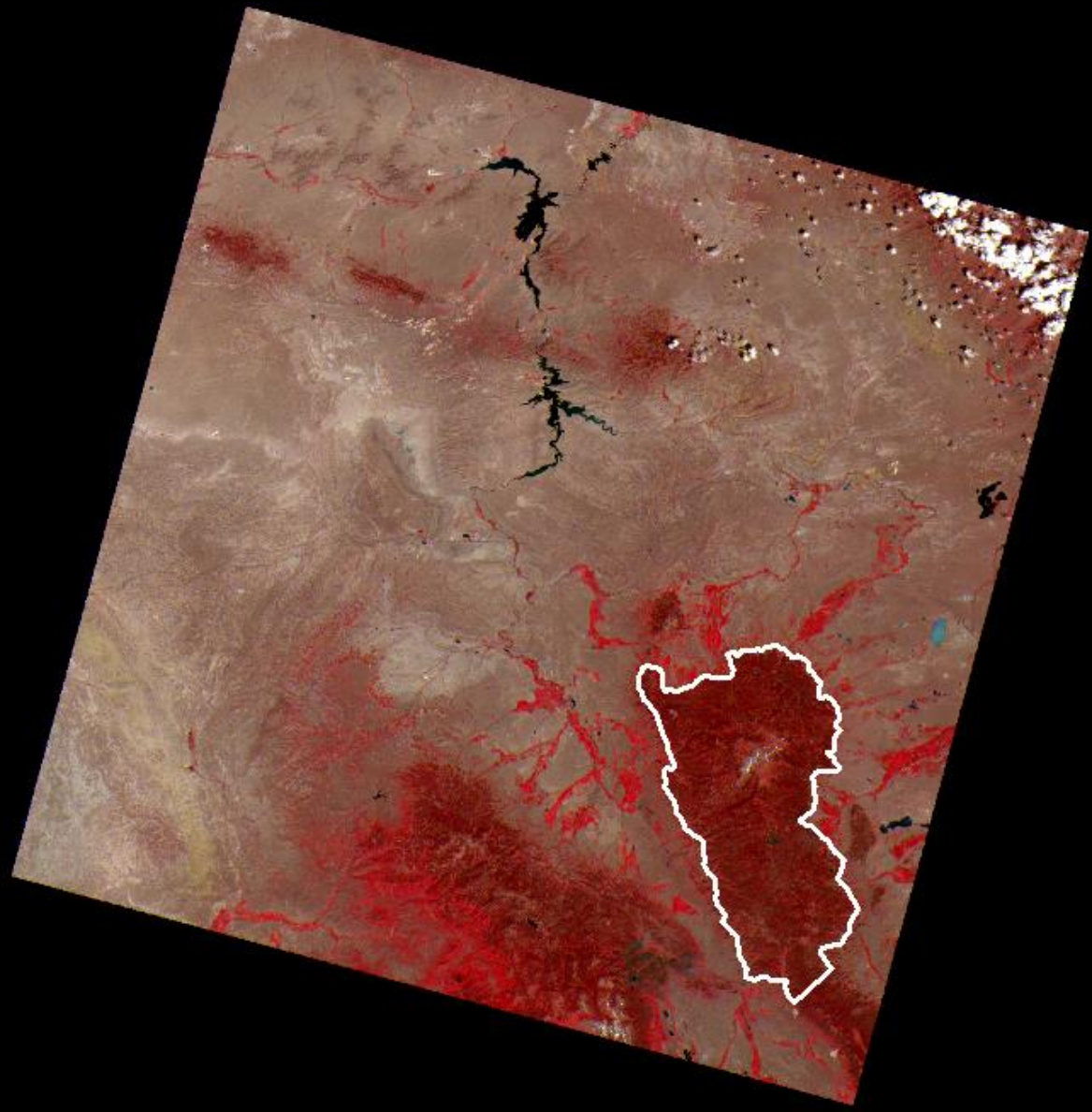
Workflow

Landsat 8 OLI



Workflow

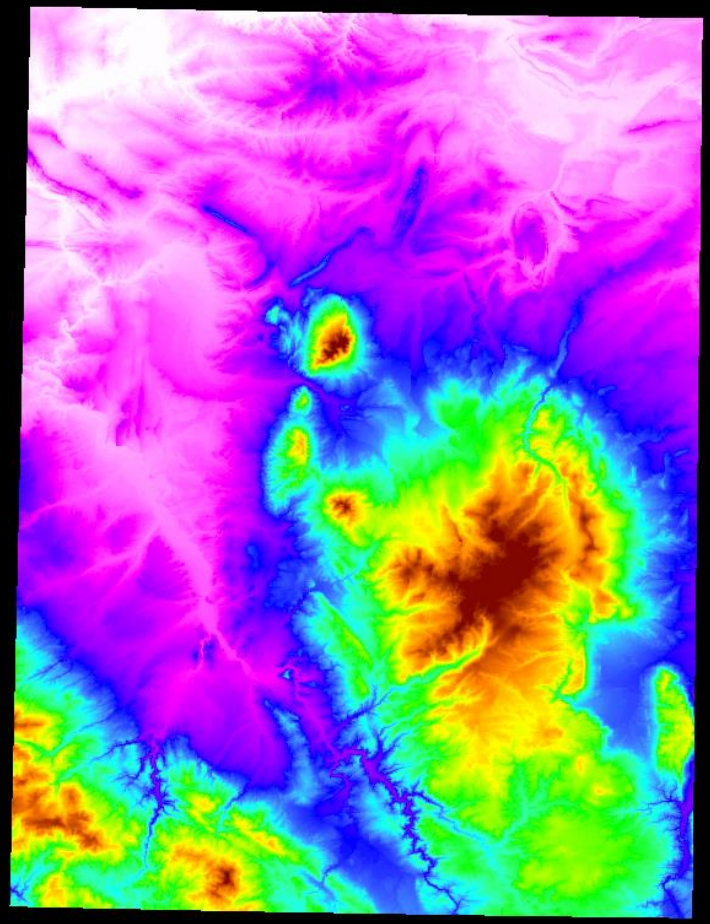
Landsat 8 OLI → Clip



Workflow

Landsat 8 OLI → Clip

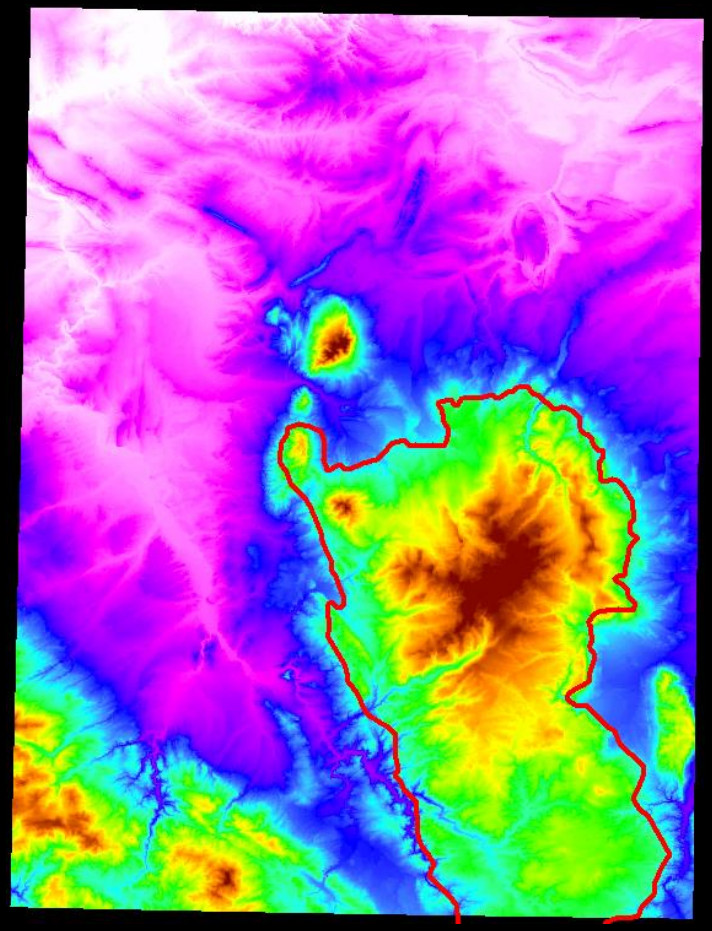
Digital Elevation Model



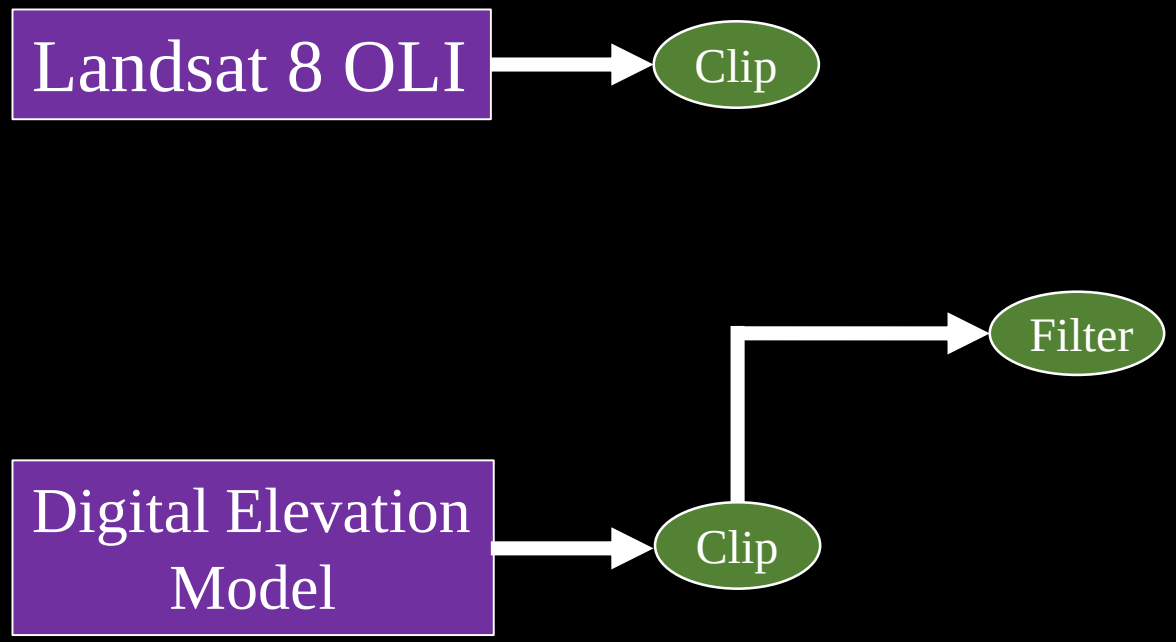
Workflow

Landsat 8 OLI → Clip

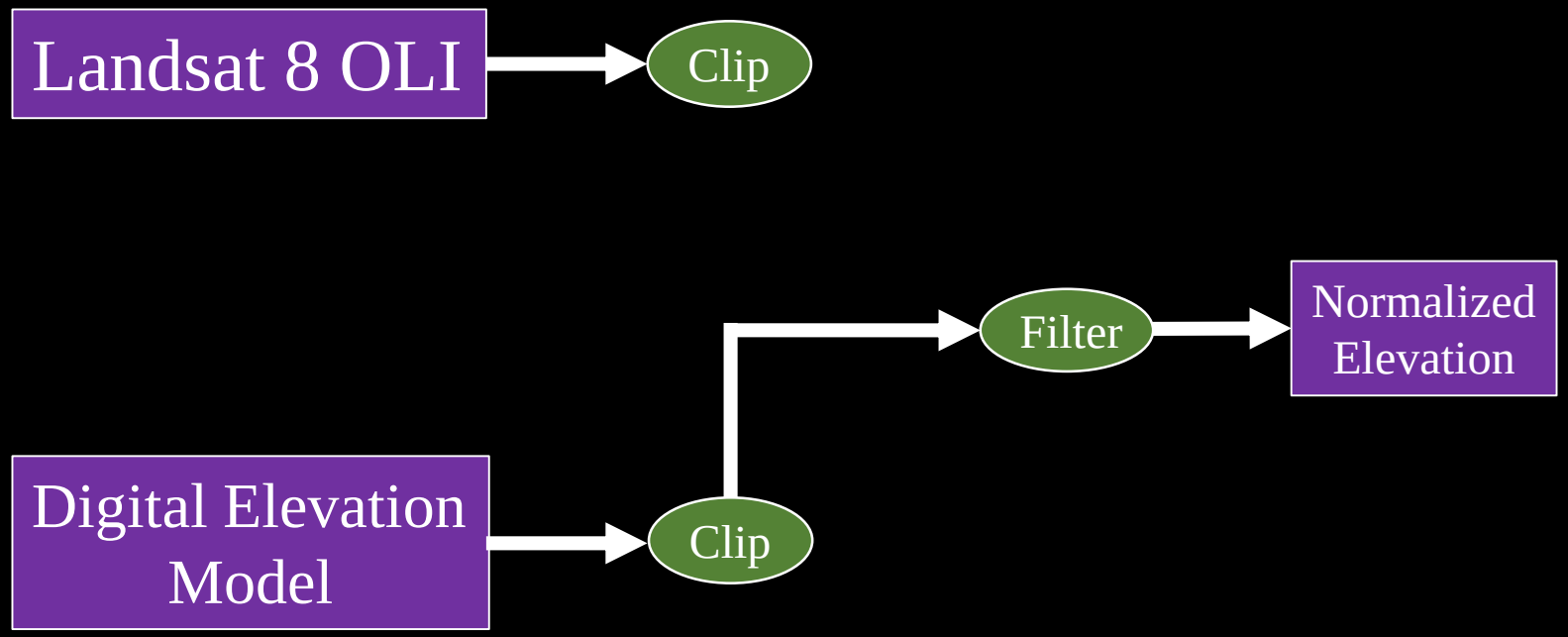
Digital Elevation Model → Clip

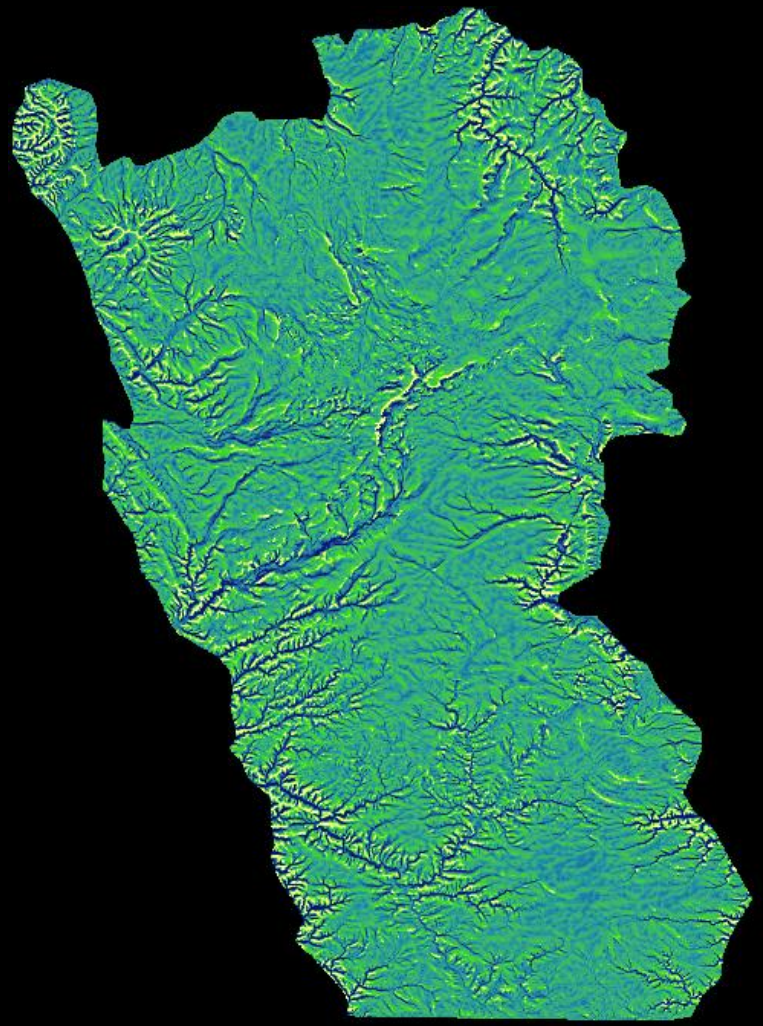


Workflow

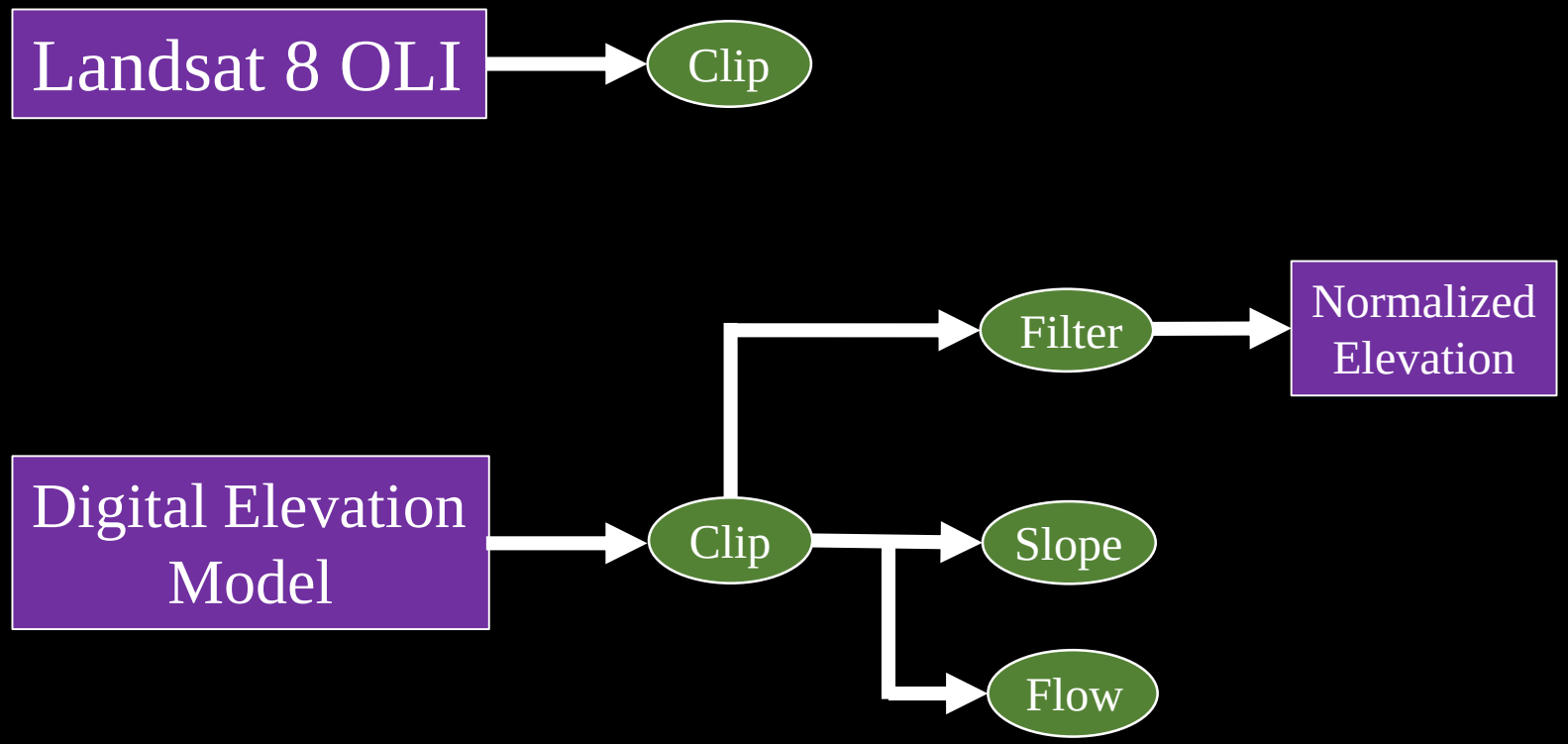


