

## BIOMASS FROM WESTERN DRY FORESTS: SPATIALLY-EXPLICIT YIELD PROJECTIONS FROM THE FIA, FVS, TREEMAP MODELLING ECOSYSTEM

REID LEWIS | PHD STUDENT AT YALE SCHOOL OF THE ENVIRONMENT



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MODELLING ECOSYSTEM**

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# BRIDGING TREEMAP AND THE FIADB FOR SPATIALLY EXPLICIT FOREST MODELING

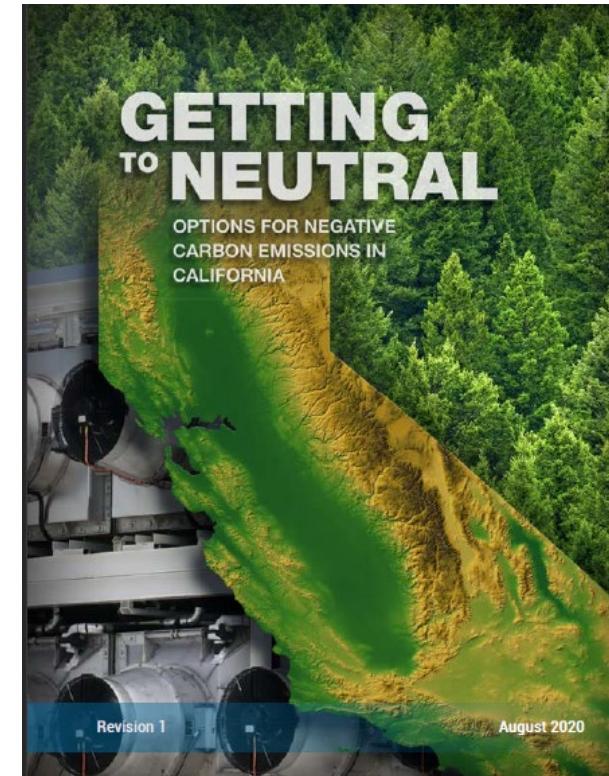
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# QUICK OVERVIEW

- Context
- Why this approach
- Overview of said approach
- Dive into the TreeMap / FVS bridge
- Further questions and musings

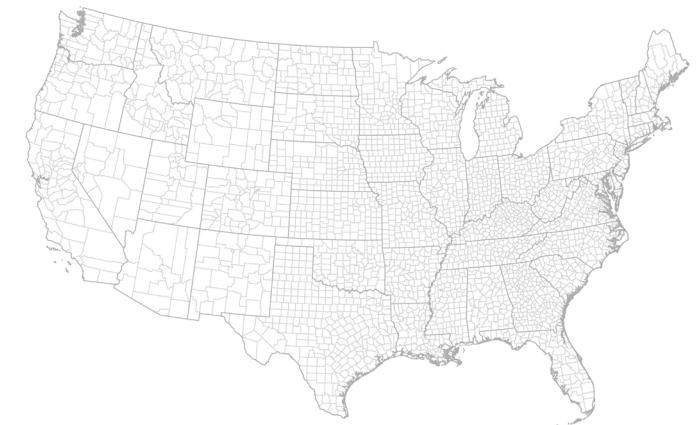
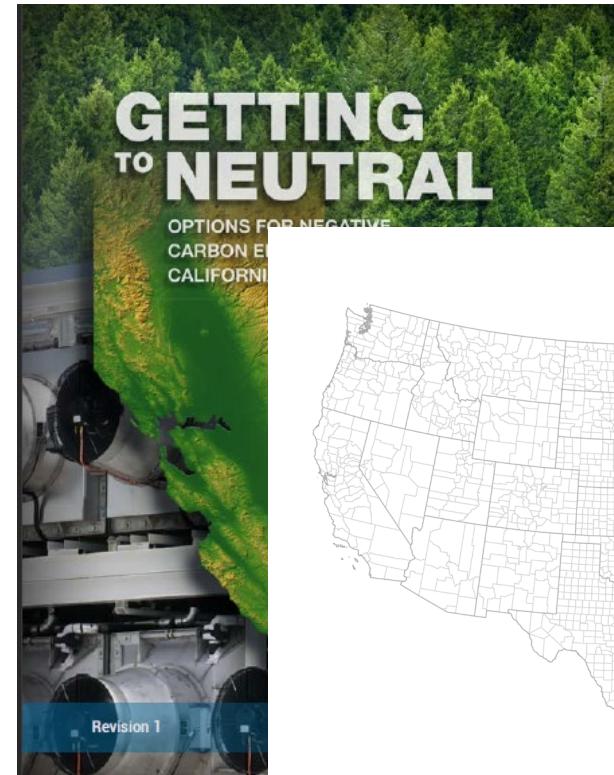
# CONTEXT

- Inspired by a prior report for the state of California
- Multi-sectoral analysis of options for negative emissions



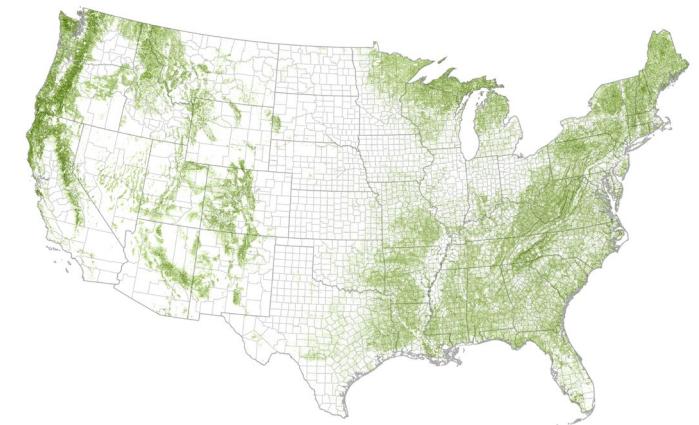
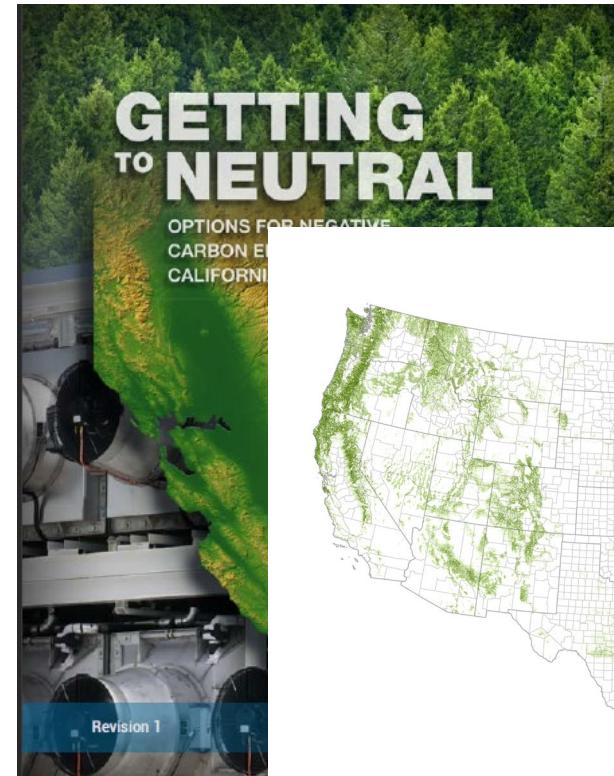
# CONTEXT

- New report: similar, but at the national level



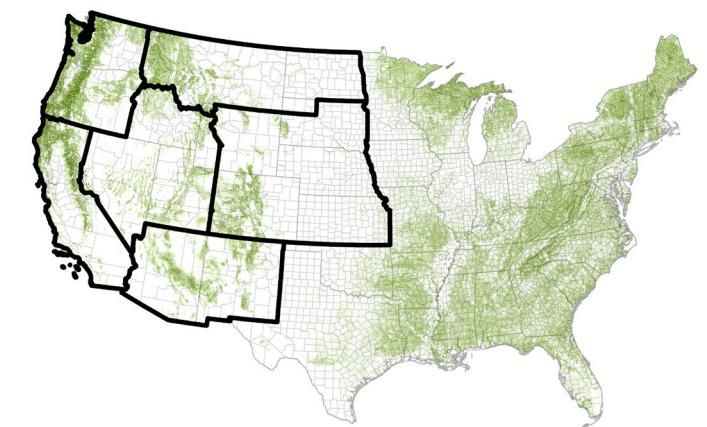
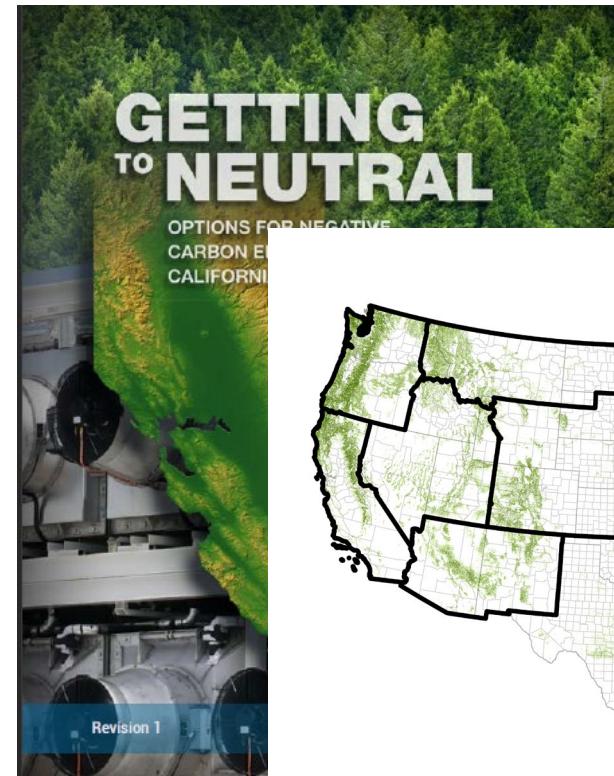
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- New report: similar, but at the national level
- Drs. Mark Ducey, Mark Ashton, Mark Bradford invited to lead on the forests section



