Spatial data for:

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# Overview

The following code will download nearly all publicly-available spatial data used in this study. Where data is not publicly-available or easy to programmatically download, we provide more details about how to access the data.

# Spatial data

## Basic Geographic data

We obtained spatial data describing state boundaries from the US Census Bureau (<https://www.census.gov/geographies/mapping-files.html>).

# states  
dir.create(here("Data", "Spatial", "States"), showWarnings = FALSE)  
temp <- here("Data", "Spatial", "States", "cb\_2018\_us\_state\_20m.zip")  
if(!file.exists(temp)){  
 download.file("https://www2.census.gov/geo/tiger/GENZ2018/shp/cb\_2018\_us\_state\_20m.zip", temp, mode="wb")  
 unzip(temp, exdir=here("Data", "Spatial", "States"))  
}

## Disturbance data

We acquired polygon data describing the extent of burned areas for the 1984-2023 period from the Monitoring Trends in Burn Severity Project ([**mtbsprojectMTBSDataAccess2022?**](#ref-mtbsprojectMTBSDataAccess2022)) (<mtbs.gov>).

# MTBS   
dir.create(here("Data", "Spatial", "MTBS"), showWarnings = FALSE)  
temp <- here("Data", "Spatial", "MTBS", "mtbs\_perimeter\_data.zip")  
if(!file.exists(temp)){  
 download.file("https://edcintl.cr.usgs.gov/downloads/sciweb1/shared/MTBS\_Fire/data/composite\_data/burned\_area\_extent\_shapefile/mtbs\_perimeter\_data.zip", temp, mode="wb")  
 unzip(temp, exdir=here("Data", "Spatial", "MTBS"))  
}

We also obtained spatially data describing land ownership from the USFS and the Colorado Natural Heritage Program and the Geospatial Centroid.

dir.create(here("Data/Spatial/USFS"), showWarnings = FALSE)  
temp <- here(paste0("Data/Spatial/USFS/RangerDistricts.zip"))  
download.file("https://data.fs.usda.gov/geodata/edw/edw\_resources/shp/S\_USA.RangerDistrict.zip", temp)  
unzip(temp, exdir=here("Data/Spatial/USFS/"))

dir.create(here("Data/Spatial/CoMaP"), showWarnings = FALSE)  
 temp <- here(paste0("Data/Spatial/CoMaP/CoMaP\_GDB.zip"))  
 download.file("https://comap.cnhp.colostate.edu/dev/mapcollab/site/COMaP\_GDB", temp)  
 unzip(temp, exdir=here("Data/Spatial/CoMaP"))

Aspen cover

# Download spatial data describing the extent of aspen  
if(!dir.exists(here("Data", "Spatial", "Aspen"))){  
 dir.create(here("Data", "Spatial", "Aspen"), showWarnings = FALSE)  
 temp <- here("Data", "Spatial", "Aspen","srme\_skcv\_distribution\_binopt.tif")  
 download.file("https://drive.google.com/uc?export=download&id=16AsVr5yYzDuAuFW5qWXmLltXPtzDUyak", temp)  
}

# Generate study area map

# Read in aspen presence/absence data  
aspen <- read\_stars(here("Data", "Spatial", "Aspen", "srme\_skcv\_distribution\_binopt.tif"))  
  
# Read in fire severity data  
severity <- read\_stars(here('Data', 'Spatial', 'MTBS', 'composite\_data', 'MTBS\_BSmosaics', '2020', 'mtbs\_CONUS\_2020', 'mtbs\_CONUS\_2020.tif'))  
  
# Read in perimeter data  
CameronPeak <- st\_read(here("Data", "Spatial", "MTBS", "mtbs\_perims\_DD.shp"))

## Reading layer `mtbs\_perims\_DD' from data source   
## `/Users/sarahhart/Library/CloudStorage/GoogleDrive-sarahjanehart13@gmail.com/My Drive/JOB/RESEARCH/Analyses/PostfireAspen/Data/Spatial/MTBS/mtbs\_perims\_DD.shp'   
## using driver `ESRI Shapefile'  
## Simple feature collection with 30032 features and 22 fields  
## Geometry type: MULTIPOLYGON  
## Dimension: XY  
## Bounding box: xmin: -166.1885 ymin: 17.94736 xmax: -65.33821 ymax: 70.15893  
## Geodetic CRS: NAD83

