


ENVIRONMENTAL DATA ANALYTICS: M9 – SPATIAL ANALYSIS

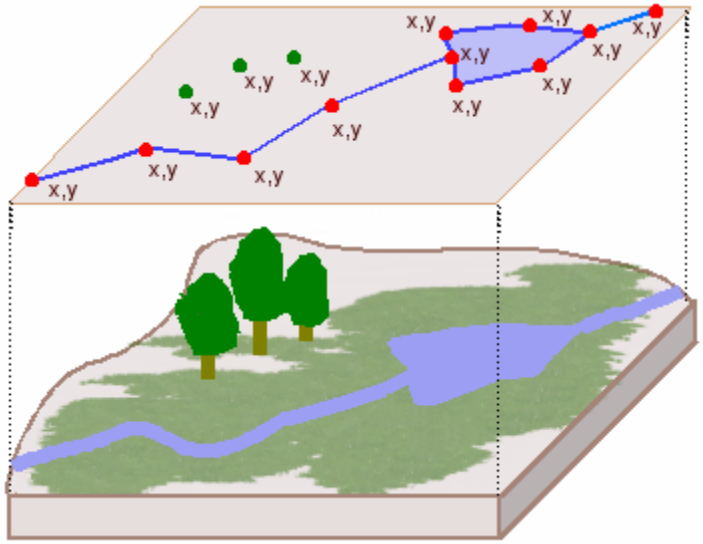
Spring 2023

Nicholas School of the Environment - Duke University

M8.1 – Spatial Data

- Importance of Spatial Analysis in EDA
- Representing Spatial Data in R
- Simple Features & Spatial Dataframes
- Creating geometries
- Coordinate Reference Systems, Transformations, EPSG codes
- GeoJSON, Shapefiles, …

Simple Features…



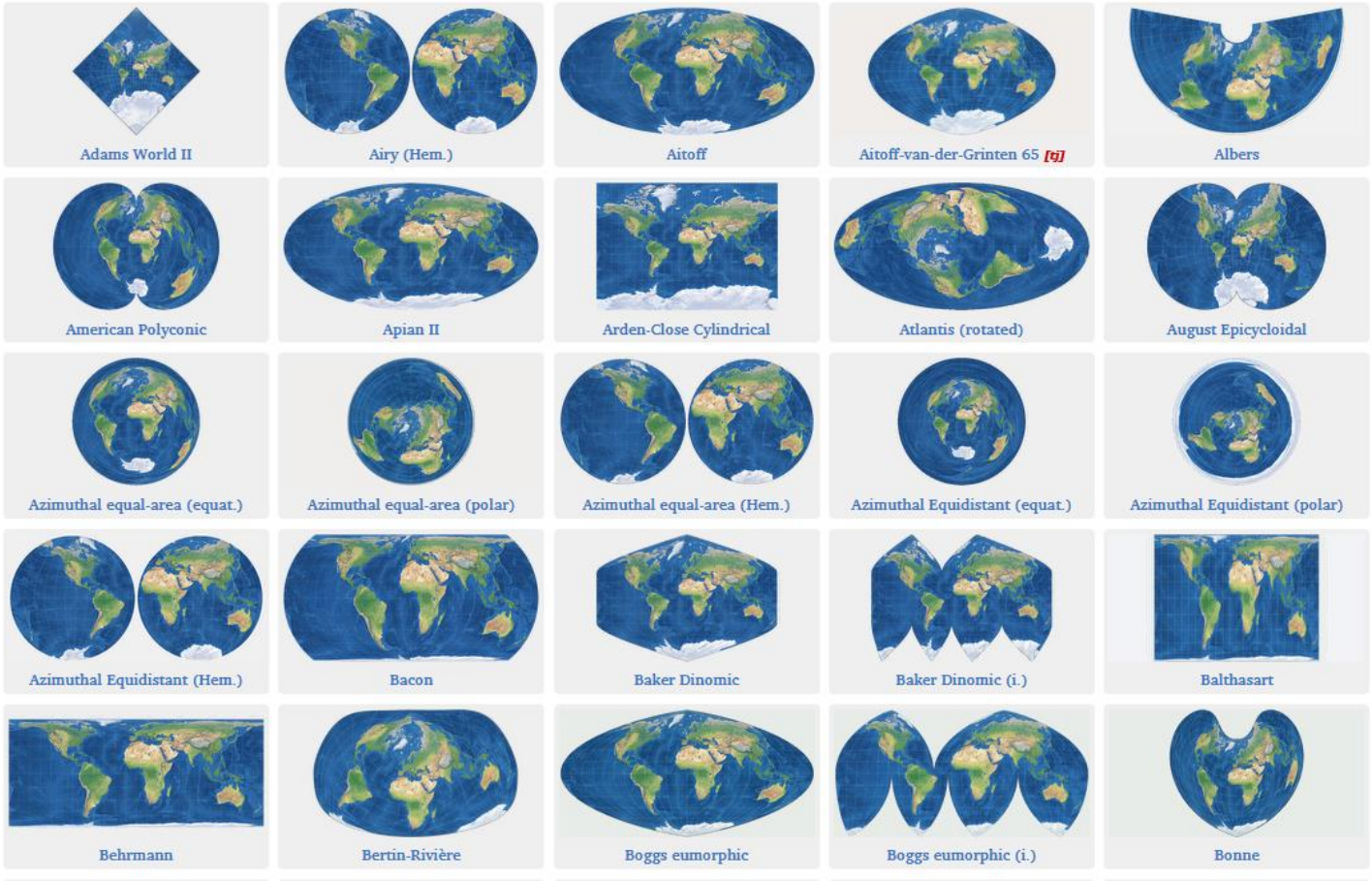

```
## Simple feature collection with 100 features and 6 fields
## geometry type:  MULTIPOLYGON
## dimension:      XY
## bbox:           xmin: -84.32385 ymin: 33.88199 xmax: -75.45698 ymax: 36.58965
## epsg (SRID):    4267
## proj4string:    +proj=longlat +datum=NAD27 +no_defs
## precision:      double (default; no precision model)
## First 3 features:
##   BIR74 SID74 NWBIR74 BIR79 SID79 NWBIR79                              geom
## 1  1091     1       10  1364     0       19 MULTIPOLYGON(((-81.47275543...
## 2   487     0       10   542     3       12 MULTIPOLYGON(((-81.23989105...
## 3  3188     5      208  3616     6      260 MULTIPOLYGON(((-80.45634460...
```