Workflow

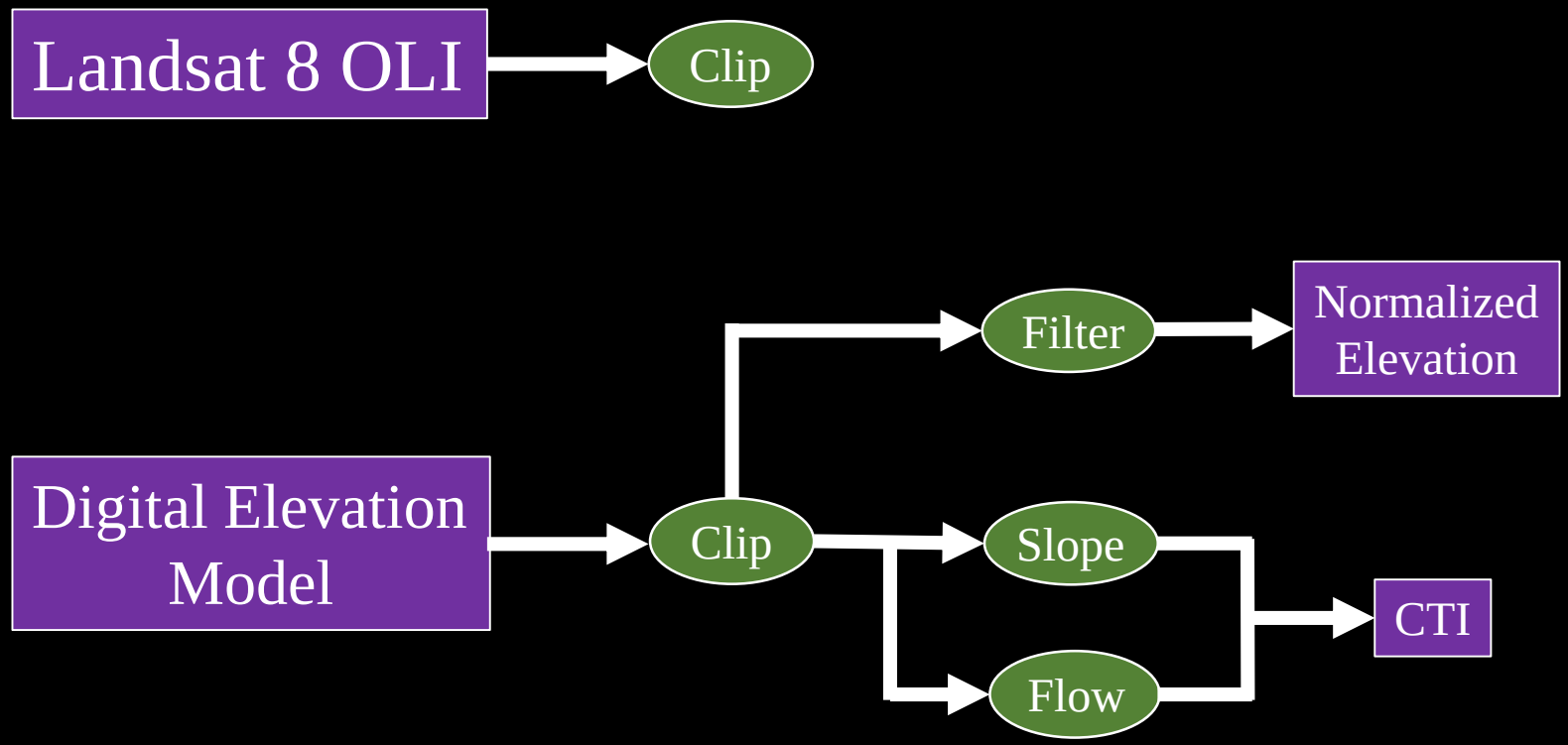

Landsat 8 OLI
Clip
Filter
Normalized Elevation
Digital Elevation Model
Clip

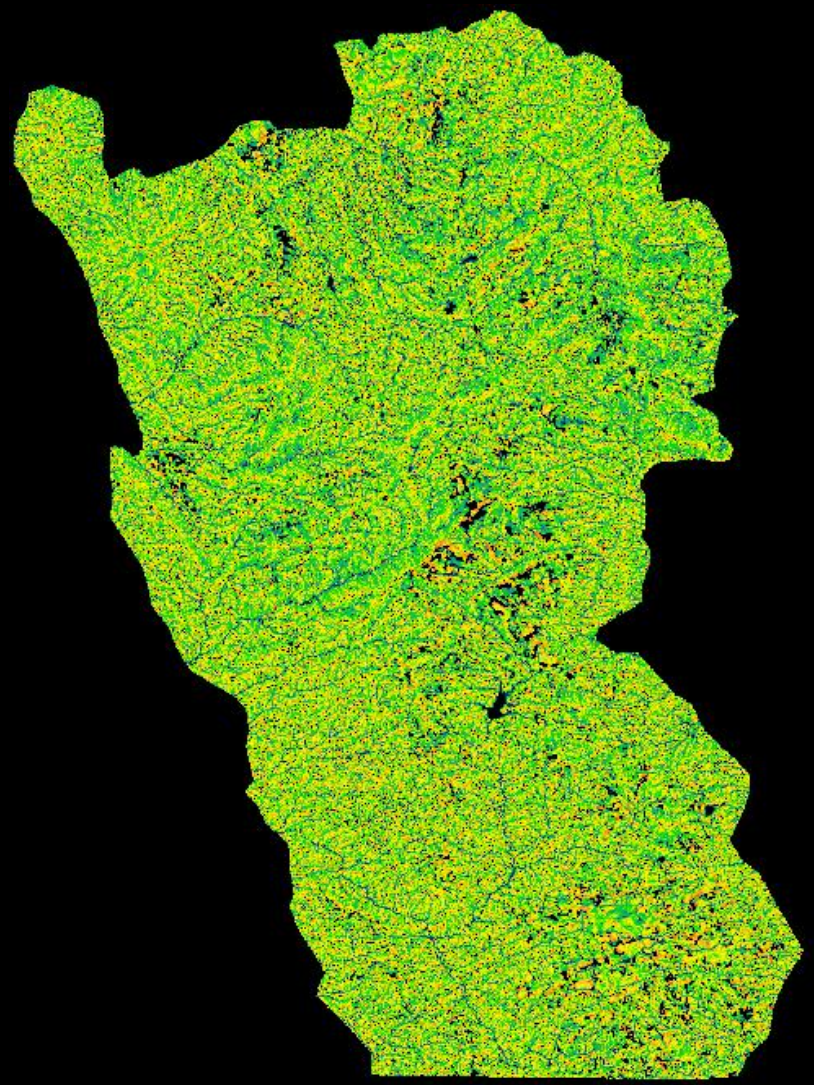


Workflow

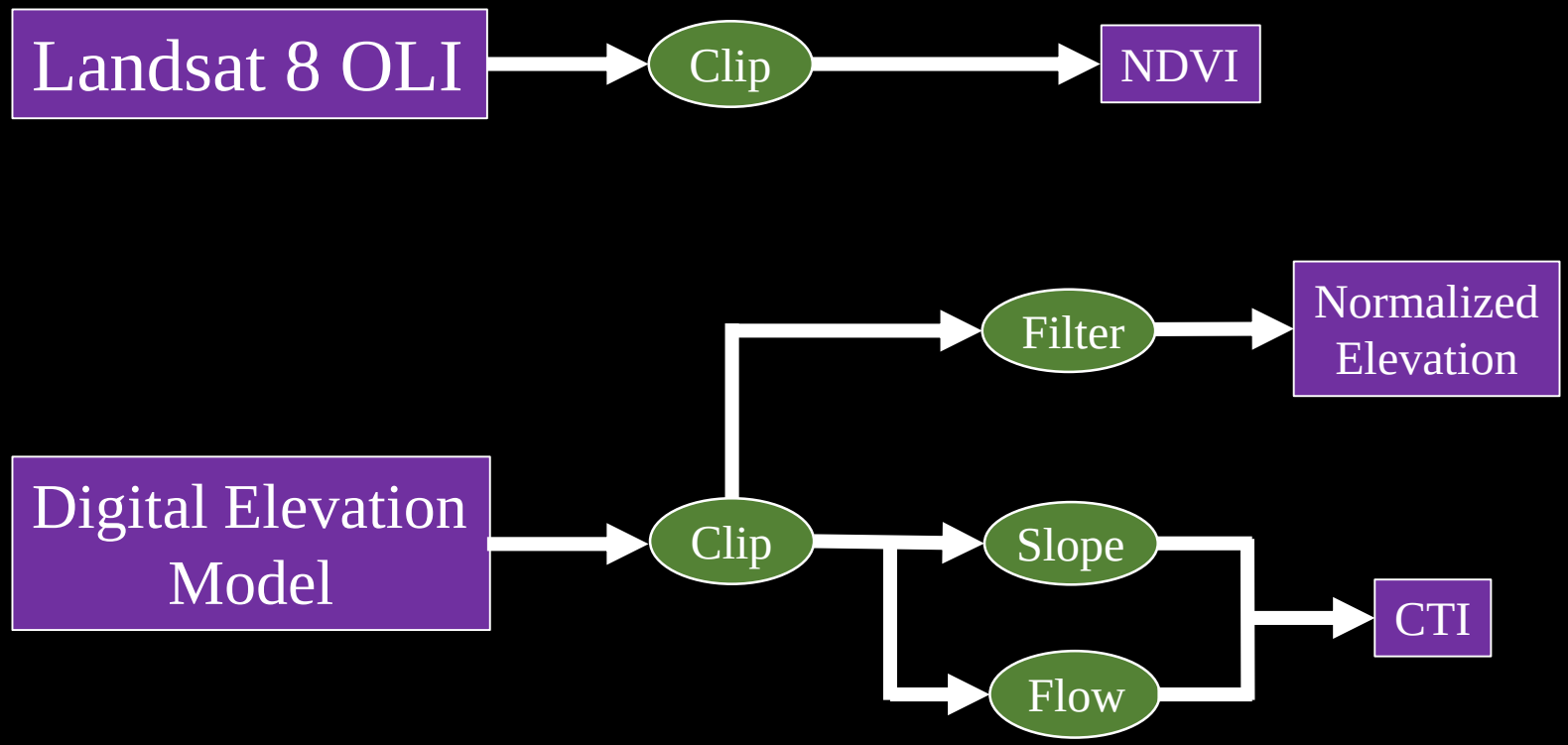

Landsat 8 OLI
Clip
Digital Elevation Model
Clip
Filter
Normalized Elevation
Slope
Flow

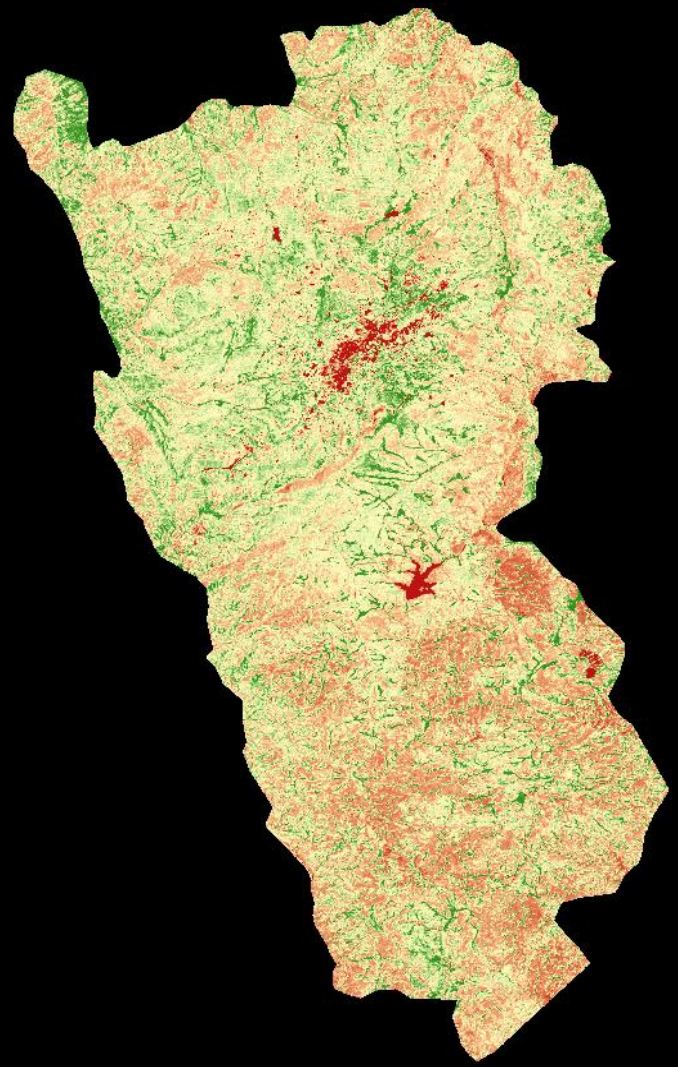
Workflow


Landsat 8 OLI
Clip
Filter
Normalized Elevation
Digital Elevation Model
Clip
Slope
CTI
Flow