# Create polygon of the area burned at moderate to high severity  
CameronPeak <- CameronPeak %>%   
 filter(Incid\_Name == "CAMERON PEAK") %>% # pull out just Cameron Peak  
 st\_transform(st\_crs(severity)) # transform   
   
CameronPeak.severity <- st\_crop(severity, st\_bbox(CameronPeak))  
CameronPeak.highseverity <- st\_as\_sf(CameronPeak.severity[1], as\_points = FALSE, merge =TRUE) %>%  
 filter(mtbs\_CONUS\_2020.tif %in% 3:4) %>% # select only moderate and high severity pixels  
 st\_union() # combine into one polygon  
st\_write(CameronPeak.highseverity, here("Data", "Spatial", "MTBS", "CameronPeak-highseverity.shp"), append=F) # write to file

## Deleting layer `CameronPeak-highseverity' using driver `ESRI Shapefile'  
## Writing layer `CameronPeak-highseverity' to data source   
## `/Users/sarahhart/Library/CloudStorage/GoogleDrive-sarahjanehart13@gmail.com/My Drive/JOB/RESEARCH/Analyses/PostfireAspen/Data/Spatial/MTBS/CameronPeak-highseverity.shp' using driver `ESRI Shapefile'  
## Writing 1 features with 0 fields and geometry type Multi Polygon.

# Convert aspen data from raster to polygon  
CameronPeak <- CameronPeak %>%   
st\_transform(st\_crs(aspen)) %>% # transform geometry to match aspen  
 st\_buffer(dist=5000) # buffer fire extent by 5 kilometers  
aspen <- aspen %>% st\_crop(st\_bbox(CameronPeak)) # crop aspen data to area in and surrounding Cameron Peak  
  
aspen.p <- st\_as\_sf(aspen[1], as\_points = FALSE, merge =TRUE)   
aspen.p1 <- aspen.p %>%  
 filter(srme\_skcv\_distribution\_binopt.tif==1) %>% # select only presence polygons  
 st\_union() # combine presence polygons into one polygon  
st\_write(aspen.p1, here("Data", "Spatial", "Aspen", "aspen.shp"), append=F) # write to file

## Deleting layer `aspen' using driver `ESRI Shapefile'  
## Writing layer `aspen' to data source   
## `/Users/sarahhart/Library/CloudStorage/GoogleDrive-sarahjanehart13@gmail.com/My Drive/JOB/RESEARCH/Analyses/PostfireAspen/Data/Spatial/Aspen/aspen.shp' using driver `ESRI Shapefile'  
## Writing 1 features with 0 fields and geometry type Multi Polygon.

# Get area of live aspen  
CameronPeak.highseverity <- st\_read(here("Data", "Spatial", "MTBS", "CameronPeak-highseverity.shp")) %>% st\_transform(st\_crs(aspen.p1))

## Reading layer `CameronPeak-highseverity' from data source   
## `/Users/sarahhart/Library/CloudStorage/GoogleDrive-sarahjanehart13@gmail.com/My Drive/JOB/RESEARCH/Analyses/PostfireAspen/Data/Spatial/MTBS/CameronPeak-highseverity.shp'   
## using driver `ESRI Shapefile'  
## Simple feature collection with 1 feature and 1 field  
## Geometry type: MULTIPOLYGON  
## Dimension: XY  
## Bounding box: xmin: -830039.8 ymin: 1977244 xmax: -773246.6 ymax: 2014787  
## Projected CRS: USA\_Contiguous\_Albers\_Equal\_Area\_Conic\_USGS\_version

aspen.live <- st\_difference(aspen.p1, CameronPeak.highseverity)  
st\_write(aspen.live, here("Data", "Spatial", "Aspen", "aspen-live.shp"), append=F) # write to file