# CONTEXT

- New report: similar, but at the national level
- Drs. Mark Ducey, Mark Ashton, Mark Bradford invited to lead on the forests section
- Invited me to contribute to western forests



## APPROACH I'M TAKING: RESTORATION IN FIRE-PRONE WUI

- Traditional harvest deferral framework doesn't fit as well
  - High stocking
  - Increasing frequency and intensity of disturbance
  - Less market pressure / opportunity



## APPROACH I'M TAKING: RESTORATION IN FIRE-PRONE WUI

- Traditional harvest deferral framework doesn't fit as well
- Staying in just the wildland urban interface
  - Budget feasibility
  - Potentially higher emissions reduction



# PROCESS OVERVIEW

- Looking at forested regions that are:
  - In the WUI (USGS product)
  - High fire risk (Wildfire Hazard Potential product)
- How much biomass is there by county?
- How much would we take in a restoration treatment?
- What's the difference in fire emissions with and without treatment?

# PROCESS OVERVIEW

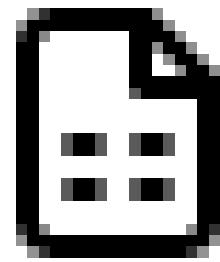
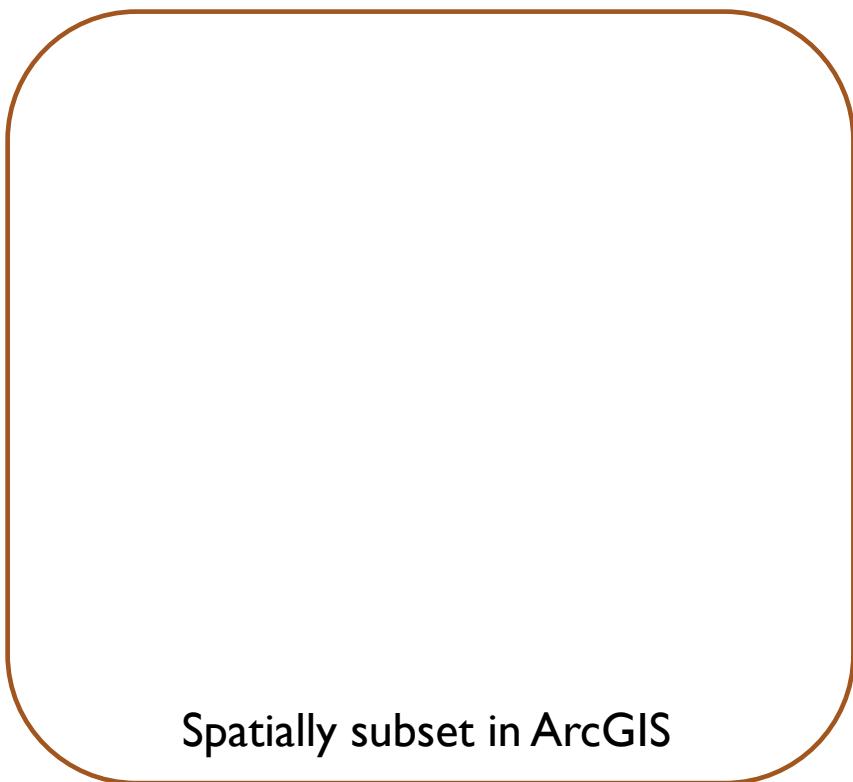
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# DIVING IN: BRIDGING TREEMAP WITH FIADB

Spatially subset in ArcGIS

Query database in R

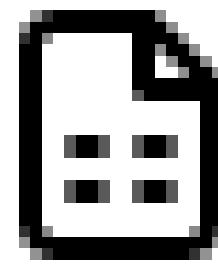
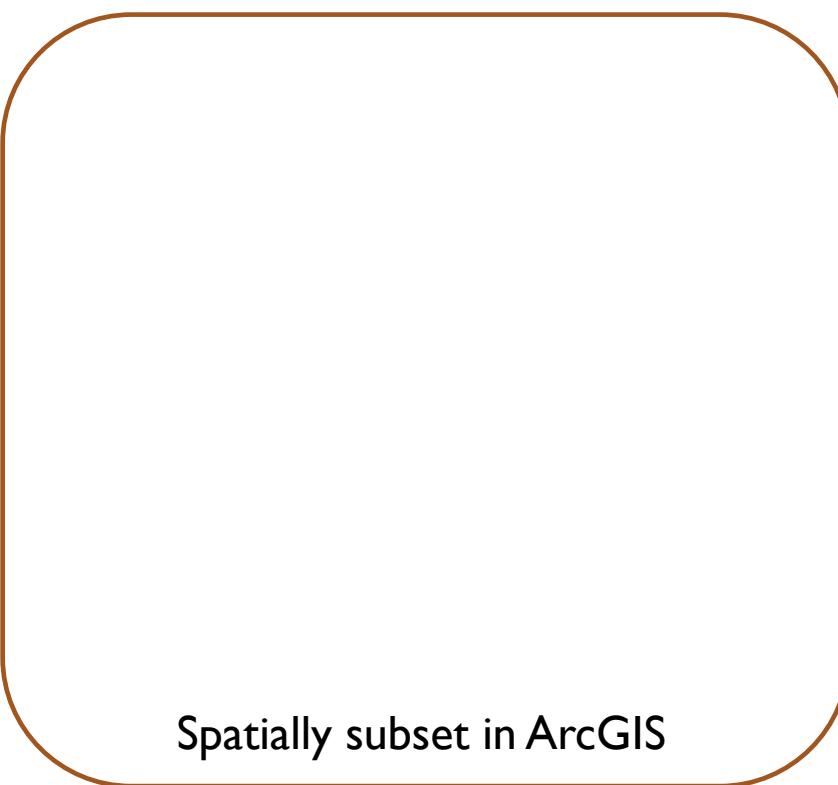
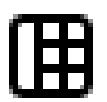
# DIVING IN: BRIDGING TREEMAP WITH FIADB