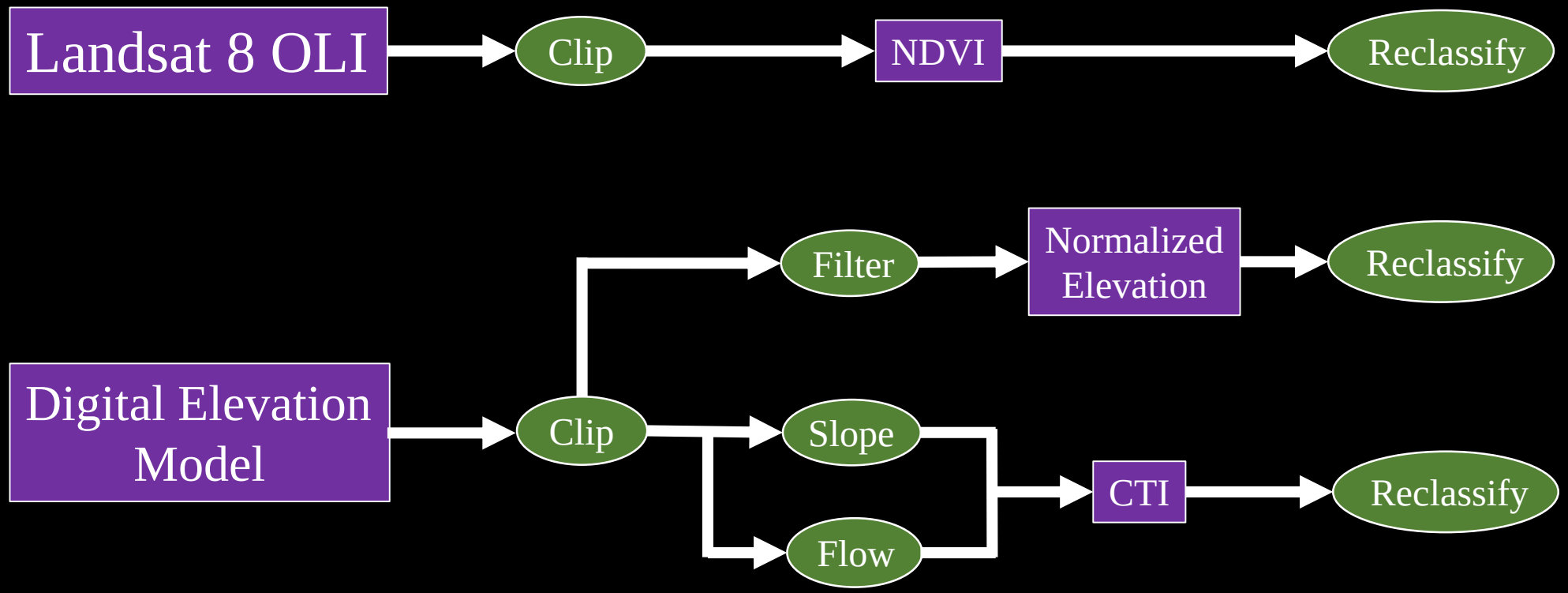


Workflow

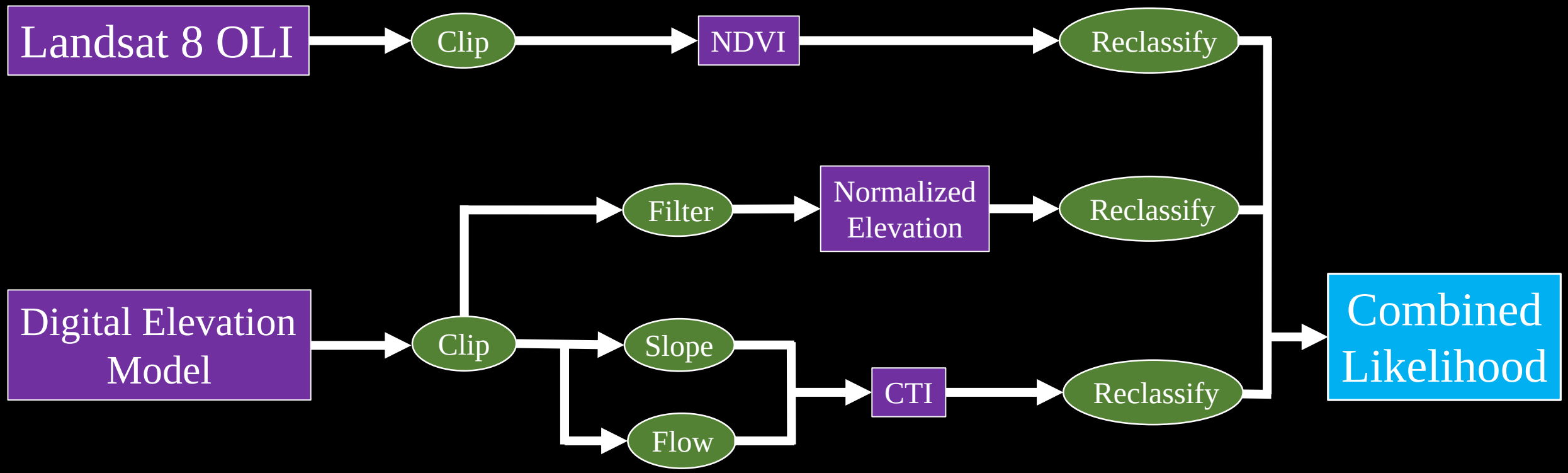

Landsat 8 OLI
Clip
NDVI
Digital Elevation Model
Clip
Filter
Normalized Elevation
Slope
Flow
CTI



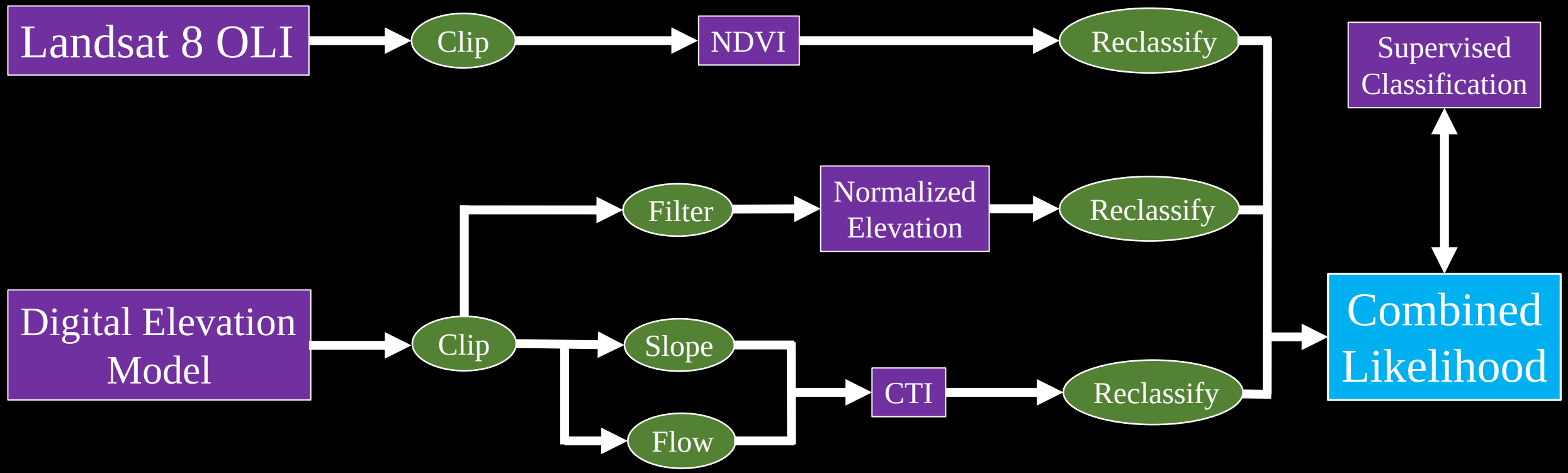
Workflow


Landsat 8 OLI
Clip
NDVI
Reclassify
Digital Elevation Model
Clip
Filter
Normalized Elevation
Reclassify
Slope
Flow
CTI
Reclassify

Workflow

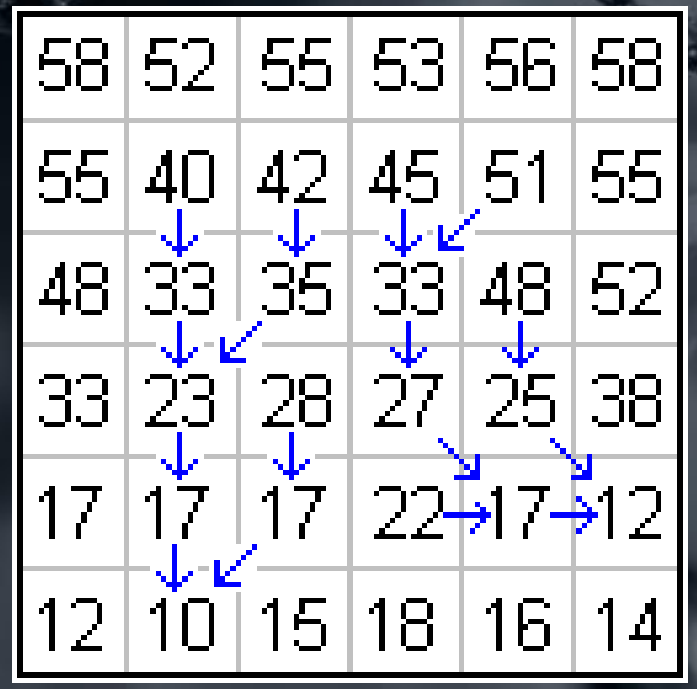

Landsat 8 OLI
Clip
NDVI
Reclassify
Filter
Normalized Elevation
Reclassify
Digital Elevation Model
Clip
Slope
Flow
CTI
Reclassify
Combined Likelihood

Workflow


Landsat 8 OLI
Clip
NDVI
Reclassify
Supervised Classification
Filter
Normalized Elevation
Reclassify
Digital Elevation Model
Clip
Slope
Flow
CTI
Reclassify
Combined Likelihood

Compound Topography Index (CTI)

Calculate Flow Direction



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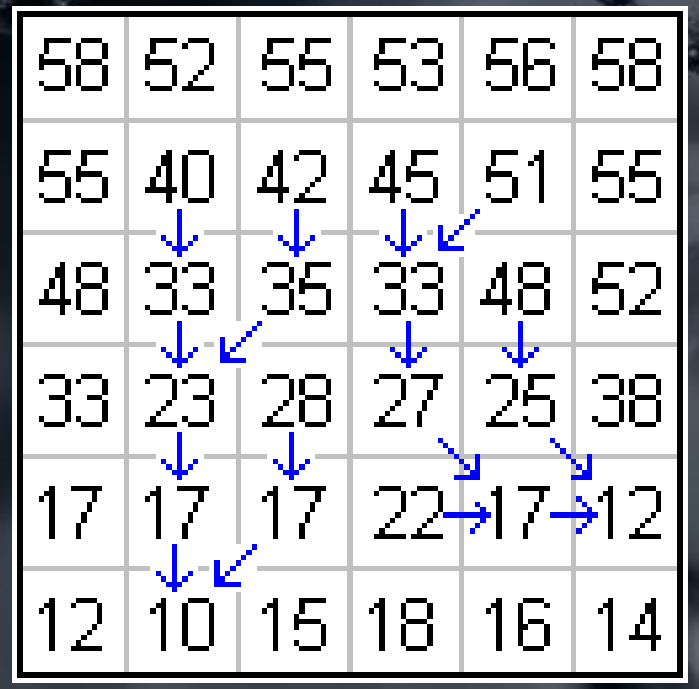
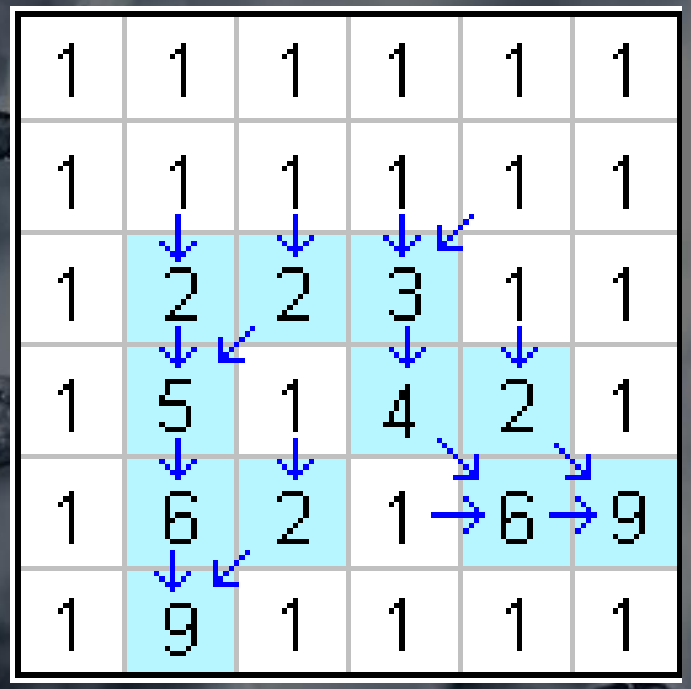
Compound Topography Index (CTI)

Calculate Flow Direction



Calculate Contributing Cells



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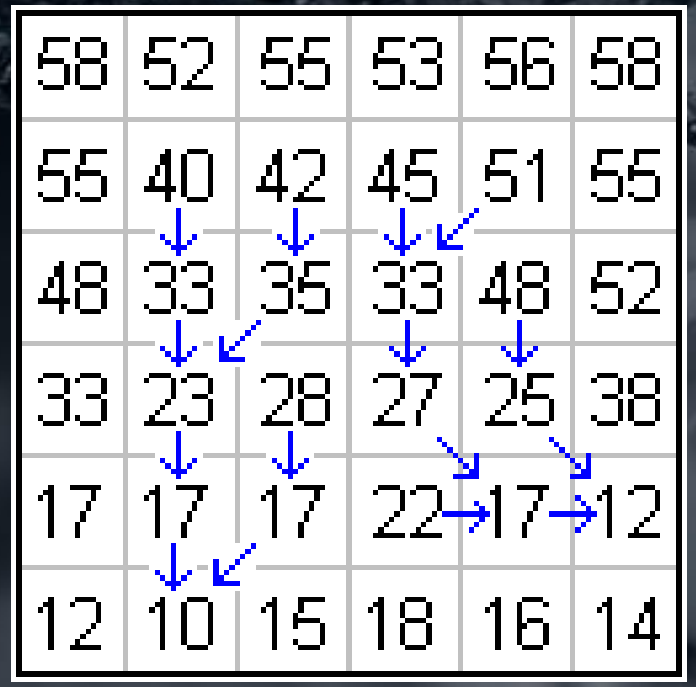
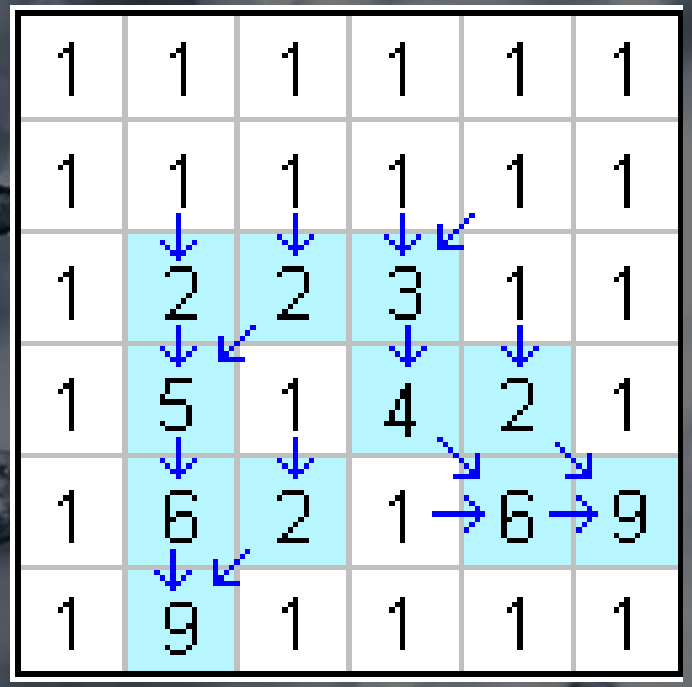
Compound Topography Index (CTI)