Simple feature

Simple feature geometry list–colum (sfc)

Simple feature geometry (sfg)

Coordinate Reference Systems



https://www.nceas.ucsb.edu/sites/default/files/2020-04/OverviewCoordinateReferenceSystems.pdf

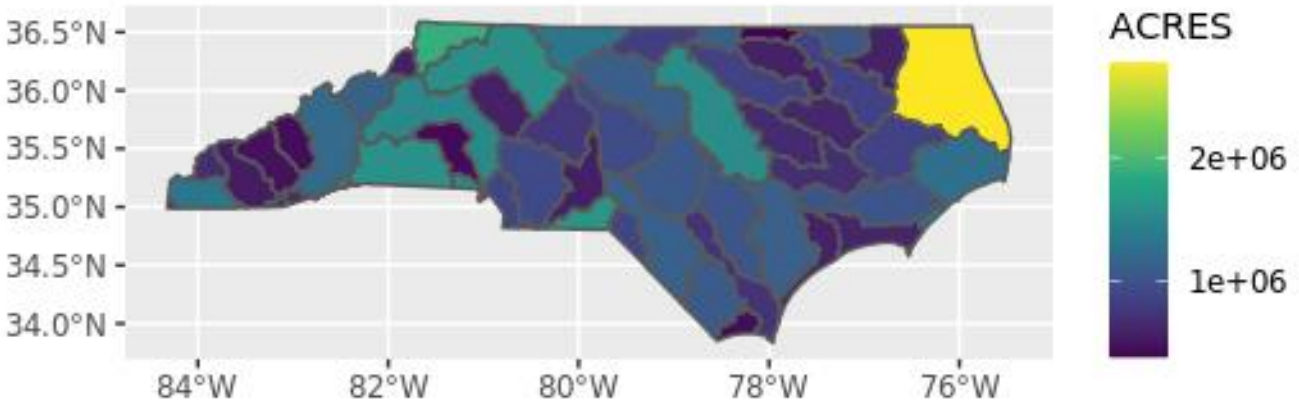
M8.2 – Spatial Analysis

Reading spatial data into R	st_read()
Attribute joins	left_join(), inner_join(),…
Spatial aggregation	group_by() & summarize()
Coordinate system transformations	st_transform()
Intersecting data	st_filter(…,.pred)
Clipping data	st_intersection()
Spatial Selection	st_intersects()