a .csv of your  
selected plot  
CNs



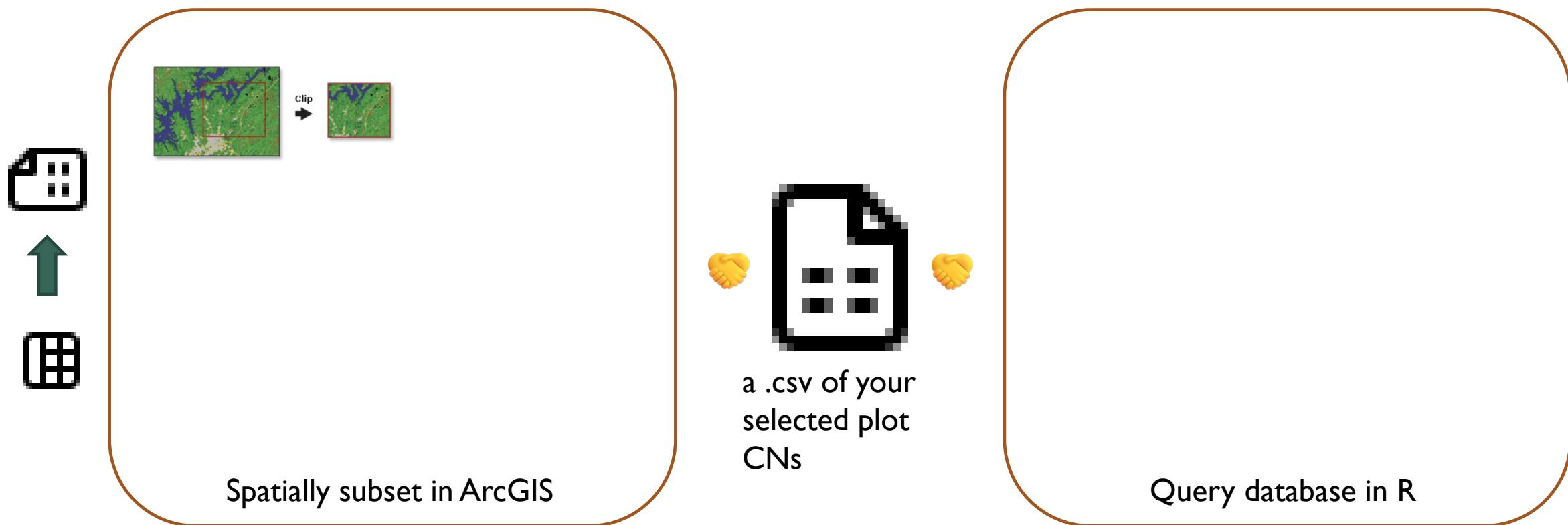
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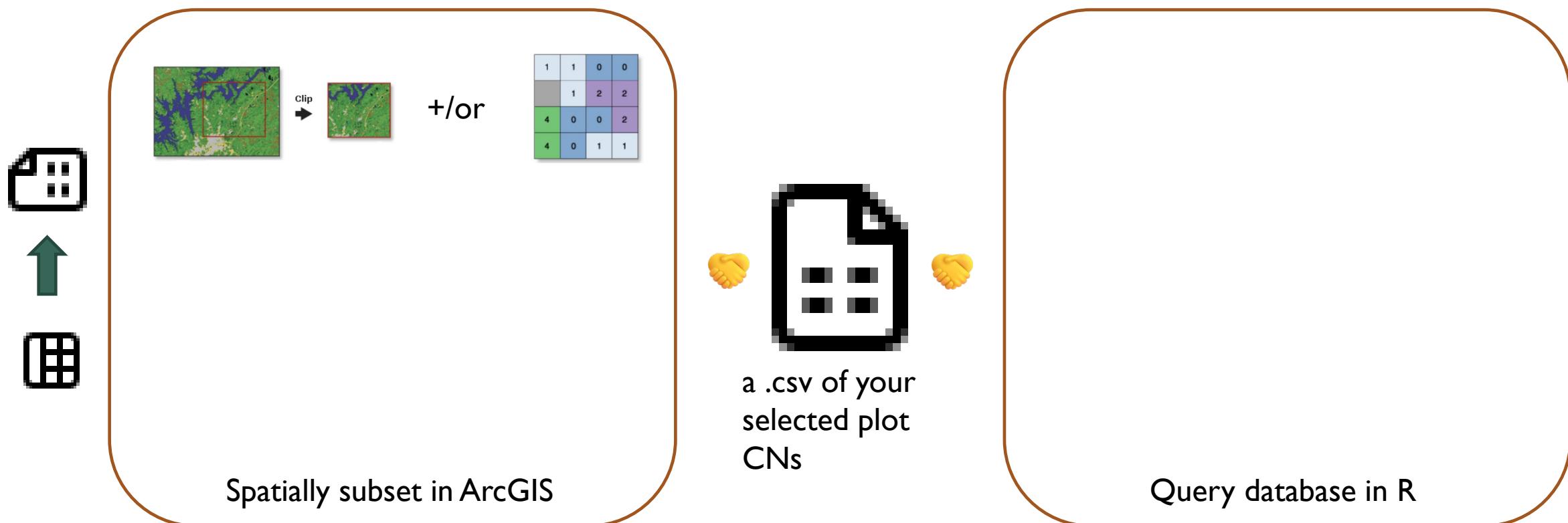
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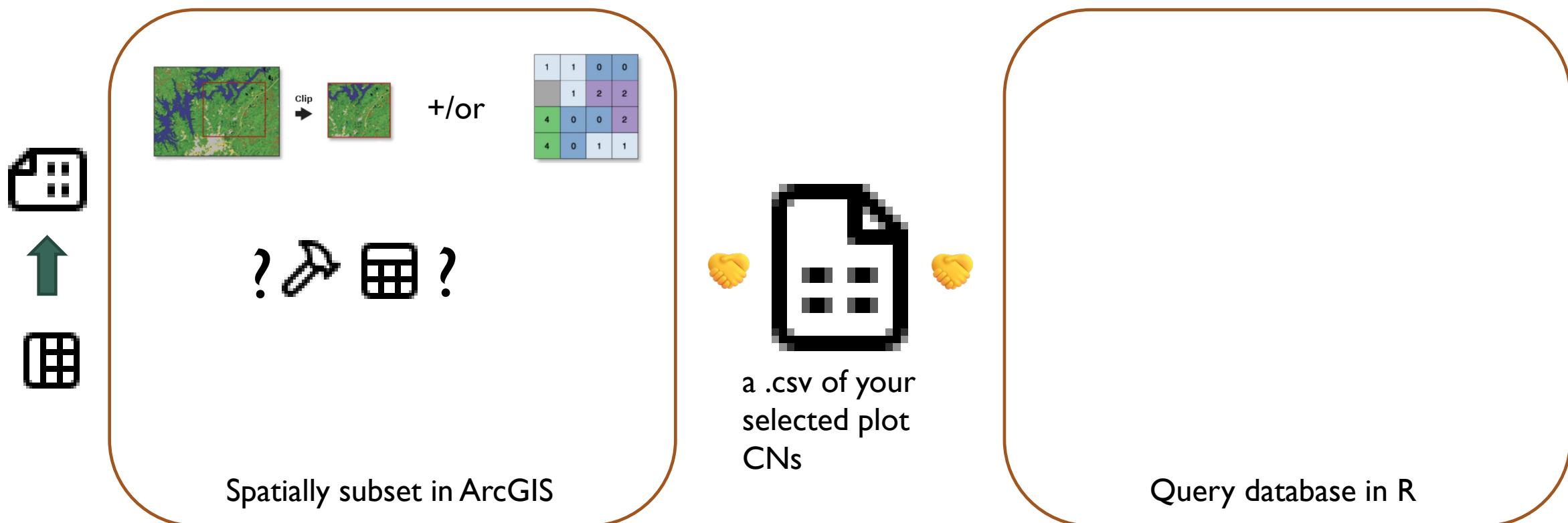
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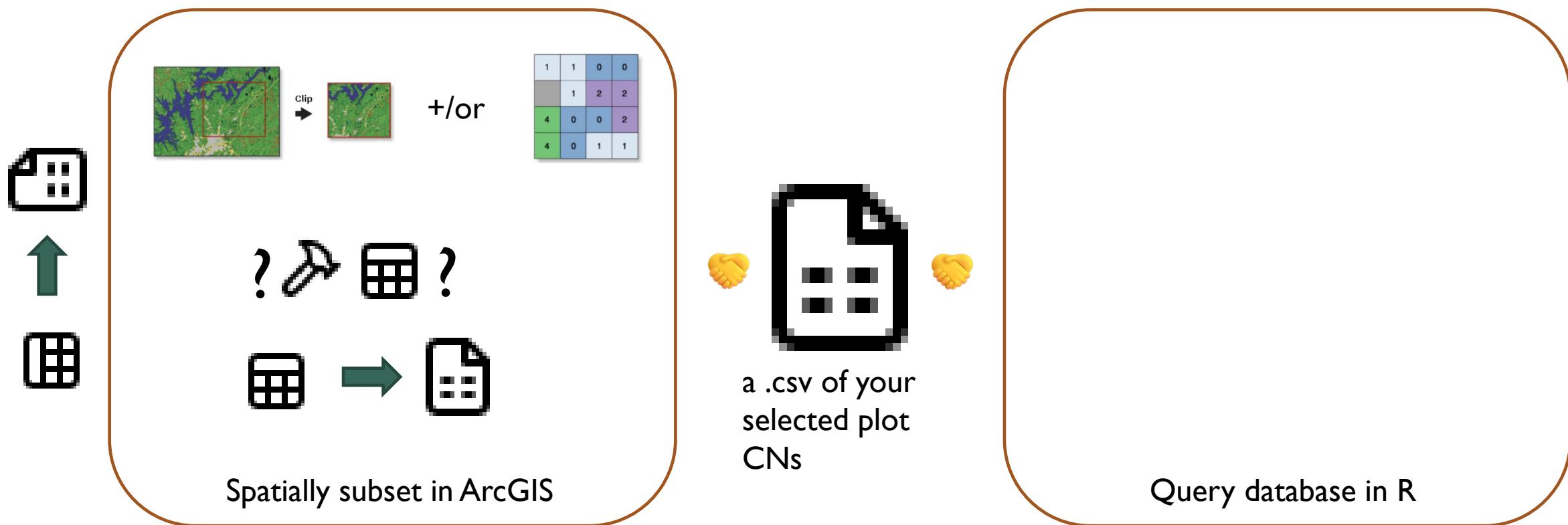
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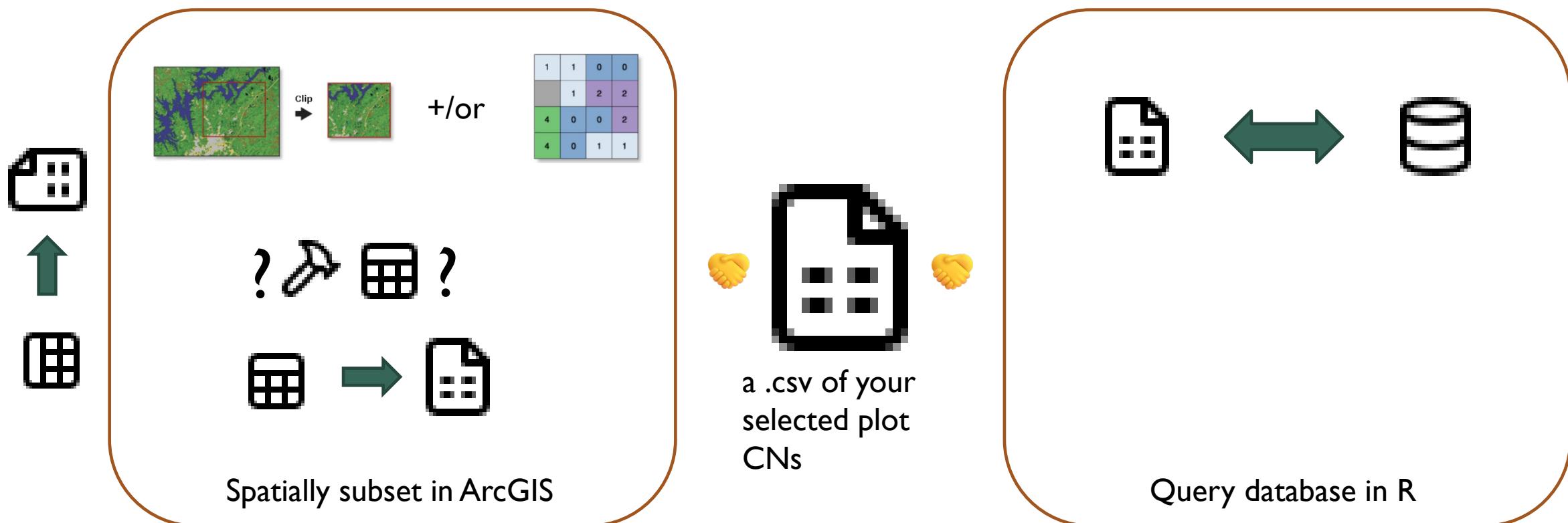