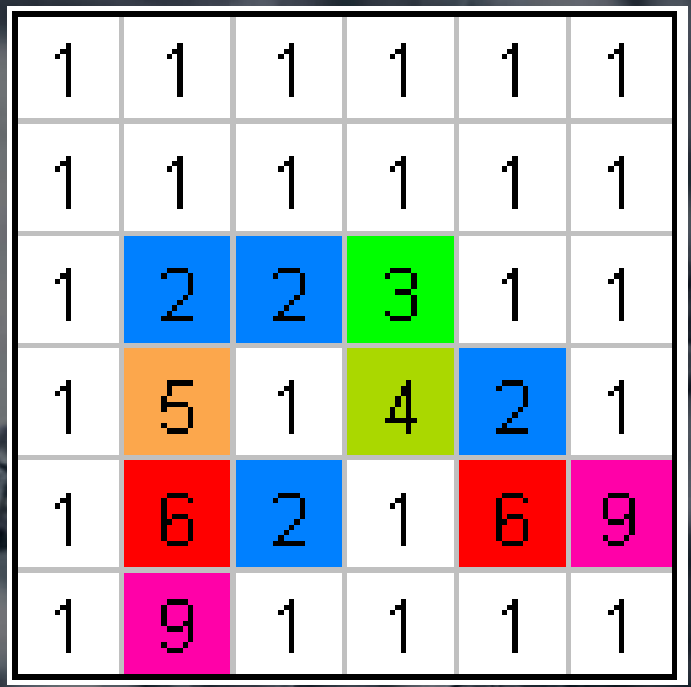
Calculate Flow Direction



Calculate Contributing Cells



Output Flow Accumulation



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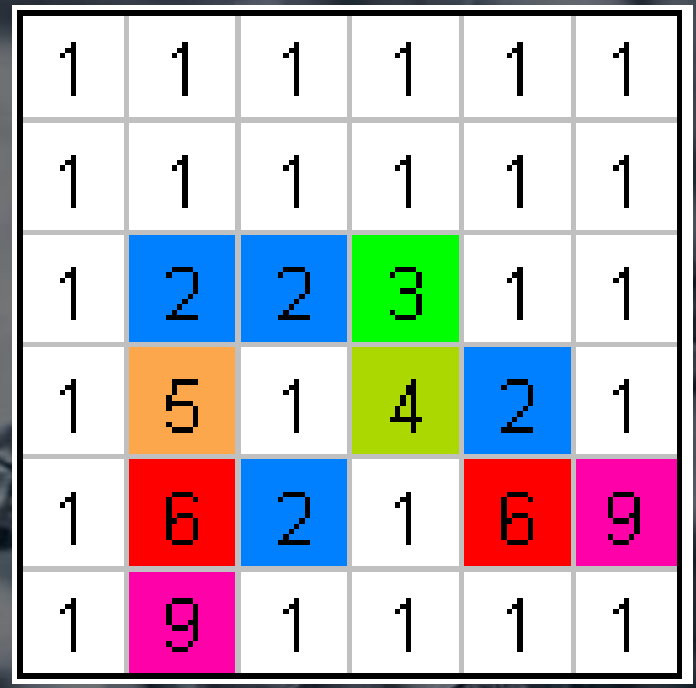
Compound Topography Index (CTI)

$$CTI = Ln\left(\frac{\text{contributing area}}{\tan(\text{slope})}\right)$$

Output Flow Accumulation



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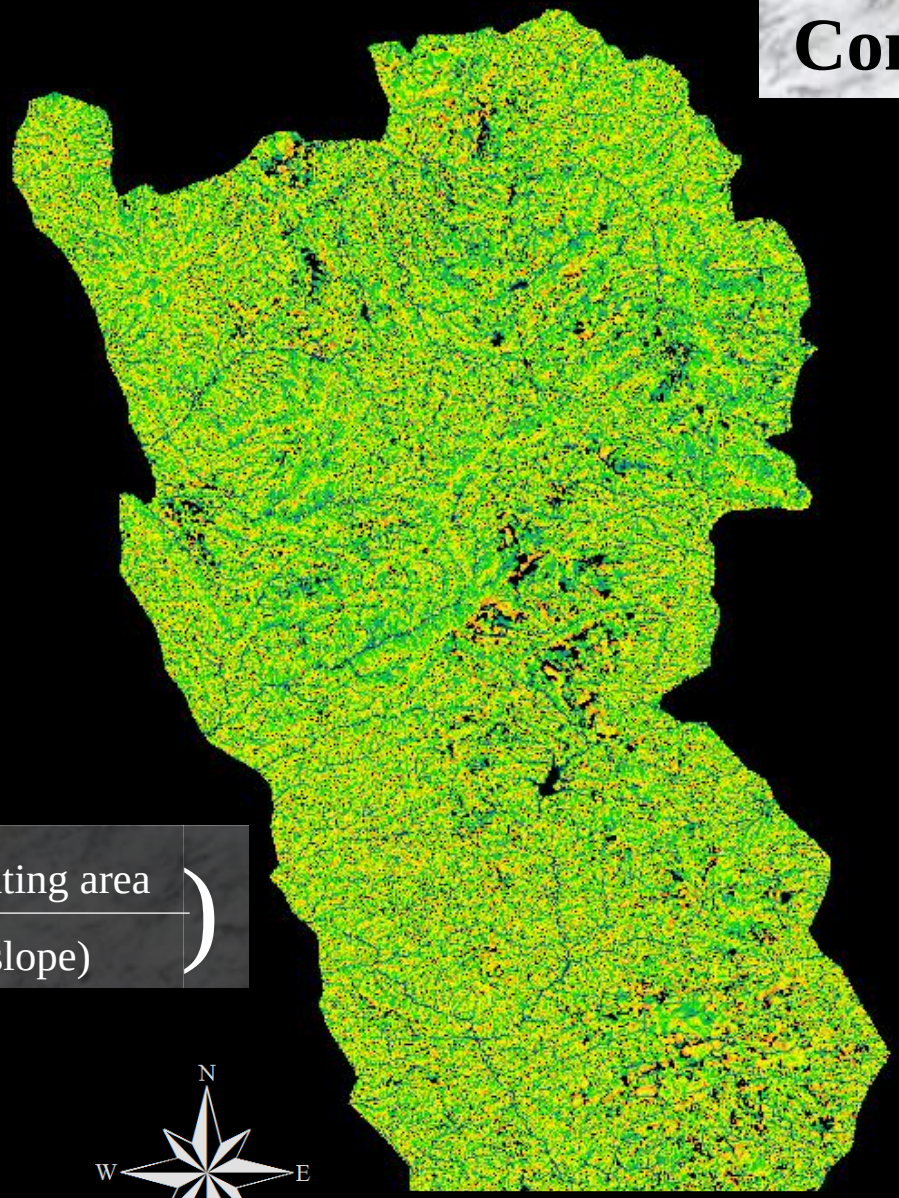
Compound Topography Index (CTI)



$$CTI = Ln\left(\frac{\text{contributing area}}{\tan(\text{slope})}\right)$$

High CTI

Low CTI

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CTI Reclassified

3

2

1

0

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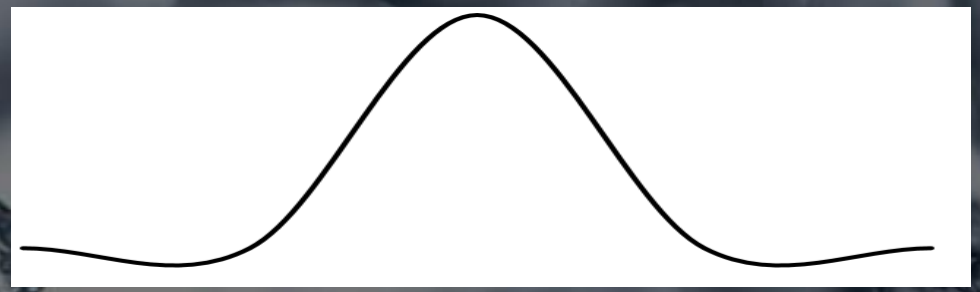
Elevation Filter

5	5	5	5	5
5	5	5	5	5
5	5	10	5	5
5	5	5	5	5
5	5	5	5	5



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Elevation Filter

5	5	5	5	5
5	5.5	5.5	5.5	5
5	5.5	5.5	5.5	5
5	5.5	5.5	5.5	5
5	5	5	5	5

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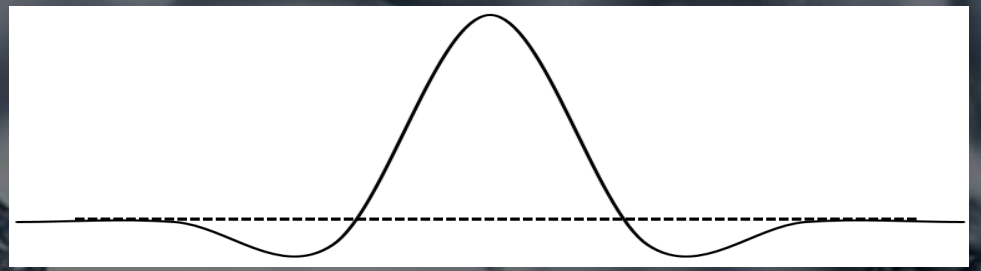
Elevation Filter

0	0	0	0	0
0	-0.5	-0.5	-0.5	0
0	-0.5	4.5	-0.5	0
0	-0.5	-0.5	-0.5	0
0	0	0	0	0



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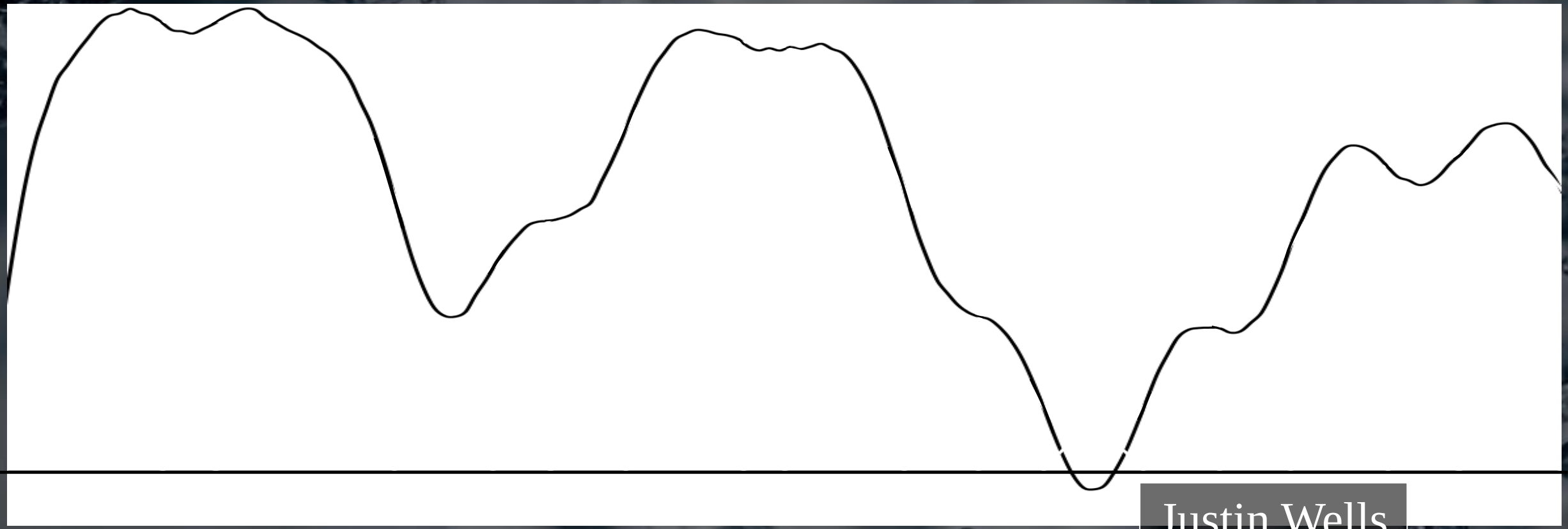
Elevation Filter

Elevation



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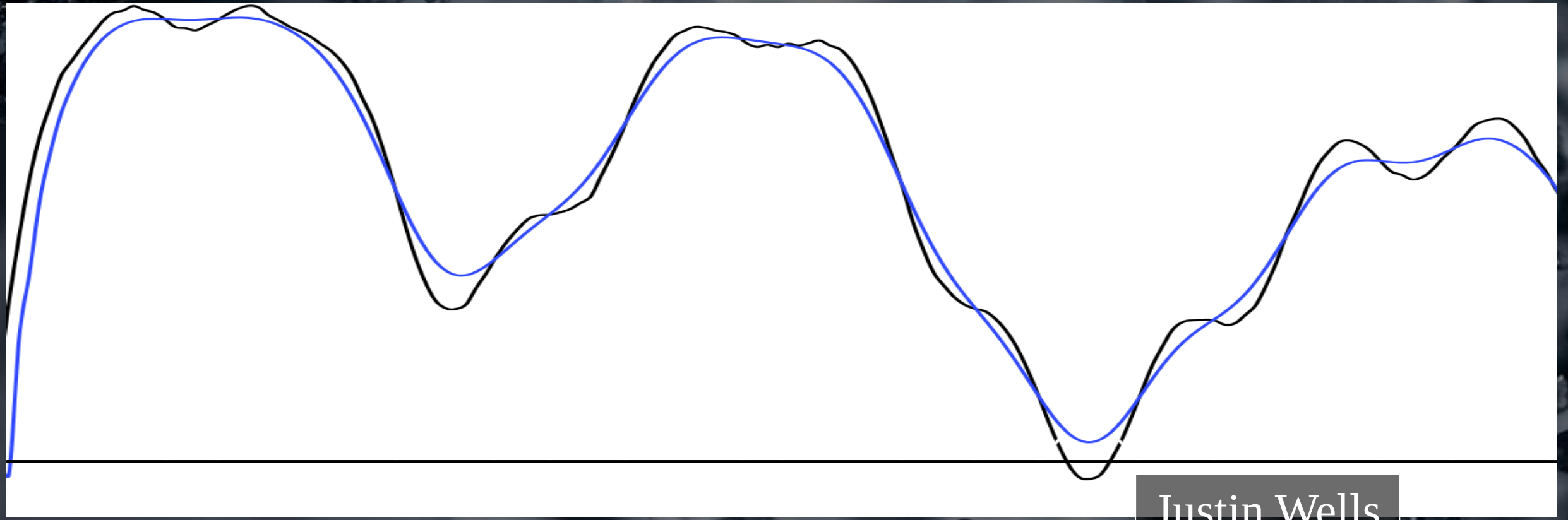
Elevation Filter