## Deleting layer `aspen-live' using driver `ESRI Shapefile'  
## Writing layer `aspen-live' to data source   
## `/Users/sarahhart/Library/CloudStorage/GoogleDrive-sarahjanehart13@gmail.com/My Drive/JOB/RESEARCH/Analyses/PostfireAspen/Data/Spatial/Aspen/aspen-live.shp' using driver `ESRI Shapefile'  
## Writing 1 features with 0 fields and geometry type Multi Polygon.

if(!file.exists(here("Results", "Figures", "FigStudyArea.jpg"))){  
   
 CameronPeak <- st\_read(here("Data", "Spatial", "MTBS", "mtbs\_perims\_DD.shp")) %>%   
 filter(Incid\_Name == "CAMERON PEAK")  
   
 CameronPeak.HS <- st\_read(here("Data", "Spatial", "MTBS", "CameronPeak-highseverity.shp"))  
   
 aspen <- st\_read(here("Data", "Spatial", "Aspen", "aspen.shp"))  
   
 aspen.live <- st\_read(here("Data", "Spatial", "Aspen", "aspen-live.shp"))  
   
 sites <- read\_excel(here("Data", "Postfire-Regen-Clean.xlsx"), sheet="Site") %>% st\_as\_sf(coords = c("Easting", "Northing"), crs = "EPSG:32613")   
 st\_write(sites, here("Data", "Spatial", "sites.shp"), append=F)  
   
 sites <- sites %>% st\_transform(st\_crs(aspen))  
   
 states <- st\_read(here("Data", "Spatial", "States", "cb\_2018\_us\_state\_20m.shp"))   
  
  
  
 x <- tmaptools::bb(sites)  
 x[1] <- x[1]-500; x[2] <- x[2]-500; x[3] <- x[3]+500; x[4] <- x[4]+500  
 asp1 <- (x$ymax - x$ymin)/(x$xmax - x$xmin)  
 sg <- bb\_poly(sites, projection = st\_crs(sites))  
  
  
studyarea <- tm\_shape(CameronPeak.HS, bbox=x) + tm\_fill(col="#BABABA") + tm\_shape(aspen, bbox=x) + tm\_fill(col="#E59E00")+ tm\_borders(col="#E59E00") + tm\_shape(aspen.live, bbox=x) + tm\_fill(col="#009D73")+tm\_borders(col="#009D73") +tm\_shape(CameronPeak, bbox=x) + tm\_borders(col="grey25")+ tm\_shape(sites) +tm\_symbols(size=0.25, shape=24,col="gray10", alpha=1, border.col="white", scale=0.9) + tm\_scale\_bar(position = c(0.05,0.005), text.size=0.75, just="left", breaks=c(0,5), bg.color="white", bg.alpha = 0.8)+tm\_compass(position=c(0.875,0.85), text.size=0.75, size=2, type="4star", bg.color="white", bg.alpha = 0.8)+tm\_graticules(lines=F)+tm\_add\_legend(title="", type="symbol",size=1, col=c("#BABABA", "#E59E00", "#009D73"), shape=22, labels=c("mod-high severity", "burned aspen", "live aspen"), is.portrait = T)+tm\_layout(legend.outside=F, legend.outside.position = "bottom", legend.position=c("right", "bottom"), legend.bg.color = "white")  
   
   
 wus <- states %>% filter(STUSPS %in% c("WA", "OR", "CA", "ID", "NV", "AZ", "MT", "UT", "NM", "CO", "WY")) %>% st\_transform(st\_crs(sites))  
xy <- st\_bbox(wus)  
asp2 <- (xy$xmax - xy$xmin)/(xy$ymax - xy$ymin)  
   
 insetmap = tm\_shape(wus) + tm\_fill(col="lightgrey") +  
 tm\_shape(wus) + tm\_borders(lwd = 1, col="grey") +  
 tm\_shape(sg) + tm\_borders(lw=2, col="black") +  
 tm\_layout(inner.margins = c(0.04,0.04,0.04,0.04), outer.margins=c(0,0,0,0))  
   
 w <- 0.2  
 h <- asp2 \* w  
 vp <- viewport(x=0.12, y=0.87, width = w, height=h, just=c("left", "top"))  
   
 tmap\_save(studyarea,filename=here("Results", "Figures", "FigStudyArea.jpg"),  
 dpi=300, insets\_tm=insetmap, insets\_vp=vp,  
 height=4.5, width=5, units="in")  
}