# DIVING IN: BRIDGING TREEMAP WITH FIADB



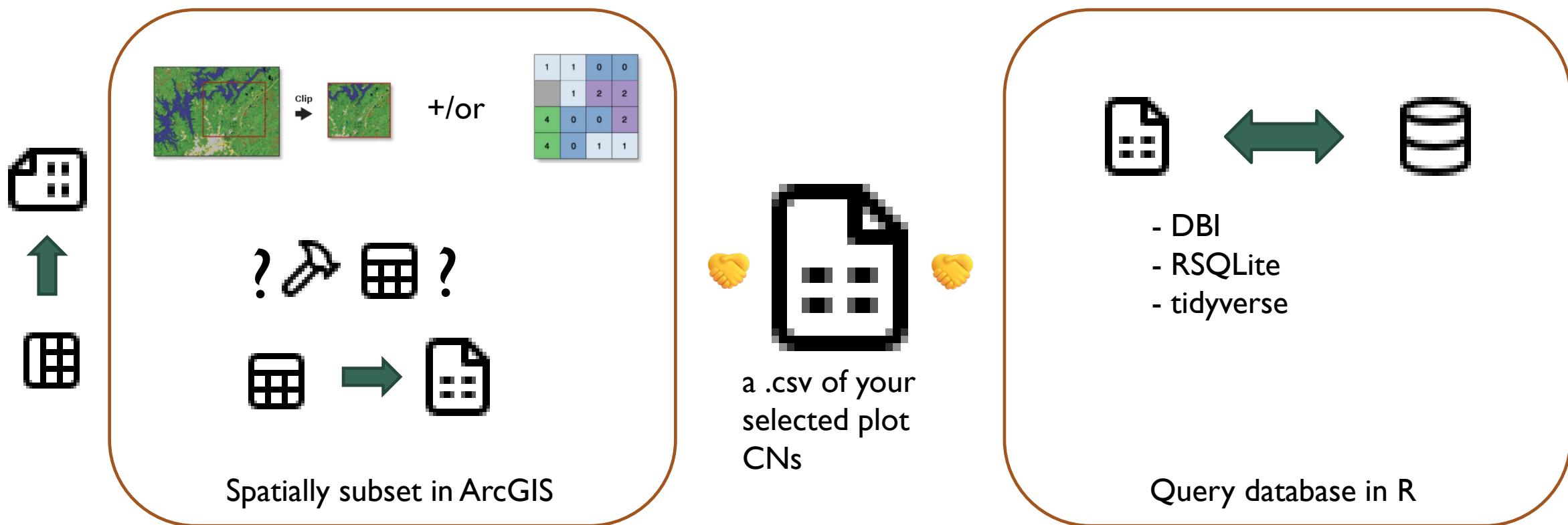
[GITHUB LINK](#)

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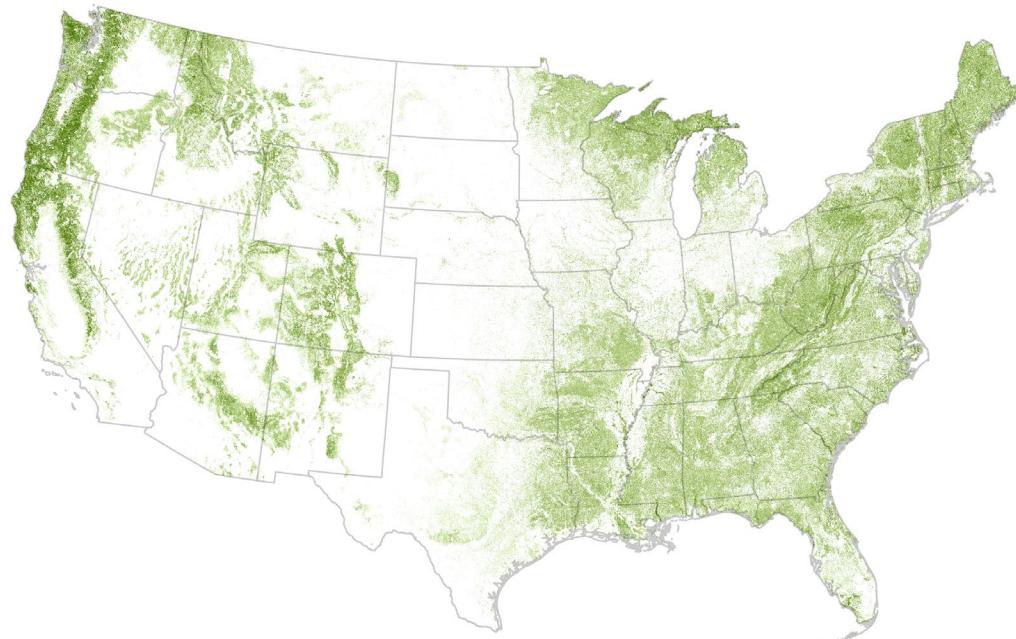
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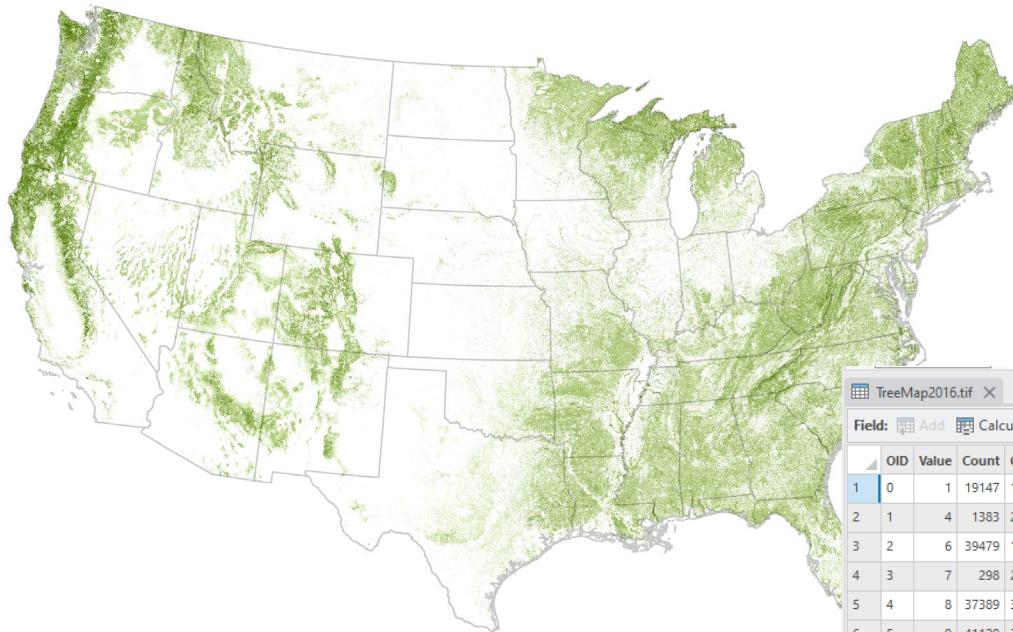


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# LOOKING AT THE TREEMAP



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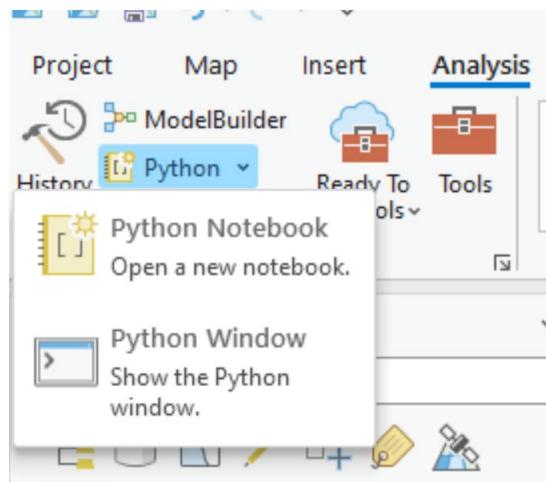


TreeMap2016.tif

Field: Add Calculate Selection: Select By Attributes Zoom To Switch Clear Delete Copy