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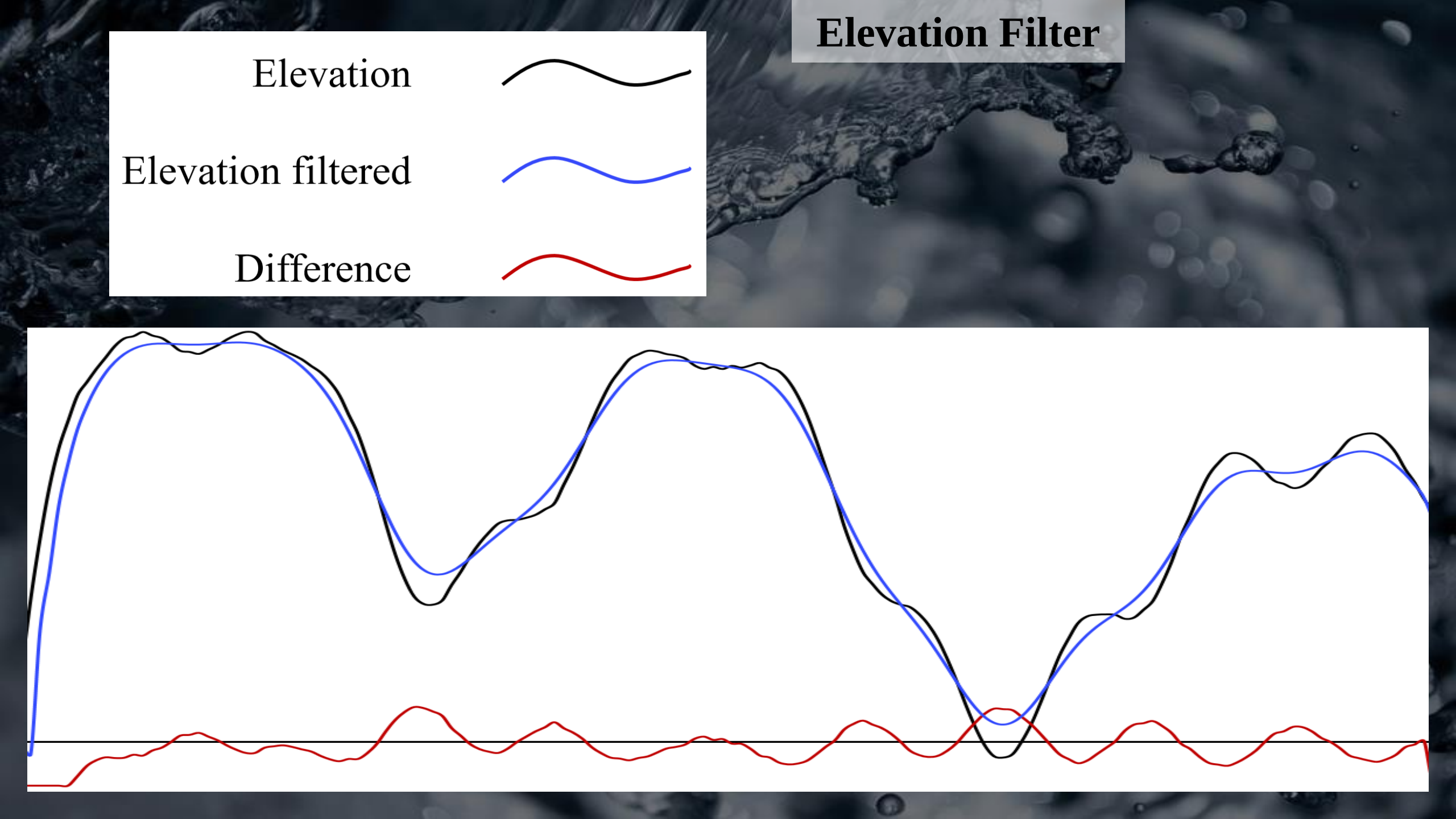
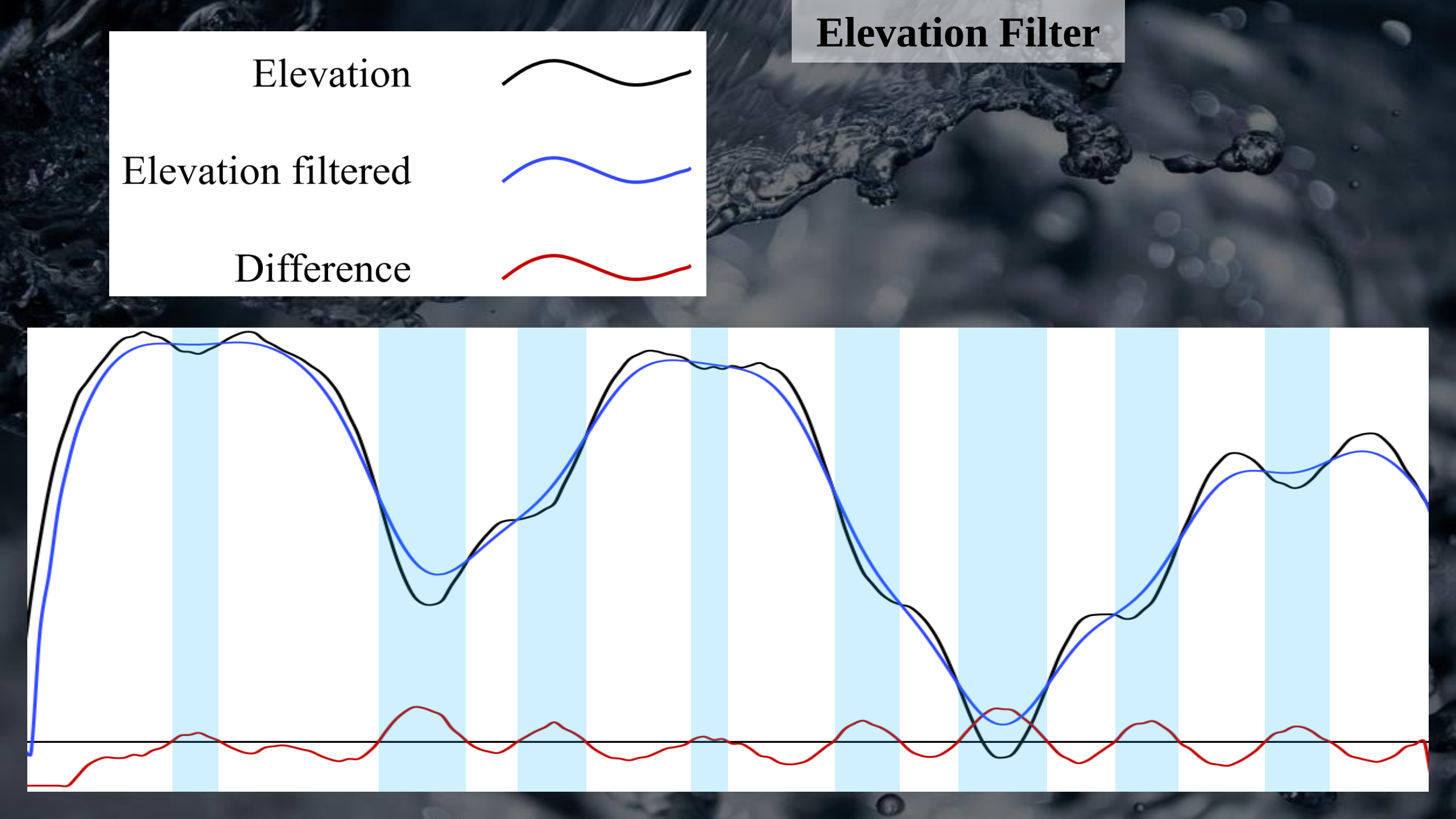
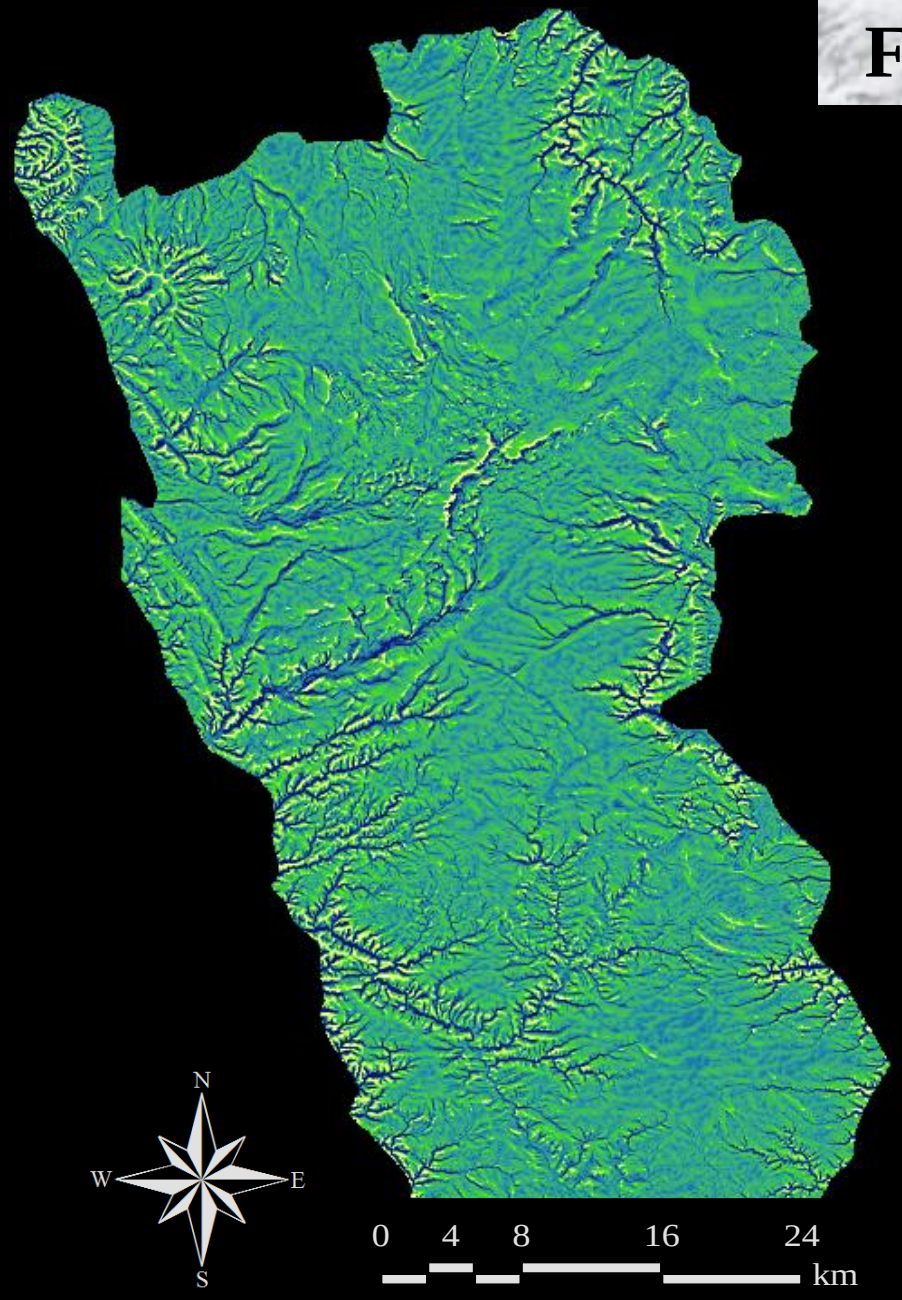
Elevation Filter



Elevation Filter



Filtered elevation minus elevation



Ridge

Valley

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Difference Reclassified

6

5

4

3

2

1

0

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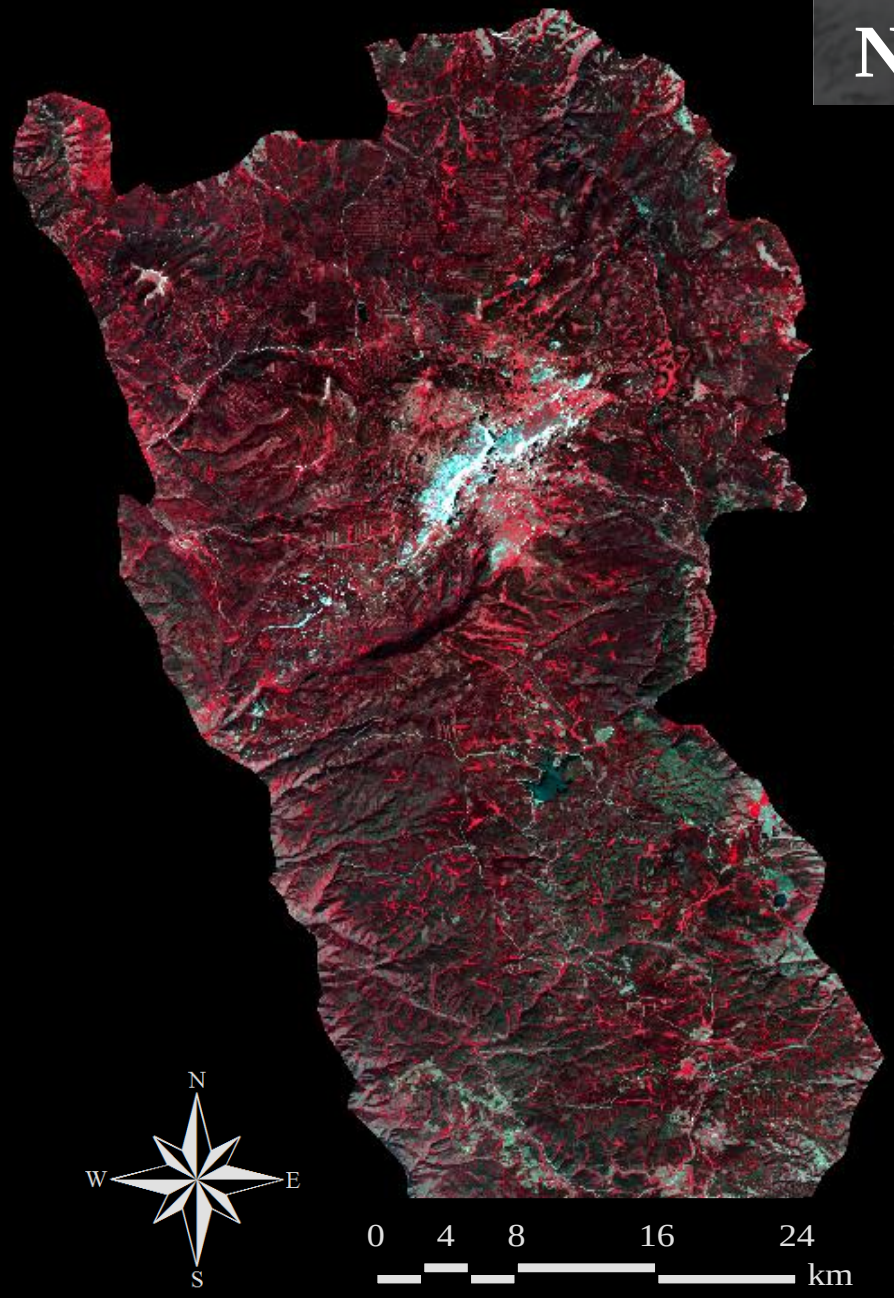
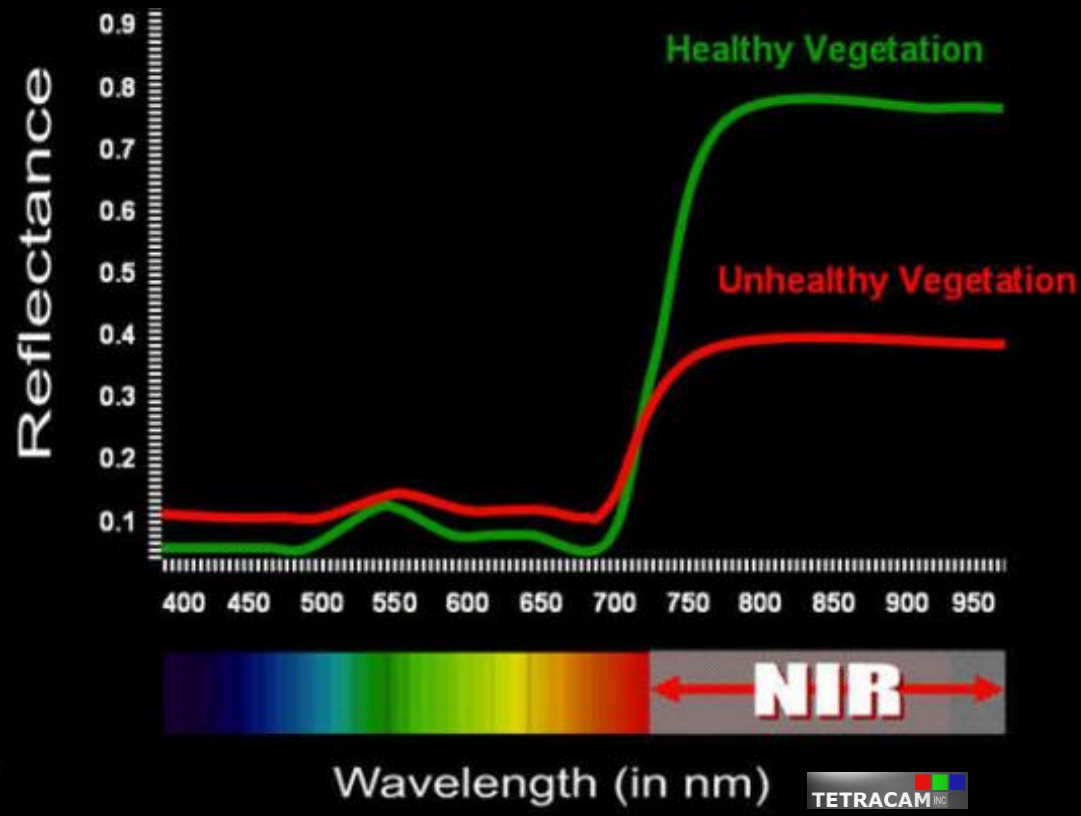
NDVI