Exercise 2.2.1

- Read in the NC HUC-8 shapefile & filter for : `./Data/Spatial/NCHUC8.shp`

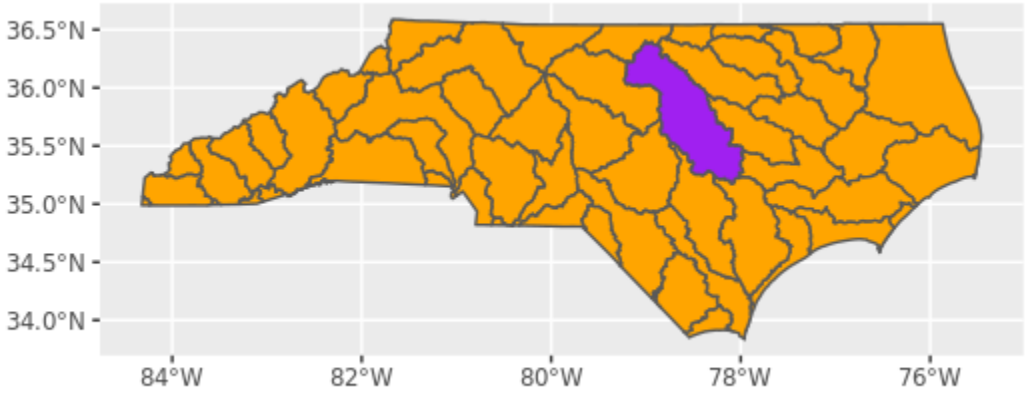
- View features, colored by ACRES



Exercise 2.2.2 - Challenge

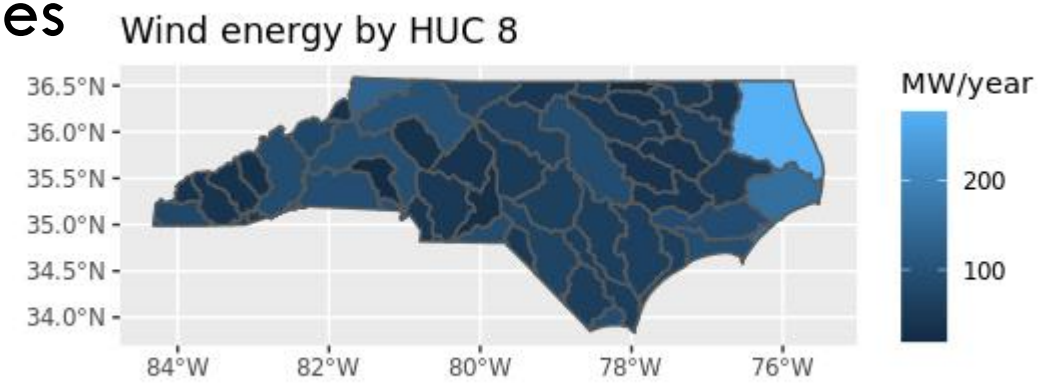
- Read in the NC HUC-8 shapefile & *filter for SUBBASIN is "Upper Neuse"*

- View all HUCs in orange, Upper Neuse in purple



Exercise 3.1.1

- Read an online CSV file into a dataframe\
  https://raw.githubusercontent.com/ENV859/EnviroAtlasData/main/Wind_Energy.csv
  - Set `HUC12` column to be a factor (*colClasses*)
  - Compute `HUC8` from `HUC12` (*substr*)
  - Group on `HUC8`
  - Compute sum of AvgWindEnergy for each HUC8
- Join to HUC8 features



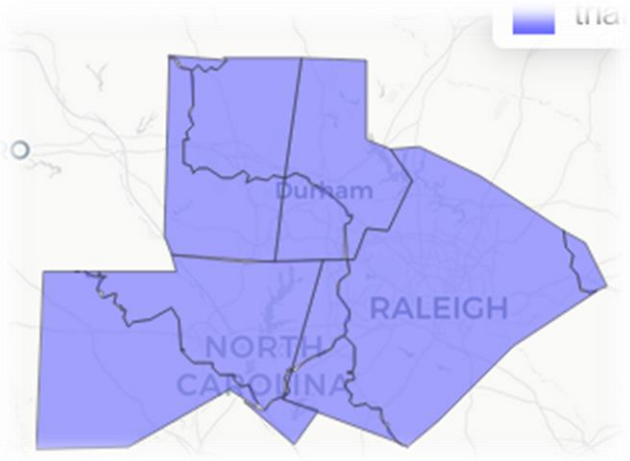
Exercise 3.2.1

- Transform all data to UTM Zone 17

```
```{r Transform the datasets to other coordinate reference systems}
#Convert all to UTM Zone 17 (crs = 26917)
epa_sf_utm <-       st_transform(epa_pm25_sites_sf, crs = 26917)
counties_sf_utm <-
state_sf_utm <-
huc8_sf_utm <-
huc2_utm <-
```
```

Exercise 3.3.1

- Select Triangle counties from all counties: *Chatham*, *Durham*, *Orange*, and *Wake*
- Select HUC8s that intersect the Triangle counties
- Intersect (clip) the HUC8 areas falling w/in Triangle



A NOTE ON KNITTING…

Maps created with MapView and Leaflet don't knit well to PDF!