	OID	Value	Count	CN	FORTYPCD	ForTypName	FLDTYPCD	FldTypName	STDSZCD	FLDSZCD	BALIVE	CANOPYPCT	STANDHT	ALSTK	GSSTK	QMD_RMRS	SDIPCT_RMR	TPA_LII
1	0	1	19147	175742190010854	161	Loblolly pine	161	Loblolly pine	2	2	135.0613	75	40	87.3381	85.2567	-99	-99	1536.45
2	1	4	1383	264159709489998	520	Mixed upland hardwo...	406	Loblolly pine / hardwo...	3	1	42.3143	58	27	87.0416	85.2522	-99	-99	1523.37
3	2	6	39479	175742192010854	602	Sweetgum / Nuttall oa...	602	Sweetgum / Nuttall oa...	2	2	71.4309	73	50	38.9876	26.0908	-99	-99	762.20
4	3	7	298	264160099489998	520	Mixed upland hardwo...	520	Mixed upland hardwo...	1	3	153.1532	79	92	83.941	75.0759	-99	-99	225.41
5	4	8	37389	335445737489998	161	Loblolly pine	161	Loblolly pine	2	2	163.3685	81	67	86.3804	84.7049	-99	-99	1227.82
6	5	9	41129	386105549489998	520	Mixed upland hardwo...	503	White oak / red oak /...	2	2	33.5966	47	44	28.8545	18.4815	-99	-99	402.1
7	6	10	511	36099363020004	520	Mixed upland hardwo...	520	Mixed upland hardwo...	3	3	56.1204	50	72	74.4088	71.0979	-99	-99	234.18
8	7	11	973	236617318010854	161	Loblolly pine	161	Loblolly pine	2	2	105.8853	74	49	65.7608	53.4618	-99	-99	483.67
9	8	12	1830	264160096489998	161	Loblolly pine	161	Loblolly pine	3	1	21.5992	31	21	46.8331	44.7109	-99	-99	461.82
10	9	13	97561	335445717489998	161	Loblolly pine	161	Loblolly pine	2	2	112.2952	62	66	74.4963	73.0645	-99	-99	375.86
11	10	14	4928	189296714020004	161	Loblolly pine	161	Loblolly pine	2	2	100.1183	67	51	65.4922	65.4922	-99	-99	798.8

# PRELUDE: MAKE A CSV OF TREEMAP ATTRIBUTE TABLE



Open python window

```
# set paths THESE ARE THE LINES TO CHANGE
# set raster path (TreeMap)
rasloc = r"Z:\Reid Lewis\dry_forests_nat_gtn_case_study\arcpro_files\slides_for_gmug\TreeMapPath.tif"
# set path where csv will be created
outPath = r"Z:\Reid Lewis\dry_forests_nat_gtn_case_study\arcpro_files\slides_for_gmug\coconino_highfire_pixels.csv"

# truncate .tif from raster name
short_raster = rasloc[:-4]

# set fields to copy DOUBLE CHECK THAT THESE ARE THE FIELDS YOU'D LIKE
fields = ["Value", "Count", "ForTypName"]
```