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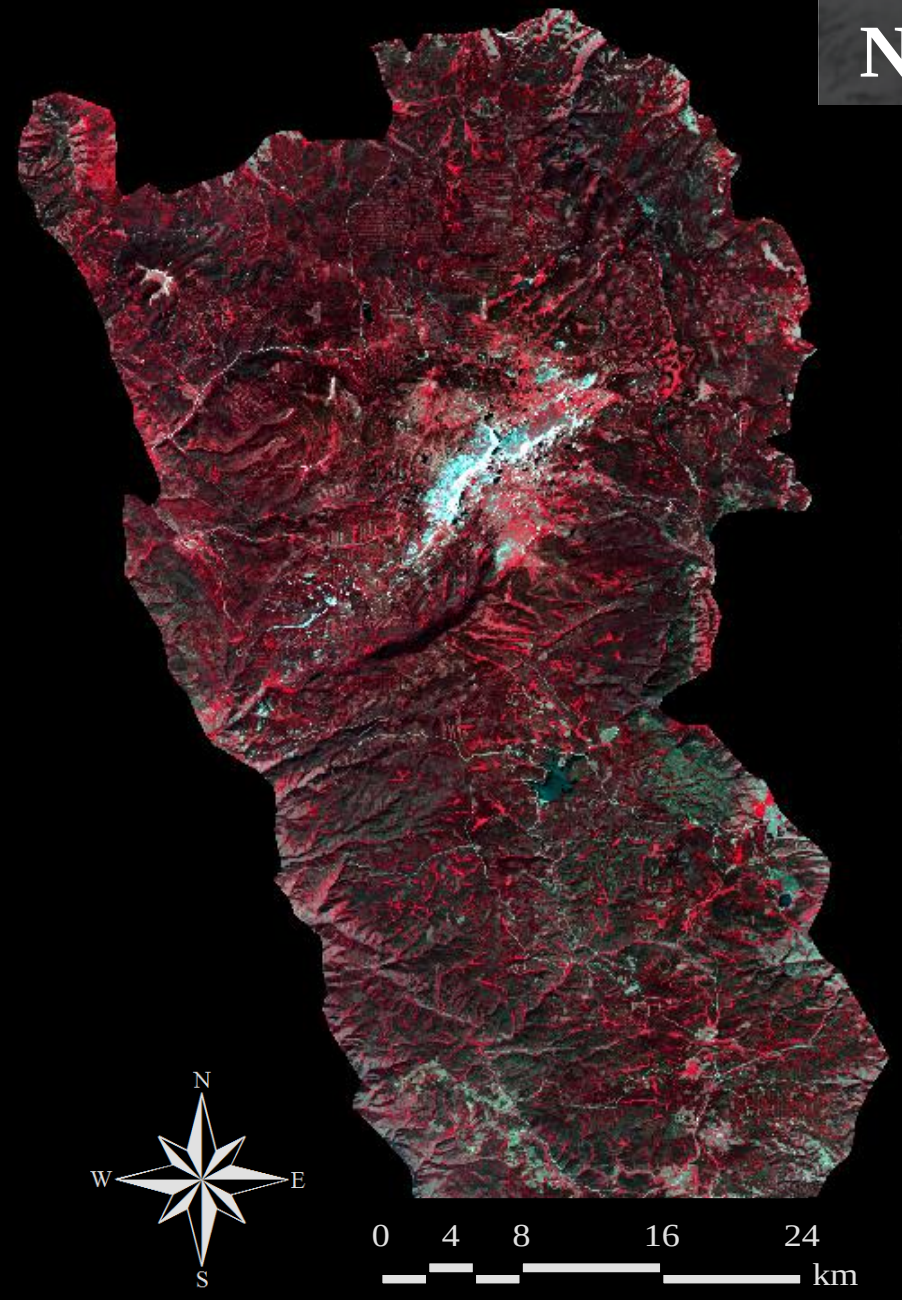
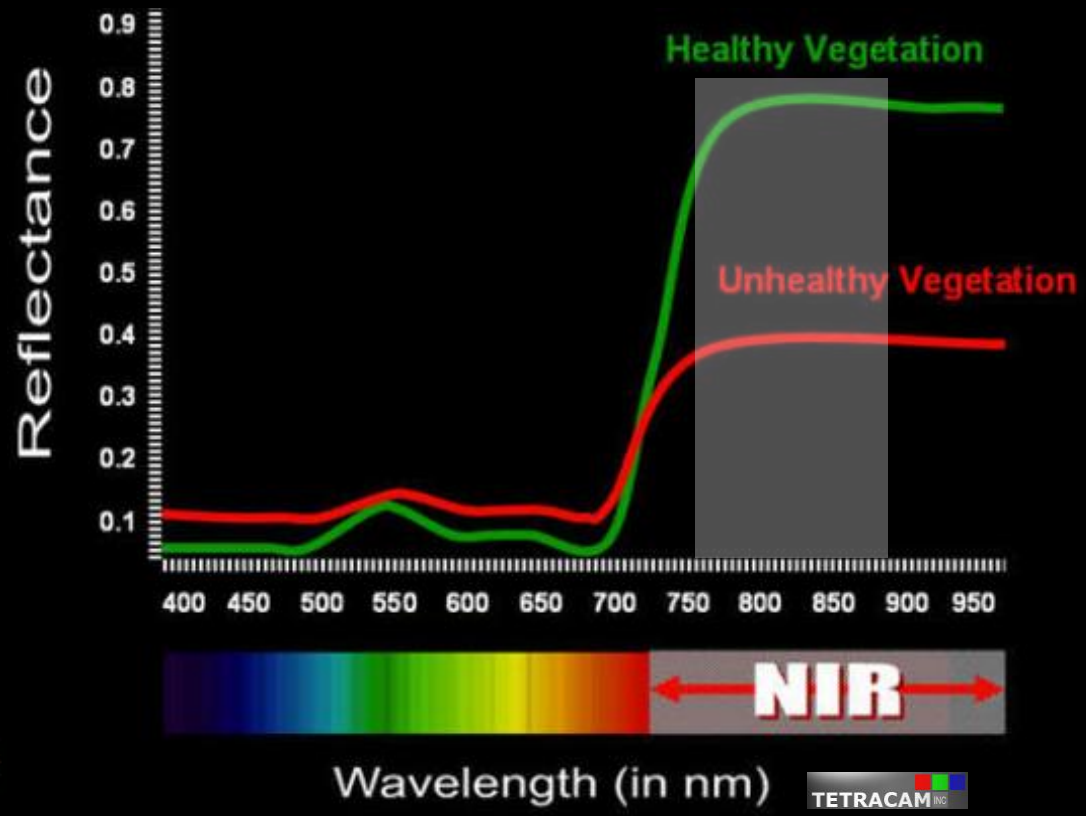
NDVI



NIR



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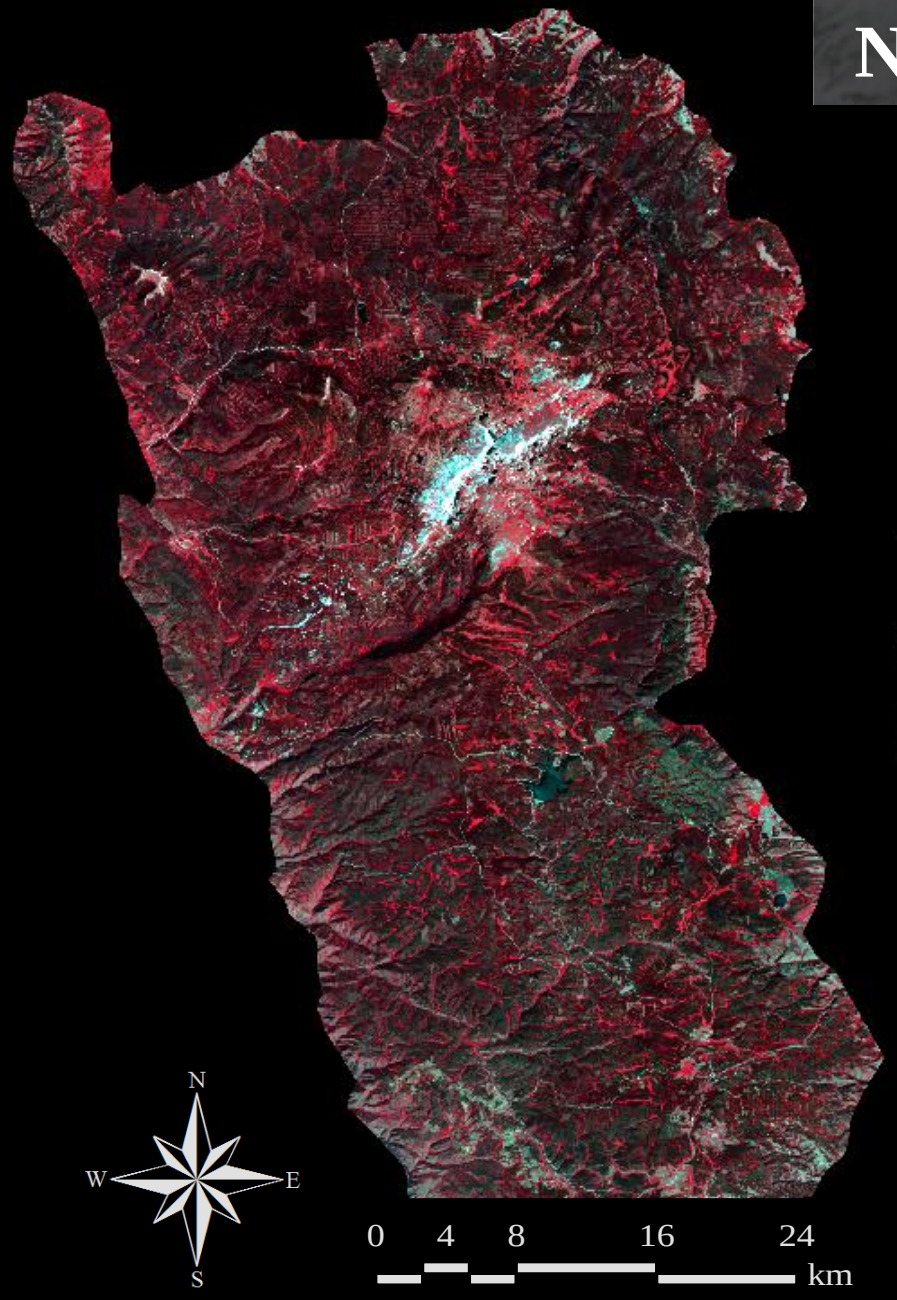
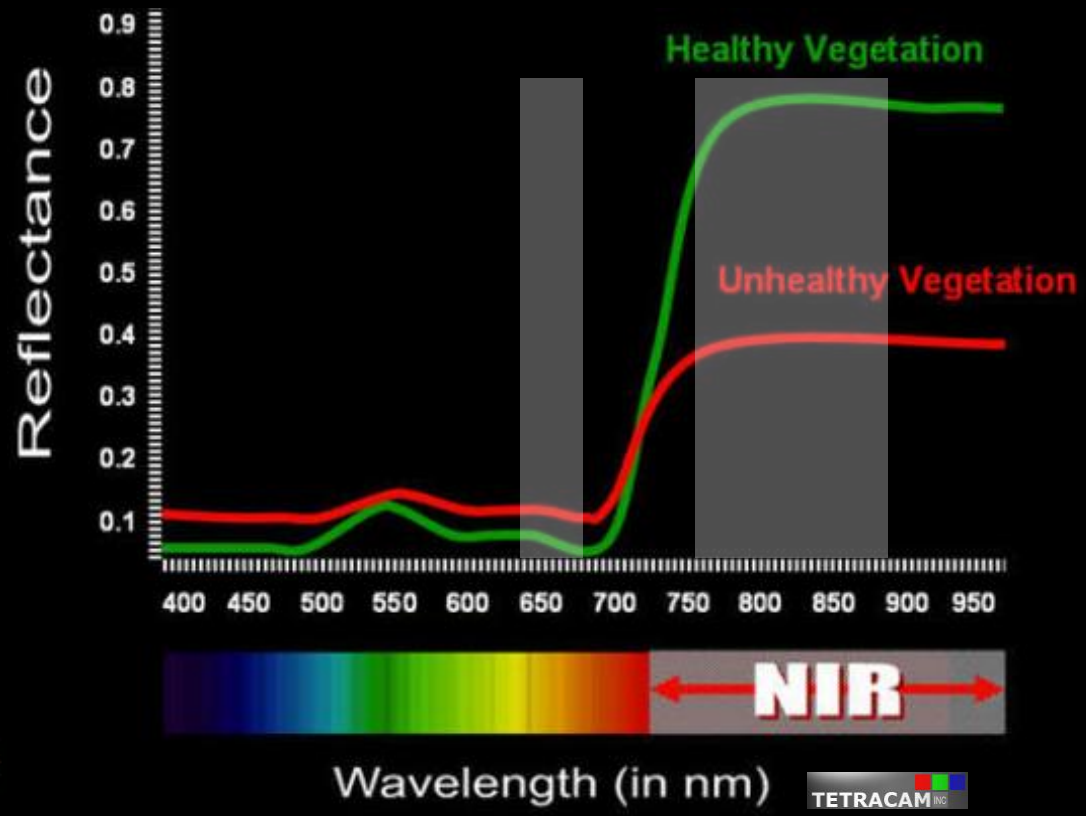
NDVI



NIR – red



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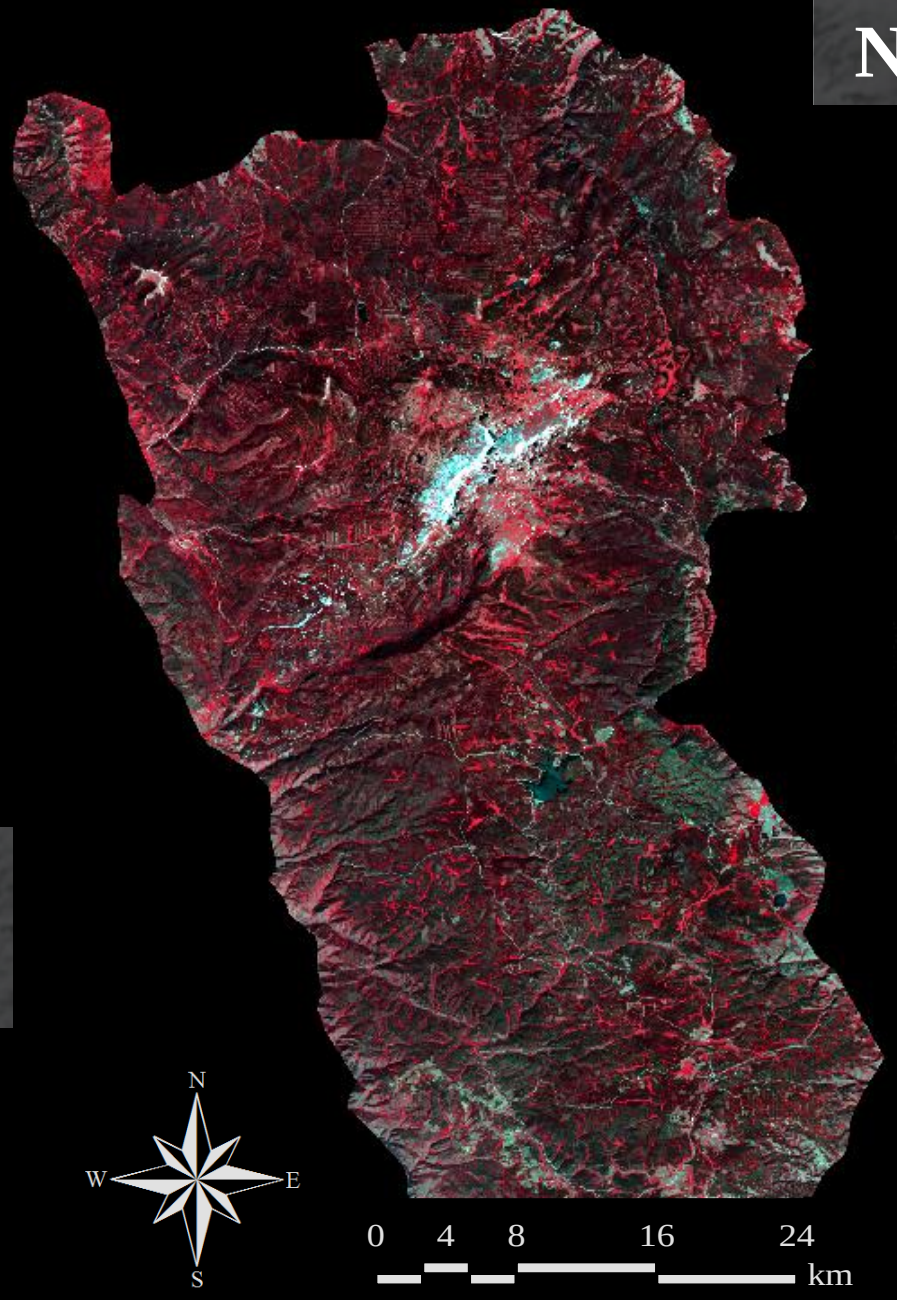
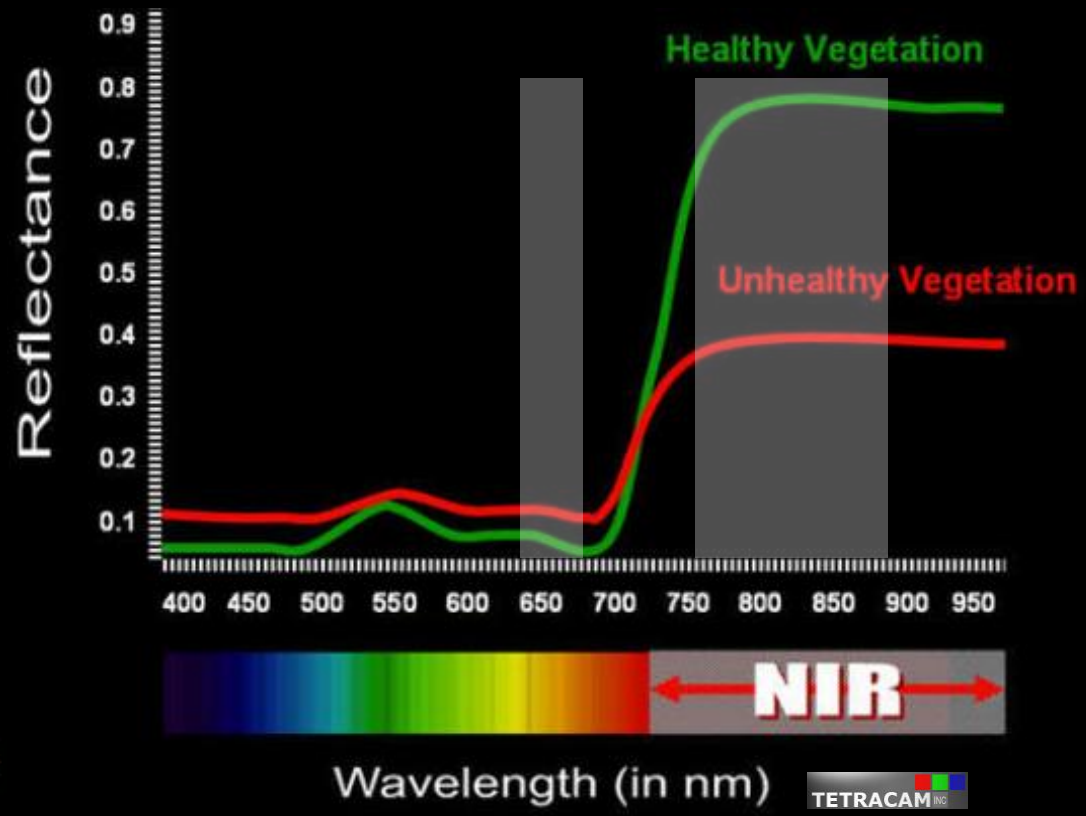
NDVI