- **Solutions:**
  - Use ggplot…
  - Knit to HTML…

M8.3 – Spatial Data Visualization

- ggplot() + geomsf()
- mapview
- leaflet

Solutions…

2.2.2 Read HUCs shapefile

```
118 ```{r read HUCs shapefile}
119 #Read the shapefile into an sf dataframe named "huc8_sf"
120 huc8_sf <- st_read('./Data/Spatial/NCHUC8.shp')
121
122 #Reveal the columns
123 colnames(huc8_sf)
124
125 #Check the CRS
126 st_crs(huc8_sf)
127
128 #Examine some records
129 head(huc8_sf)
130
131 #View the data as a map, colored by the acreage in each
132 ggplot() +
133   geom_sf(data=huc8_sf, aes(fill=ACRES))+
134   scale_fill_distiller(palette = "YlOrRd")
135
136 mapview(huc8_sf,zcol='ACRES')
137 ```
```

2.2.3 Challenge

```
```{r Select the Upper Neuse HUC 8}
#Read the shapefile into an sf dataframe
neuse_sf <- st_read('./Data/Spatial/NCHUC8.shp') %>%
  filter(SUBBASIN == 'Upper Neuse')

#Create a map
ggplot() +
  geom_sf(data=huc8_sf,fill='purple',color='gray') +
  geom_sf(data=neuse_sf,fill='orange')

mapview(huc8_sf,col.regions='purple') +
  mapview(neuse_sf,col.regions='orange',alpha=1)
```
```

3.1 Join wind data to HUC8s

```r
#Compute HUC8 wind energy
wind_raw <- read.csv('https://raw.githubusercontent.com/ENV859/EnviroAtlasData/main/Wind_Energy.csv',
  colClasses = c('HUC_12' = 'factor')) %>%
  mutate(HUC_8 = substr(HUC_12,1,8)) %>%
  group_by(HUC_8) %>%
  summarize(SumWindEnergy = sum(AvgWindEnergy))

#Join to HUC_8 features
huc8_sf_join = merge(x = huc8_sf,
                     y = wind_raw,
                     by.x = 'HUC_8',
                     by.y = 'HUC_8')

#View the outputs
ggplot(data=huc8_sf_join) +
  geom_sf(aes(fill=SumWindEnergy)) +
  labs(
    title='Wind energy by HUC 8',
    fill ='MW/year'
  )
```

3.1 Aggregate HUC-8s to HUC-2s

```
```{r Aggregate the HUC data on an attribute, saving as huc2_sf}
#List the unique values in the DWQ_Basin field
unique(huc8_sf$DWQ_Basin)

#Summarize on DWQ Basin value
huc2_sf <- huc8_sf %>%
  group_by(DWQ_Basin) %>%
  summarize(
    ACRES = sum(ACRES),
    SQ_MILES = sum(SQ_MILES)
  )

#Map the data
mapview(huc2_sf,zcol='ACRES')

```
```

3.3 Select HUC8s in the Triangle

```r
#Select the Triangle County from the
triCo_sf <- counties_sf_utm %>%
  filter(NAME %in% c('Chatham','Durham','Orange','Wake'))

#Grab the intersecting HUC_8s
triHucs_1 <- huc8_sf_utm[triCo_sf,]
mapview(triHucs_1)

triHucs_2 <- huc8_sf_utm %>%
  st_filter(triCo_sf)
mapview(triHucs_2)

#Intersect the HUC_8s
truHucs_clipped = huc8_sf_utm %>%
  st_intersection(triCo_sf)
mapview(truHucs_clipped)
```

3.4 Select counties w/in 30 km of pt

```
```{r Select counties within a 30 km area from the site}
the_site_counties <- theSite_sfc_transformed %>%
  st_buffer(.,dist=30000)

counties_3k <- counties_sf_utm %>%
  st_filter(the_site_counties)

mapview(counties_3k) +
  mapview(the_site_counties,col.regions='red',alpha=0.1)

```
```