Set paths to TreeMap file  
and desired .csv destination in  
**Treemap\_to\_csv.py**

```
Python
# treemap_to_csv.py
# Feb 21, 2023
# Reidosaurus

# A script using arcpy to take create a csv
# from the attribute table of a raster file
# with great thanks to the authors here:
# https://community.esri.com/t5/python-questions/export-raster-attribute-table-into-csv-using/td-p/756900

import arcpy, os

# set paths THESE ARE THE LINES TO CHANGE
# set raster path (TreeMap)
rasloc = r"Z:\Reid Lewis\dry_forests_nat_gtn_case_study\arcpro_files\slides_for_gmug\TreeMapPath.tif"
# set path where csv will be created
outPath = r"Z:\Reid Lewis\dry_forests_nat_gtn_case_study\arcpro_files\slides_for_gmug\coconino_highfire_pixels.csv"

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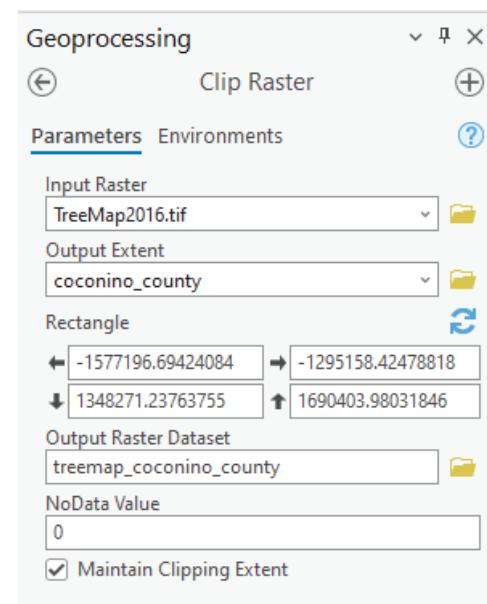
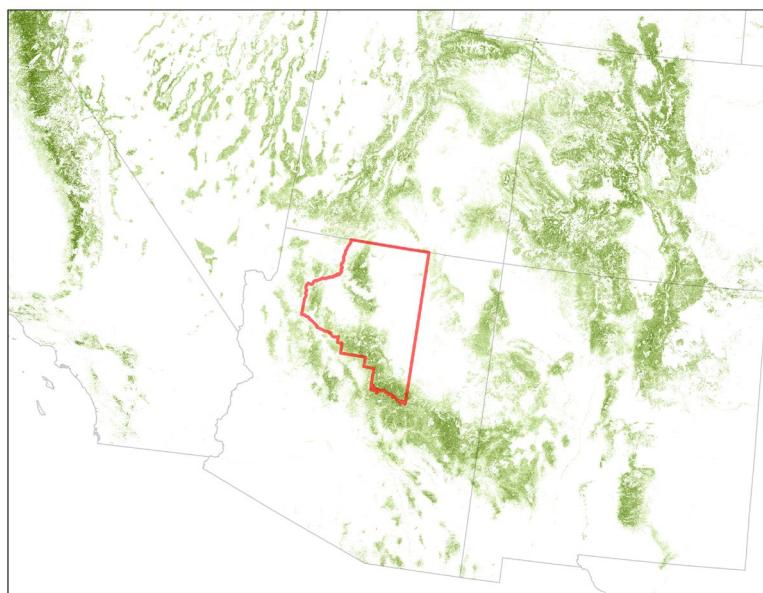
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```

Paste into Python window

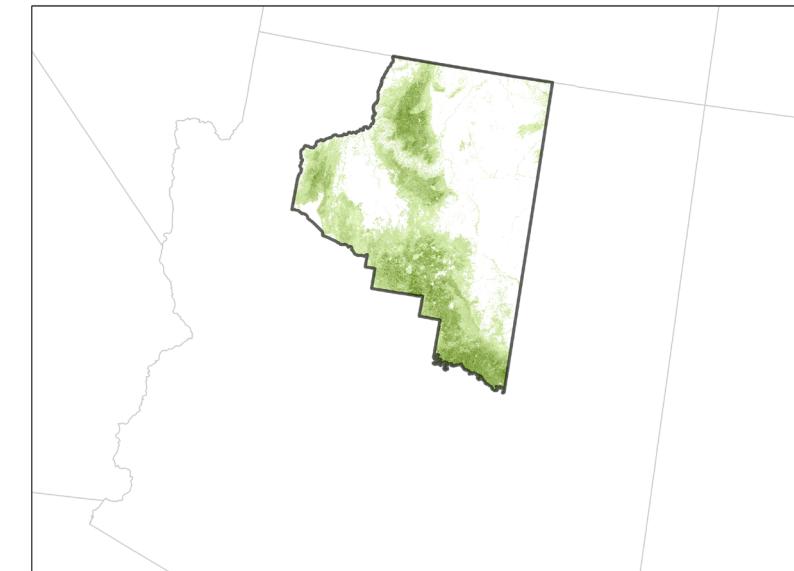
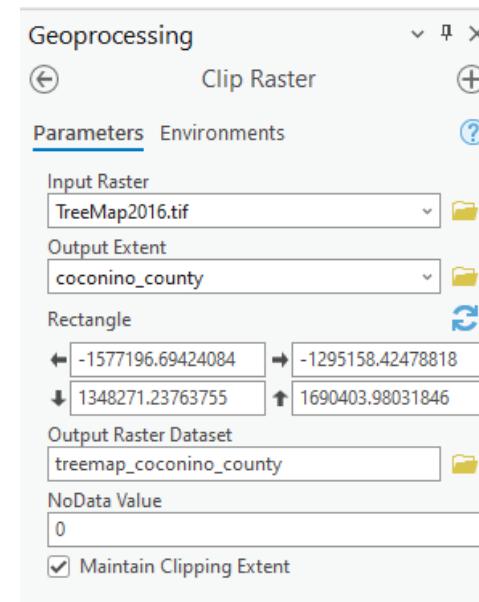
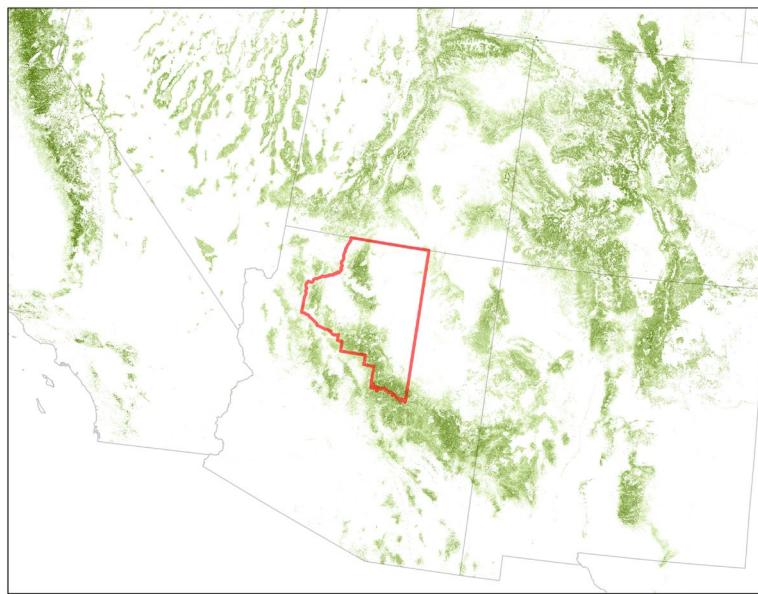
## SUBSET TREEMAP: CLIP RASTER (BY A POLYGON)



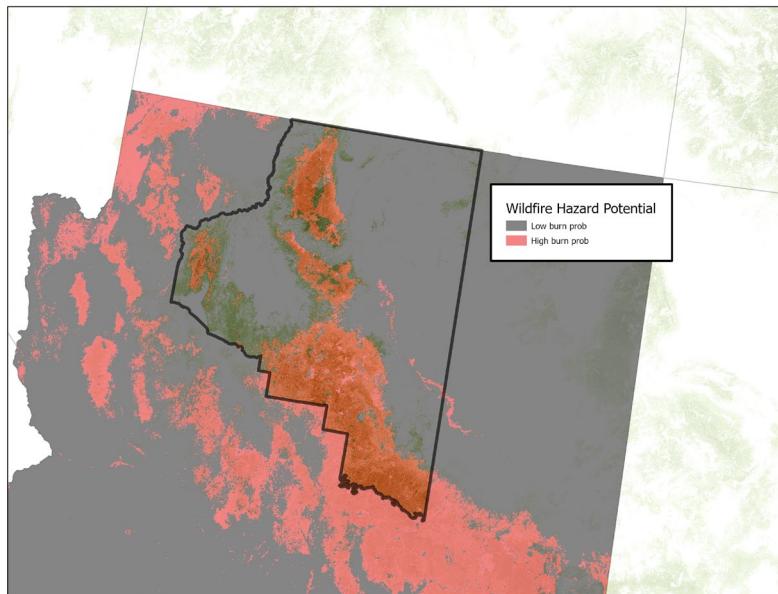
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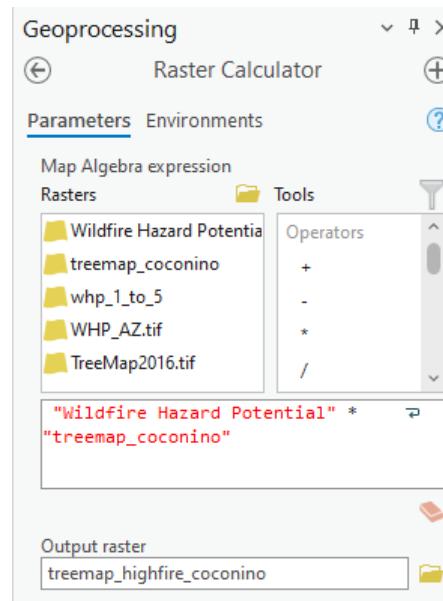
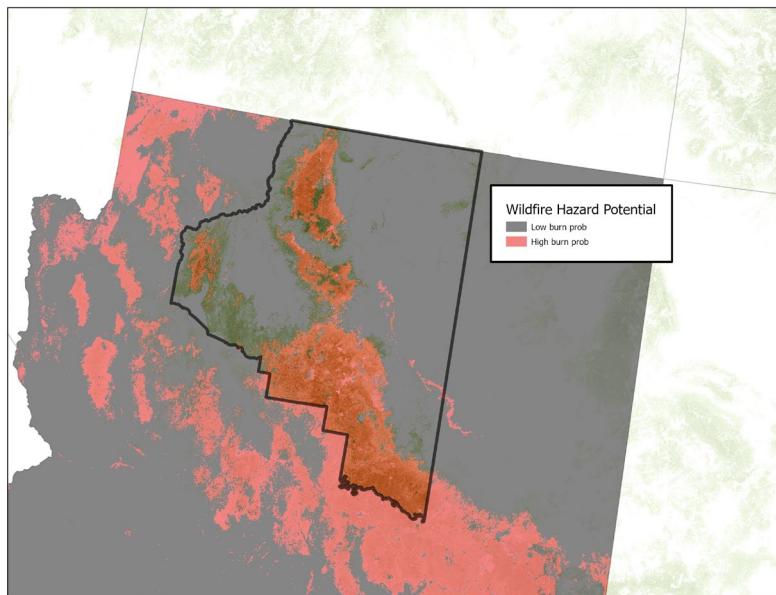
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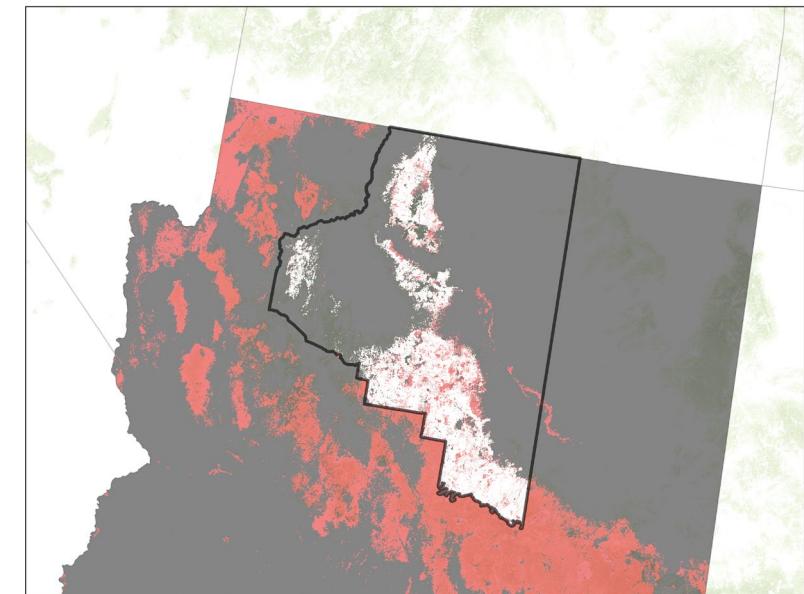
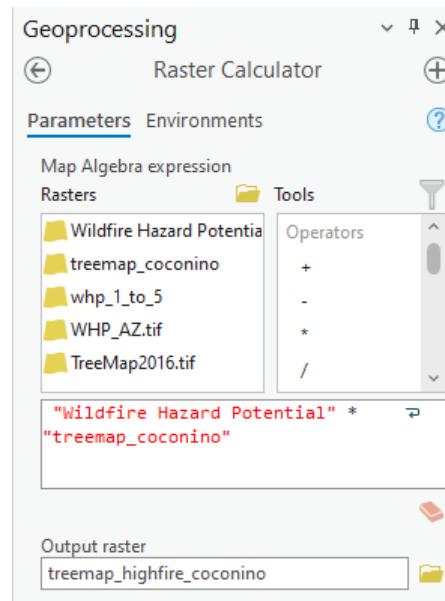
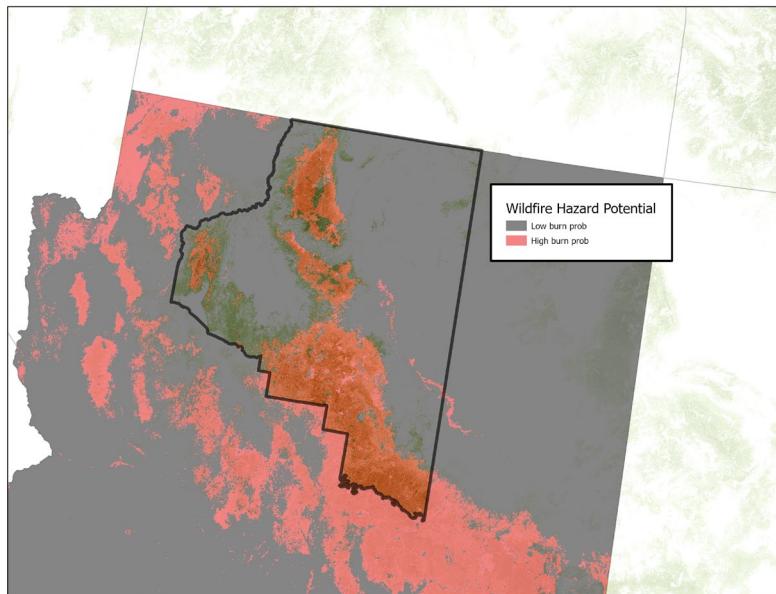
# SUBSET TREEMAP: RASTER CALCULATOR (BY A RASTER)



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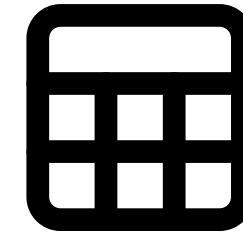
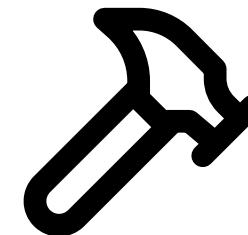
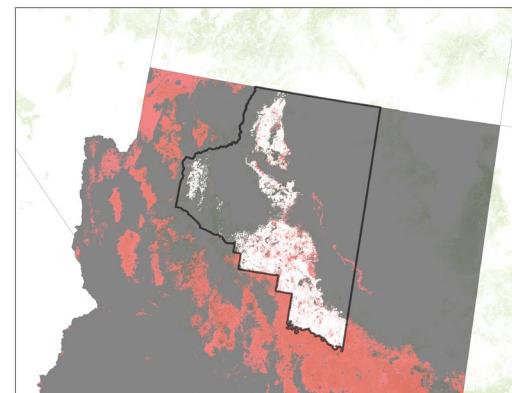


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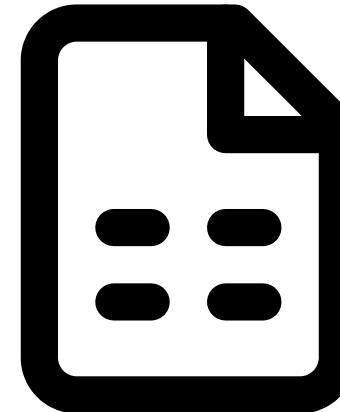
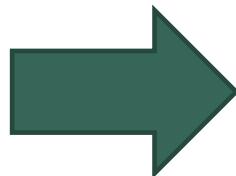
## CREATE ATTRIBUTE TABLE AND CSV FROM TREEMAP SUBSET

- Very similar to raster attribute to csv of TreeMap
- Set proper paths in ***create\_attribute\_table\_for\_raster.py***
- Copy and paste into Python window

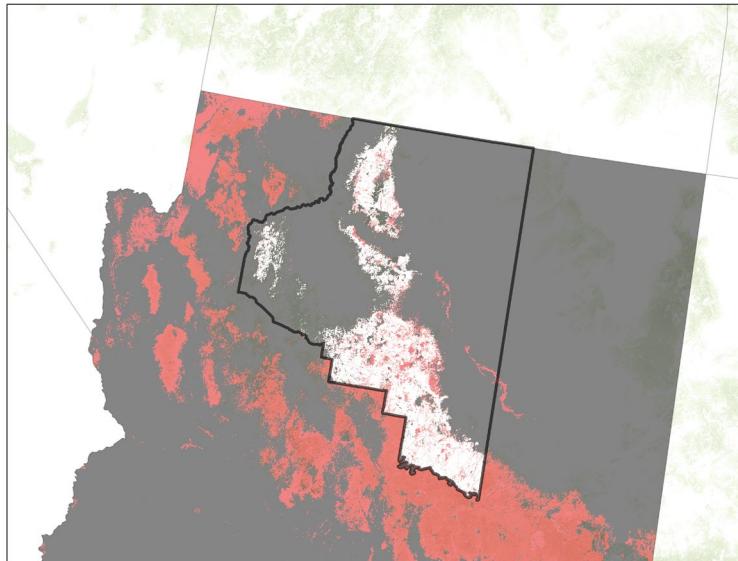


## VERY SIMILAR FOR RASTER ATTRIBUTE TO CSV OF THE SUBSET

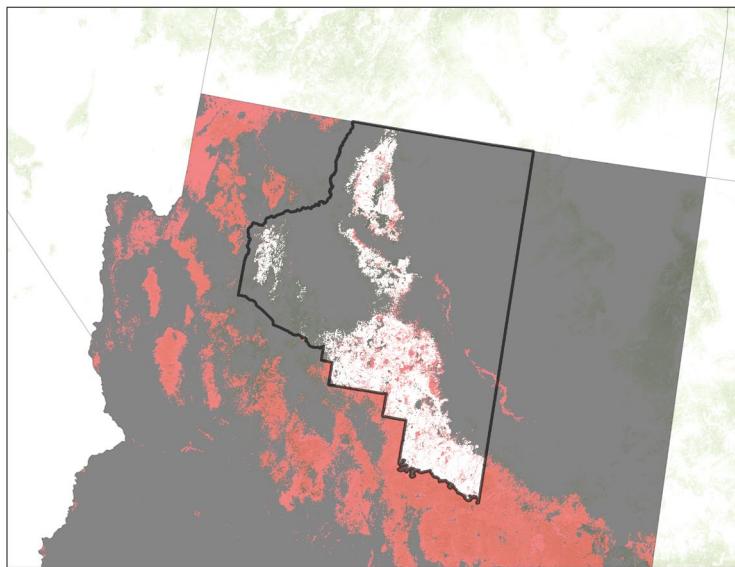
- Set proper paths in **get\_csv\_from\_raster.py**
- Copy and paste into Python window



GOTCHA:WE DON'T HAVE QUITE WHAT WE'RE HOPING FOR



# GOTCHA:WE DON'T HAVE QUITE WHAT WE'RE HOPING FOR



treemap\_highfire\_coconino

Field: [Add](#) [Calculate](#) Selection: [Select By Attributes](#) [Zoom To](#) [Swap](#)

OBJECTID *	Value	Count
1	1	5022573
2	2	3725
3	3	3728
4	4	3739
5	5	3742
6	6	3748
7	7	3749
8	8	3751
9	9	3757
10	10	3762
11	11	3763
12	12	3765
13	13	3766

## JOIN TREEMAP MASTER CSV TO SUBSETTED (FOR PLOT CN)

- This is why we made the TreeMap .csv 😊
- Into the R world...

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- This is why we made the TreeMap .csv 😊
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- Merge the TreeMap table to our subset table
- *join\_treeplot\_master\_to\_subset.R*

# JOIN TREEMAP MASTER CSV TO SUBSETTED (FOR PLOT CN)

- This is why we made the TreeMap .csv 😊
- Into the R world...
- Merge the TreeMap table to our subset
- ***join\_treeplot\_master\_to\_subset.R***