$$\frac{\text{NIR} - \text{red}}{\text{NIR} + \text{red}}$$



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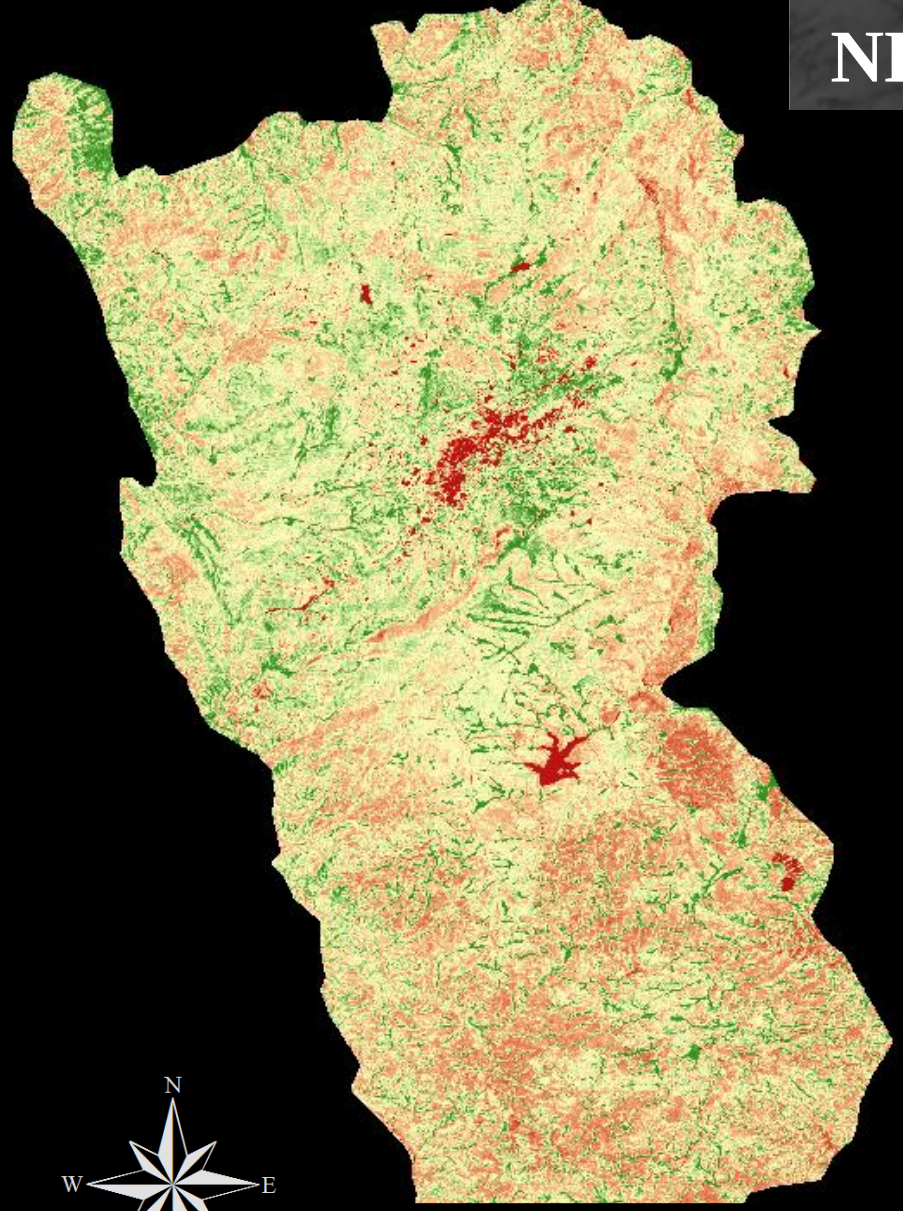
NDVI



Healthy Vegetation

Stressed Vegetation
or Pine Forest

No Vegetation

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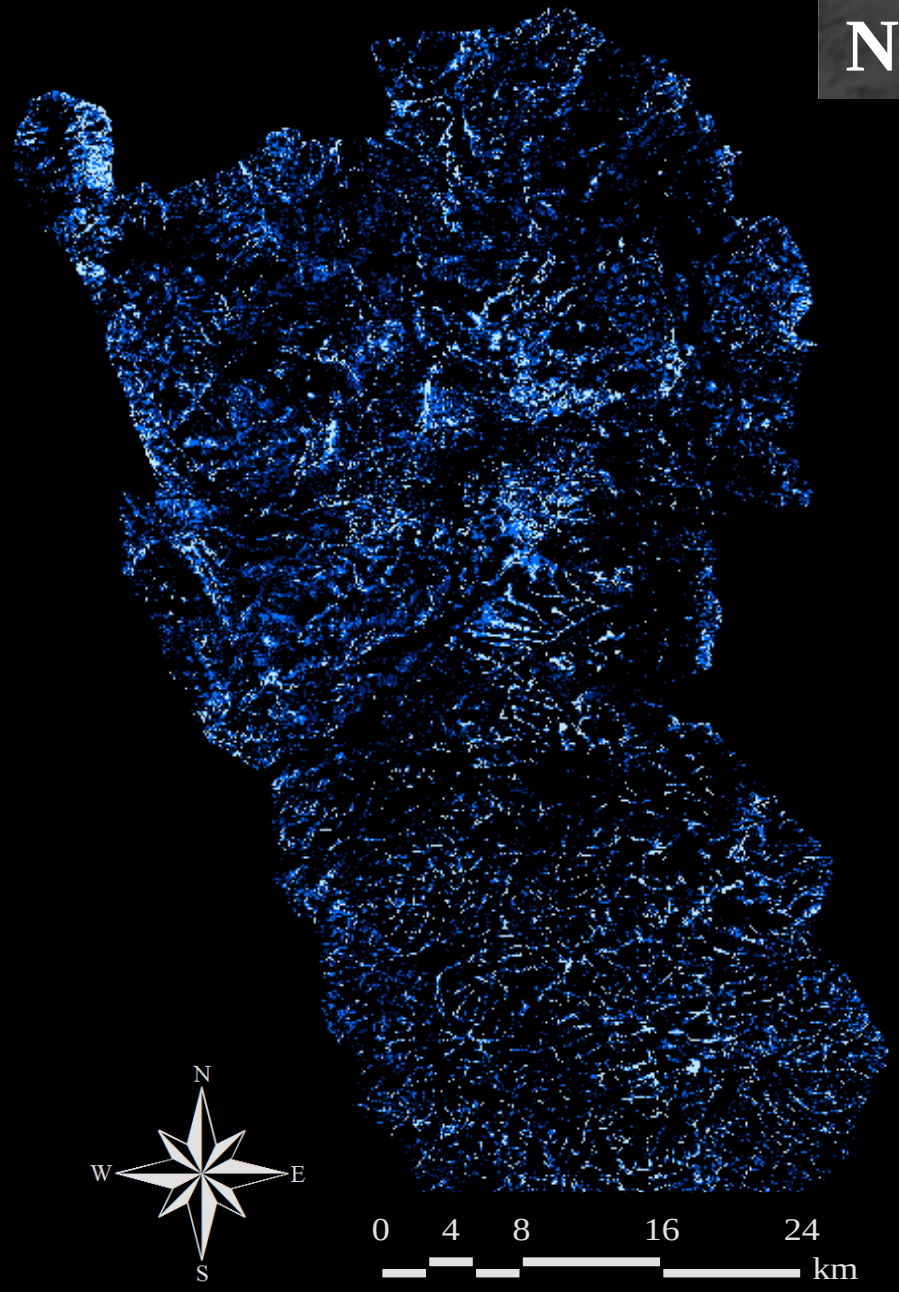
NDVI Reclassified



5 Most Likely

2

0 Least Likely

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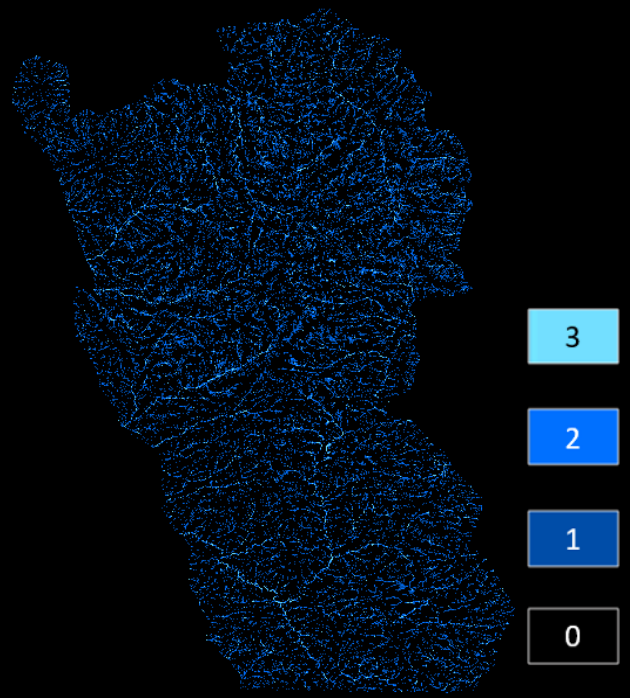
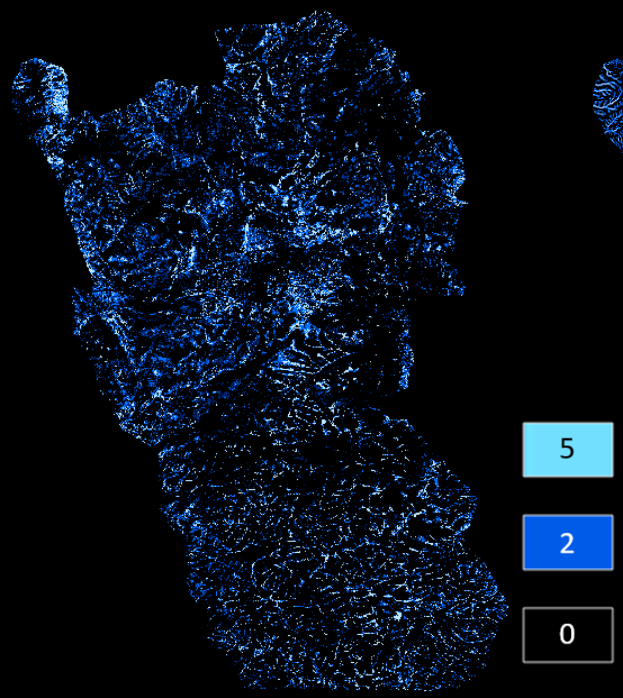
Combined Likelihood