## Reading layer `mtbs\_perims\_DD' from data source   
## `/Users/sarahhart/Library/CloudStorage/GoogleDrive-sarahjanehart13@gmail.com/My Drive/JOB/RESEARCH/Analyses/PostfireAspen/Data/Spatial/MTBS/mtbs\_perims\_DD.shp'   
## using driver `ESRI Shapefile'  
## Simple feature collection with 30032 features and 22 fields  
## Geometry type: MULTIPOLYGON  
## Dimension: XY  
## Bounding box: xmin: -166.1885 ymin: 17.94736 xmax: -65.33821 ymax: 70.15893  
## Geodetic CRS: NAD83  
## Reading layer `CameronPeak-highseverity' from data source   
## `/Users/sarahhart/Library/CloudStorage/GoogleDrive-sarahjanehart13@gmail.com/My Drive/JOB/RESEARCH/Analyses/PostfireAspen/Data/Spatial/MTBS/CameronPeak-highseverity.shp'   
## using driver `ESRI Shapefile'  
## Simple feature collection with 1 feature and 1 field  
## Geometry type: MULTIPOLYGON  
## Dimension: XY  
## Bounding box: xmin: -830039.8 ymin: 1977244 xmax: -773246.6 ymax: 2014787  
## Projected CRS: USA\_Contiguous\_Albers\_Equal\_Area\_Conic\_USGS\_version  
## Reading layer `aspen' from data source   
## `/Users/sarahhart/Library/CloudStorage/GoogleDrive-sarahjanehart13@gmail.com/My Drive/JOB/RESEARCH/Analyses/PostfireAspen/Data/Spatial/Aspen/aspen.shp'   
## using driver `ESRI Shapefile'  
## Simple feature collection with 1 feature and 1 field  
## Geometry type: MULTIPOLYGON  
## Dimension: XY  
## Bounding box: xmin: 418500 ymin: 4474020 xmax: 488140 ymax: 4519320  
## Projected CRS: WGS 84 / UTM zone 13N  
## Reading layer `aspen-live' from data source   
## `/Users/sarahhart/Library/CloudStorage/GoogleDrive-sarahjanehart13@gmail.com/My Drive/JOB/RESEARCH/Analyses/PostfireAspen/Data/Spatial/Aspen/aspen-live.shp'   
## using driver `ESRI Shapefile'  
## Simple feature collection with 1 feature and 1 field  
## Geometry type: MULTIPOLYGON  
## Dimension: XY  
## Bounding box: xmin: 418500 ymin: 4474020 xmax: 488140 ymax: 4519320  
## Projected CRS: WGS 84 / UTM zone 13N

## Deleting layer `sites' using driver `ESRI Shapefile'  
## Writing layer `sites' to data source   
## `/Users/sarahhart/Library/CloudStorage/GoogleDrive-sarahjanehart13@gmail.com/My Drive/JOB/RESEARCH/Analyses/PostfireAspen/Data/Spatial/sites.shp' using driver `ESRI Shapefile'  
## Writing 34 features with 9 fields and geometry type Point.  
## Reading layer `cb\_2018\_us\_state\_20m' from data source   
## `/Users/sarahhart/Library/CloudStorage/GoogleDrive-sarahjanehart13@gmail.com/My Drive/JOB/RESEARCH/Analyses/PostfireAspen/Data/Spatial/States/cb\_2018\_us\_state\_20m.shp'   
## using driver `ESRI Shapefile'  
## Simple feature collection with 52 features and 9 fields  
## Geometry type: MULTIPOLYGON  
## Dimension: XY  
## Bounding box: xmin: -179.1743 ymin: 17.91377 xmax: 179.7739 ymax: 71.35256  
## Geodetic CRS: NAD83

# References