```
# set paths to csvs CHANGE THESE
# treemap csv
treemap_path <- "Z:/Reid Lewis/dry_forests_nat_gtn_case_study
/datasets/TreeMap/Data/treemap_value_cn_fortyp.csv"

# subset csv
subset_path <- "Z:/Reid Lewis/dry_forests_nat_gtn_case_study
/arcpro_files/slides_for_gmug/coconino_highfire_pixels.csv"

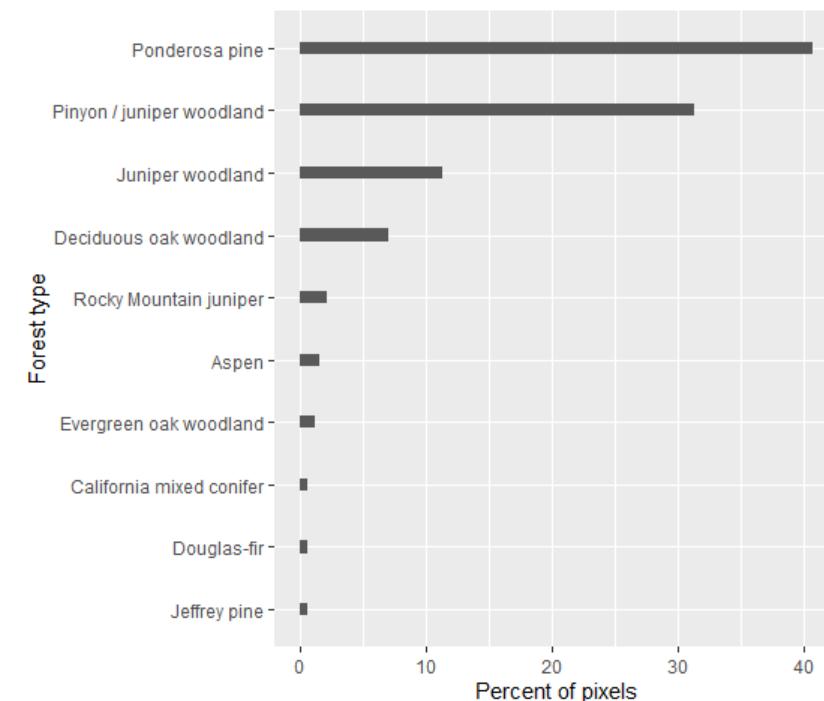
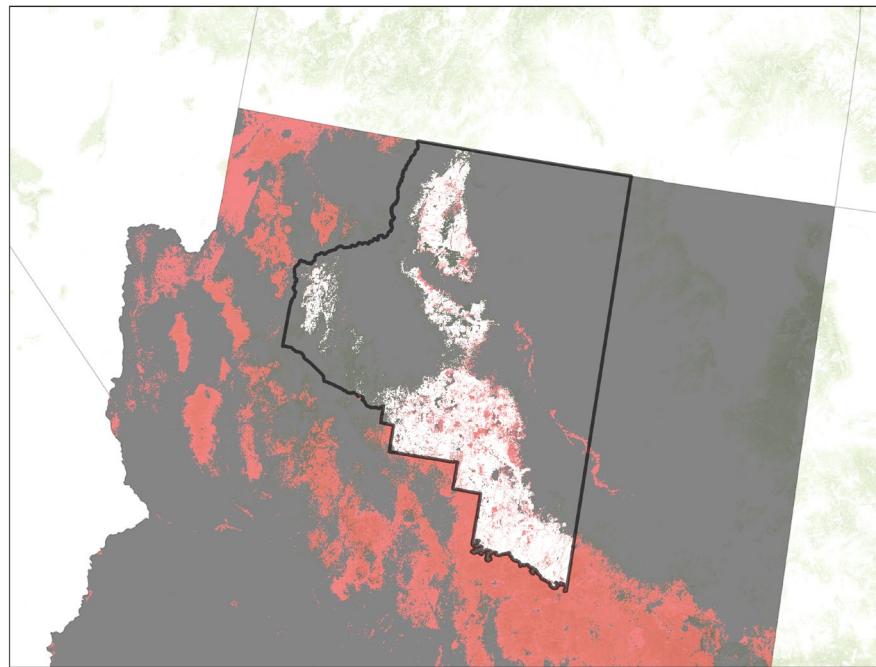
# target csv path to store joined csv
target_path <- "Z:/Reid Lewis/dry_forests_nat_gtn_case_study
/arcpro_files/slides_for_gmug/coconino_highfire_joined.csv"