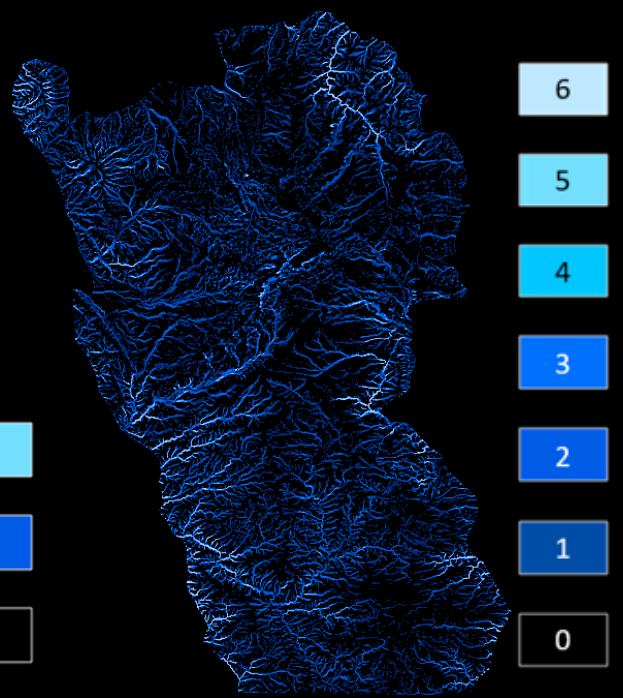
CTI



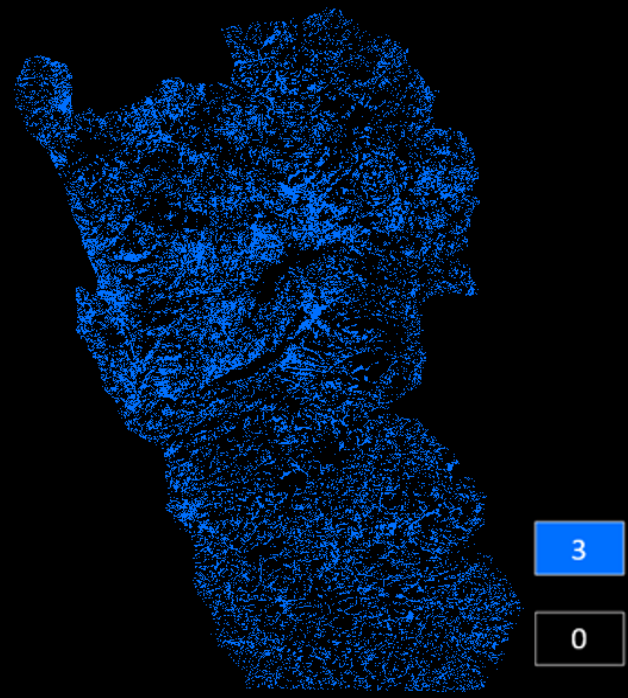
NDVI



Normalized Elevation



Multispectral Classification



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Combined Likelihood

16-17

14-15

11-13

9-10

8

6-7

0-5

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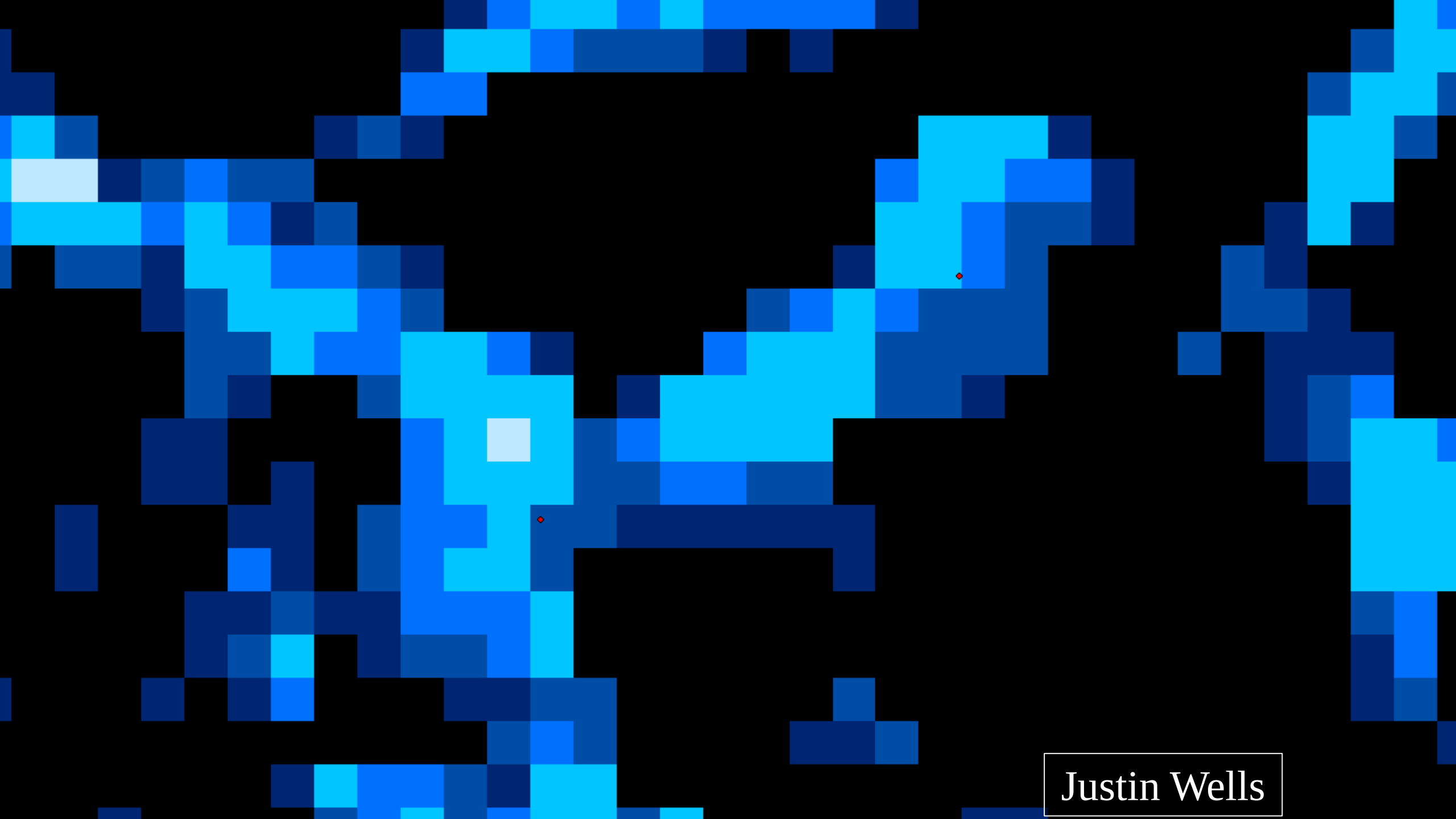
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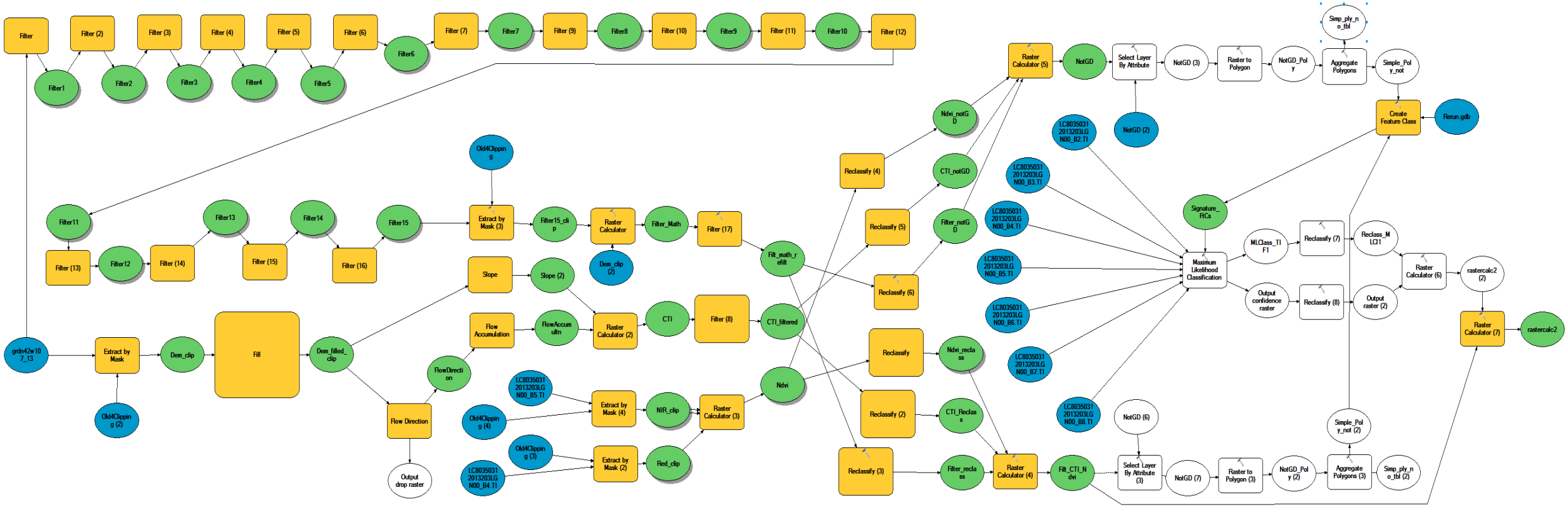
Filter
Filter (2)
Filter (3)
Filter (4)
Filter (5)
Filter (6)
Filter (7)
Filter (9)
Filter (10)
Filter (11)
Filter (12)
Filter1
Filter2
Filter3
Filter4
Filter5
Filter6
Filter7
Filter8
Filter9
Filter10
Filter11
Filter (13)
Filter12
Filter (14)
Filter13
Filter (15)
Filter14
Filter (16)
Filter15
Old4Clipping
Extract by Mask (3)
Filter15_clip
Raster Calculator
Dem_clip (2)
Filter_Math
Filter (17)
Filt_math_refilt
grdn42w107_13
Extract by Mask
Old4Clipping (2)
Dem_clip
Fill
Dem_filled_clip
Slope
Slope (2)
Flow Accumulation
FlowAccumultn
Raster Calculator (2)
CTI
Filter (8)
CTI_filtered
Flow Direction
FlowDirection
Output drop raster
LC8035031 2013203LGN00_B5.TI
Extract by Mask (4)
NIR_clip
Raster Calculator (3)
Old4Clipping (4)
Old4Clipping (3)
LC8035031 2013203LGN00_B4.TI
Extract by Mask (2)
Red_clip
Ndvi
Reclassify (4)
Reclassify (5)
Reclassify (6)
Reclassify
Reclassify (2)
Reclassify (3)
Ndvi_notGD
CTI_notGD
Filter_notGD
Ndvi_reclass
CTI_Reclass
Filter_reclass
Raster Calculator (5)
NotGD
Select Layer By Attribute
NotGD (3)
Raster to Polygon
NotGD_Poly
Aggregate Polygons
Simple_Poly_not
Simp_ply_no_tbl
Create Feature Class
Rerun.gdb
NotGD (2)
LC8035031 2013203LGN00_B2.TI
LC8035031 2013203LGN00_B3.TI
LC8035031 2013203LGN00_B4.TI
LC8035031 2013203LGN00_B5.TI
LC8035031 2013203LGN00_B6.TI
LC8035031 2013203LGN00_B7.TI
LC8035031 2013203LGN00_B8.TI
Signature_RCa
Maximum Likelihood Classification
MLClass_TIF1
Output confidence raster
Reclassify (7)
Reclassify (8)
Reclass_MLC1
Output raster (2)
Raster Calculator (6)
rastercalc2 (2)
Raster Calculator (7)
rastercalc2
Raster Calculator (4)
Filt_CTI_Ndvi
Select Layer By Attribute (3)
NotGD (6)
NotGD (7)
Raster to Polygon (3)
NotGD_Poly (2)
Aggregate Polygons (3)
Simple_Poly_not (2)
Simp_ply_no_tbl (2)

Conclusion

- Accuracy Assessment
- Radar
- Characterizing and Classifying GDEs provides insight to larger-scale ecologic and hydrologic processes.
- Geospatial technologies could increase efficiency several fold for dozens of research teams across the nation.

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Acknowledgements

- Narcisa Pricope PhD.

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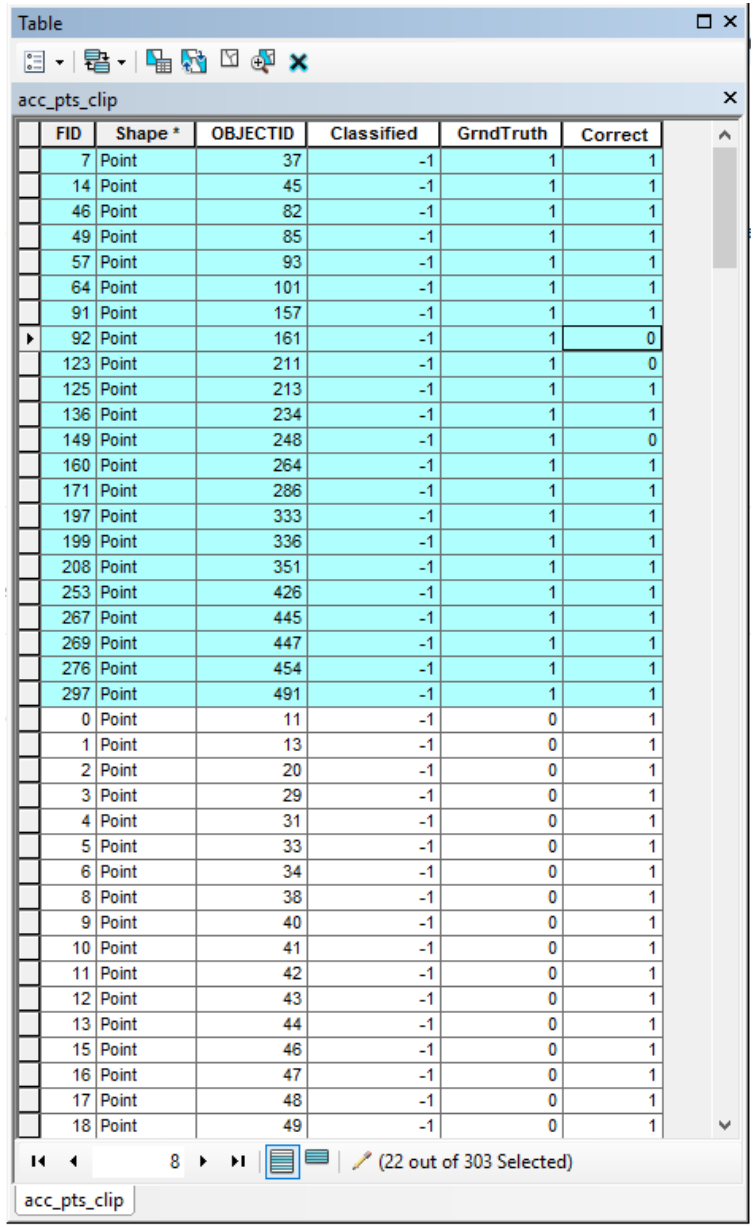
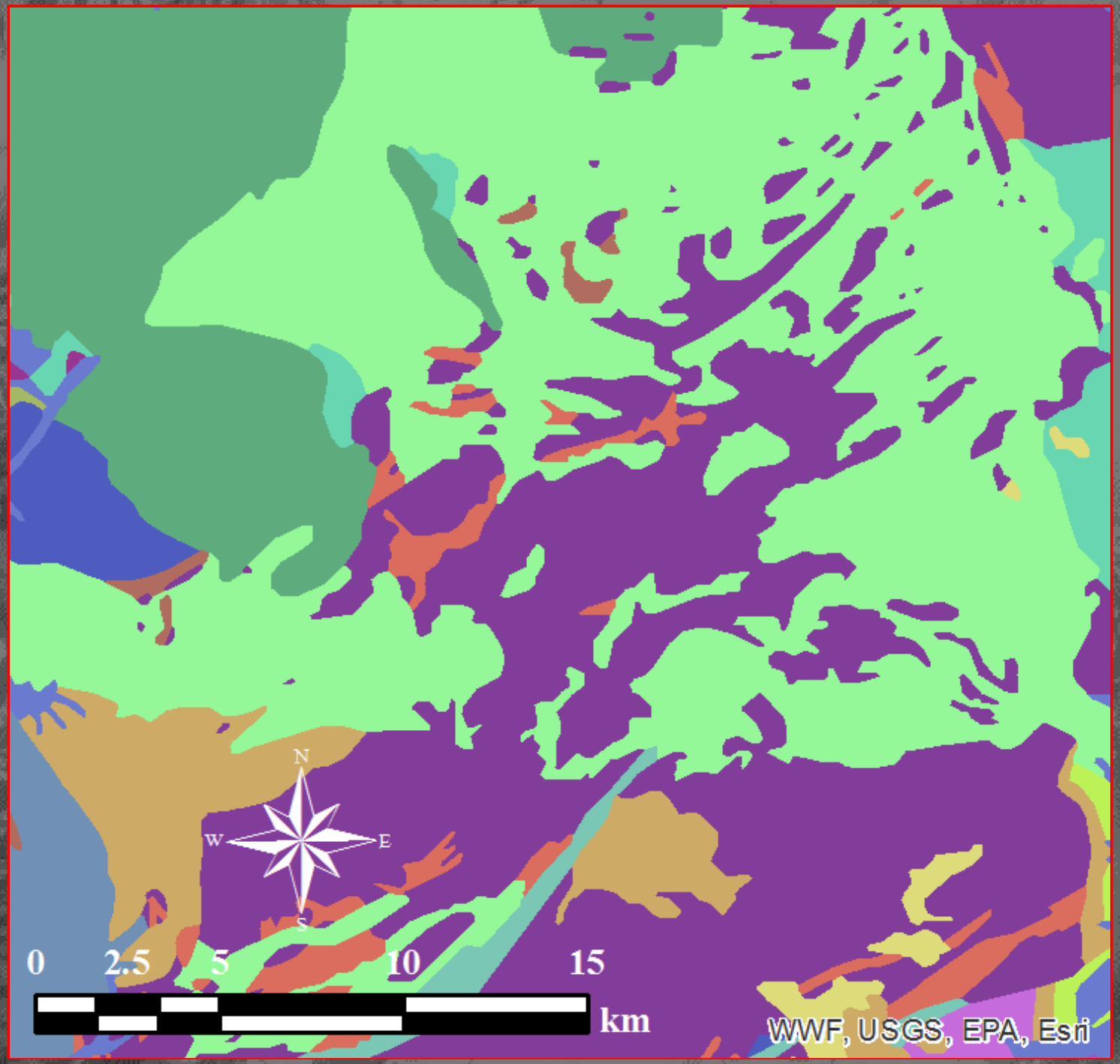


GDE class accuracy: 86% 19/22 total
Total Accuracy: 97% 9/303 not correct

Combined Likelihood of GDE Locations



- sandstone
- sedimentary rock
- shale
- siltstone
- tectonite
- limestone
- medium-grained mixed clastic
- metasedimentary rock
- alluvium
- conglomerate
- unconsolidated deposit
- plutonic rock (phaneritic)
- granite
- granitic gneiss
- granitoid

Data Source: USGS
Date: 12/1/2016
Imagery: Landsat 5 8/18/2011
DEM: 1/3 arc-sec 1/1/2013
NAD 83, UTM 13T

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