# load dataframes
treemap_df <- read.csv(treemap_path)
subset_df <- read.csv(subset_path)

# merge
merged_df <- merge(subset_df, treemap_df, by="value")
```

# PAUSE FOR A QUICK SANITY CHECK

- Plot percent of pixels by forest type (in `join_treeplot_master_to_subset.R`)





FINALLY: QUERY FIADB WITH JOINED SUBSET CSV

## FINALLY: QUERY FIADB WITH JOINED SUBSET CSV

- Create a temporary table on FIADB
- Use that table to query FVS plot(stand) table
- Write plot table (a dataframe) to your subset database
- Use temporary table to query FVS tree table
- Write tree table to database
- Clean up by removing temporary table from FIADB

# YOUR DATABASE IS READY TO ROLL

DB Browser for SQLite - Z:\Reid Lewis\dry\_forests\_nat\_gtn\_case\_study\arcpro\_files\slides\_for\_gmug\coconino\_highfir

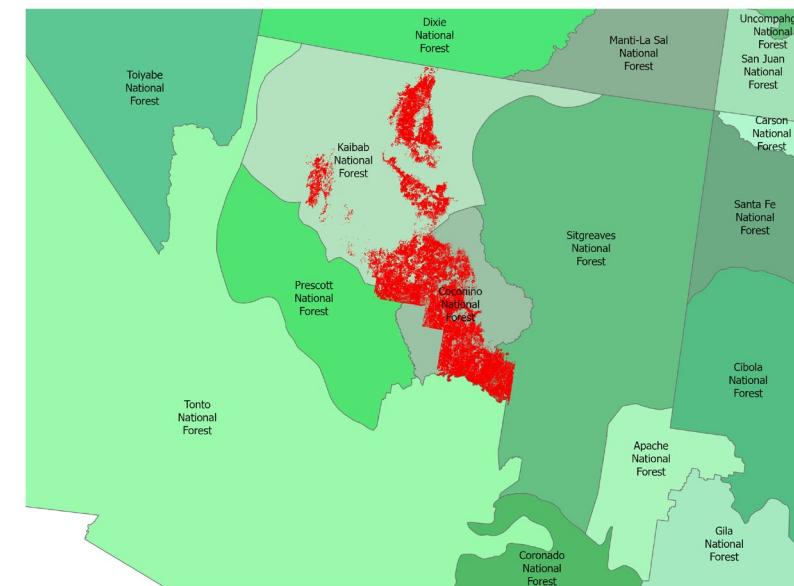
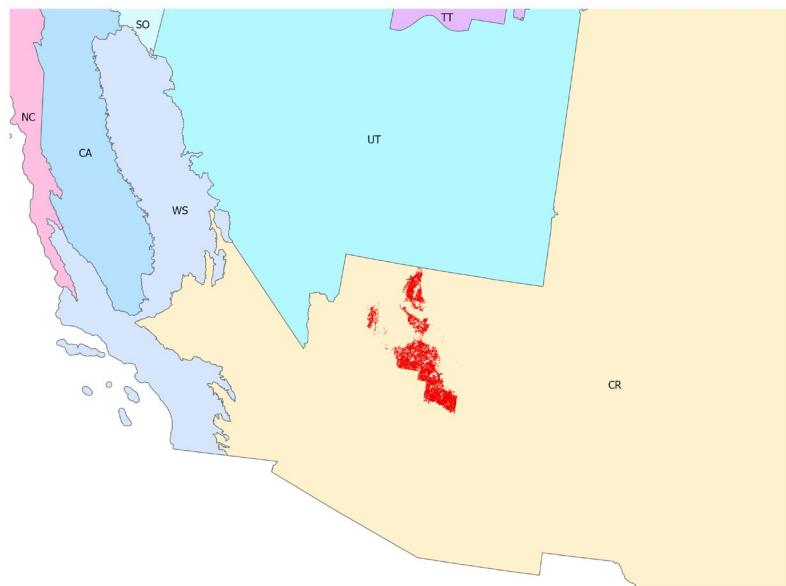
Stand_Plot							
	STAND_CN	STAND_ID	VARIANT	INV_DAY	INV_YEAR	INV_MONTH	GROUPS
1	482037170...	00062011...	CR	26	2011	4.0	All_FIA_Plots ...
2	345936483...	00062016...	CR	19	2016	7.0	All_FIA_Plots ...
3	273640990...	00062015...	CR	21	2015	5.0	All_FIA_Plots ...
4	273641296...	00062015...	CR	1	2015	9.0	All_FIA_Plots ...
5	307619720...	00062012...	CR	20	2012	6.0	All_FIA_Plots ...
6	307623860...	00062012...	CR	2	2012	7.0	All_FIA_Plots ...
7	307625170...	00062012...	CR	6	2012	6.0	All_FIA_Plots ...
8	307631290...	00062012...	CR	28	2012	4.0	All_FIA_Plots ...
9	482035800...	00062011...	CR	27	2011	6.0	All_FIA_Plots ...
10	229318180...	00062008...	CR	6	2008	6.0	All_FIA_Plots ...
11	229318730...	00062008...	CR	23	2008	10.0	All_FIA_Plots ...
12	482057940...	00062011...	CR	9	2011	6.0	All_FIA_Plots ...
13	482056330...	00062011...	CR	9	2011	5.0	All_FIA_Plots ...
14	307620110...	00062012...	CR	27	2012	6.0	All_FIA_Plots ...
15	307624080...	00062012...	CR	11	2012	5.0	All_FIA_Plots ...
16	482057300...	00062011...	CR	4	2011	5.0	All_FIA_Plots ...

DB Browser for SQLite - Z:\Reid Lewis\dry\_forests\_nat\_gtn\_case\_study\arcpro\_files\slides\_for\_gmug\coconino\_highfire.db

Tree_Plot								
	STAND_CN	STAND_ID	PLOT_CN	STANDPLOT_CN	STANDPLOT_ID	PLOT_ID	TREE_CN	TREE_ID
1	482027450...	00062011...	4820274...	48202745010497_4	00062011060102...		1	44777092020004
2	482027450...	00062011...	4820274...	48202745010497_4	00062011060102...		1	44777093020004
3	482027450...	00062011...	4820274...	48202745010497_4	00062011060102...		1	44777094020004
4	482027450...	00062011...	4820274...	48202745010497_4	00062011060102...		1	44777095020004
5	482027450...	00062011...	4820274...	48202745010497_4	00062011060102...		1	44777096020004
6	482027450...	00062011...	4820274...	48202745010497_4	00062011060102...		1	44777098020004
7	482027450...	00062011...	4820274...	48202745010497_4	00062011060102...		1	44777099020004
8	482027450...	00062011...	4820274...	48202745010497_1	00062011060102...		1	S44777036020004
9	482027450...	00062011...	4820274...	48202745010497_2	00062011060102...		2	S44777037020004
10	482027450...	00062011...	4820274...	48202745010497_4	00062011060102...		4	S44777038020004
11	482027550...	00062011...	4820275...	48202755010497_1	00062011060102...		1	44769804020004
12	482027550...	00062011...	4820275...	48202755010497_1	00062011060102...		1	44769805020004
13	482027550...	00062011...	4820275...	48202755010497_1	00062011060102...		1	44769806020004
14	482027550...	00062011...	4820275...	48202755010497_2	00062011060102...		1	44769807020004
15	482027550...	00062011...	4820275...	48202755010497_2	00062011060102...		1	44769808020004
16	482027550...	00062011...	4820275...	48202755010497_2	00062011060102...		1	44769809020004
17	482027550...	00062011...	4820275...	48202755010497_3	00062011060102...		1	44769810020004

## BRIEF ASIDE ON VARIANTS

- TreeMap will pull plots across FVS variants and locations
- Consider overwriting the relevant fields in your database



# QUESTIONS, CONSIDERATIONS, NEXT STEPS

- Run analyses in FVS
- Streamline: an R package?
- What does inference look like with such a process?
  - i.e. how do you trace uncertainty through the whole model?
- What are target treatment levels for a healthy forest? How fine grained is fine grained enough for such a model?
- Considerations of probability in fire occurrence and treatment interaction



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- Dr. John Shaw



# THANK YOU VERY MUCH. QUESTIONS OR COMMENTS?

- [Reid.lewis@yale.edu](mailto:Reid.lewis@yale.edu)
- Questions?

# THANKS TO THE IMAGES I USED

- California GTN report: <https://livermorelabfoundation.org/2019/12/19/getting-to-neutral/>
- Dixie fire: <https://www.sfchronicle.com/bayarea/article/California-wildfires-are-climbing-higher-up-16418967.php>
- Schultz fire: <https://news.nau.edu/nau-employees-affected-by-schultz-fire-get-help-from-emergency-workers-and-neighbors/>
- Icons: <https://lucide.dev/>
- Arcgis clip: <https://pro.arcgis.com/en/pro-app/latest/tool-reference/data-management/clip.htm>
- Arcgis raster calc (actually zonal stats icon): <https://pro.arcgis.com/en/pro-app/2.8/tool-reference/spatial-analyst/zonal-statistics.htm>