VA STATE UNIVERSITY
ment of Community and Regional Planning

Mapping Social Vulnerability and Flood Damages

Public Housing Units in Lumberton, North Carolina after Hurricane Matthew, 2016

Sayma Khajehei- MCRP

May 6,2019

Abstract

Scholars believe that residents of public housing are one of the most socially vulnerable people that face significant damages in disasters.

Hurricane Matthew made landfall in North Carolina on October 8, 2016, as a Category 1 storm.

Lumberton were devastated by heavy rainfall and the river flooding that began after Hurricane Matthew.

Lumberton is a diverse socio-demographic city with one-third of households who live at or below the poverty level.

Lumberton has a particular combination of minorities with a high percentage of African American and Native American.

This city has 729 public housing units.

The flood destroyed 37% of public housing units in Lumberton.

Data and Maps

Data:

- 2015-ACS estimation data
- U.S. Department of Housing and Urban Development (HUD) d
- Housing Authority of City of Lumberton (HACL) data
- A part of survey data of my thesis

Maps:

- Social vulnerability at the block-group level in Lumberton, NC,
- Location of public housing developments in the city,
- Damage assessment of public housing units' samples
- Abandoned public housing developments

This Project & My Thesis

My thesis Goals:

Find the specific vulnerabilities of the public housing residents in Lumberton, North Carolina

- I use social vulnerability weighted Index defined by Van Zandt and Colleagues in 2012 to show the distribution of vulnerability in the city.

How these vulnerabilities affect the impact of flood damages in the public housing developments.

- Show the location of public housing developments and the damages to these units based on damage assessment of the sampled units to show the severity of damages.

My thesis is a part of a larger longitudinal and interdisciplinary recovery-based field study in Lumberton conducted by **the Center of Excellence (CoE)** on Risk-Based Community Resilience Planning with collaborators from the **National Institute of Standards and Technology (NIST).**

Web Mapping Technology

- Excel
- QGIS
- GeoJSON
- HTML, CSS, JavaScript, and JQuery
- Leaflet maps
- HighCharts
- Array

Key Challenges

Preparing my damage assessment data that I have to reduce the sampled units for this project. I have 596 samples and I need 88 of them for this project.

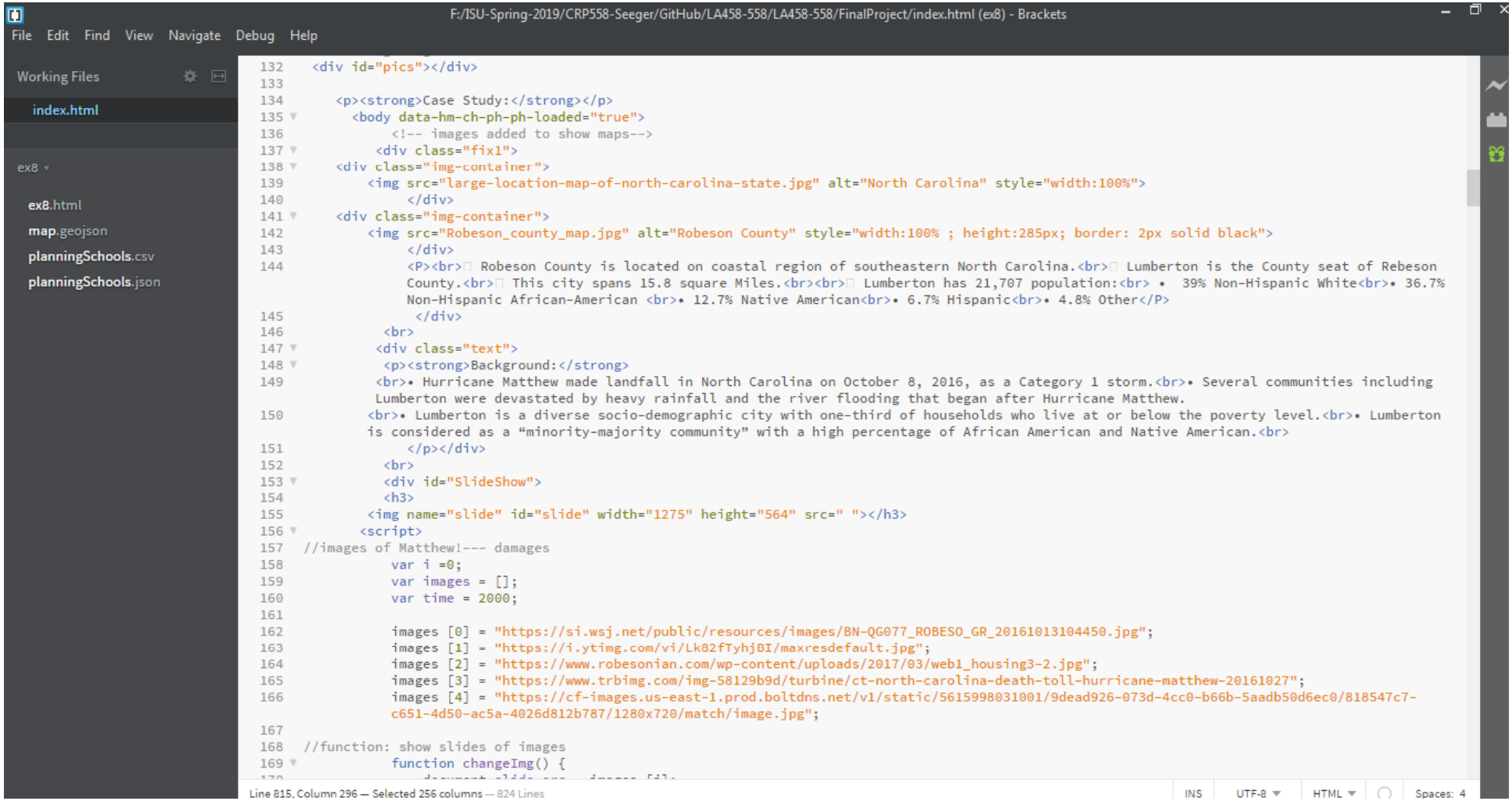
Making Coropleth maps

Find a way to present all the information on a single map.

Working on the format of the webpage to present maps and charts ar the texts

ntroduction Part

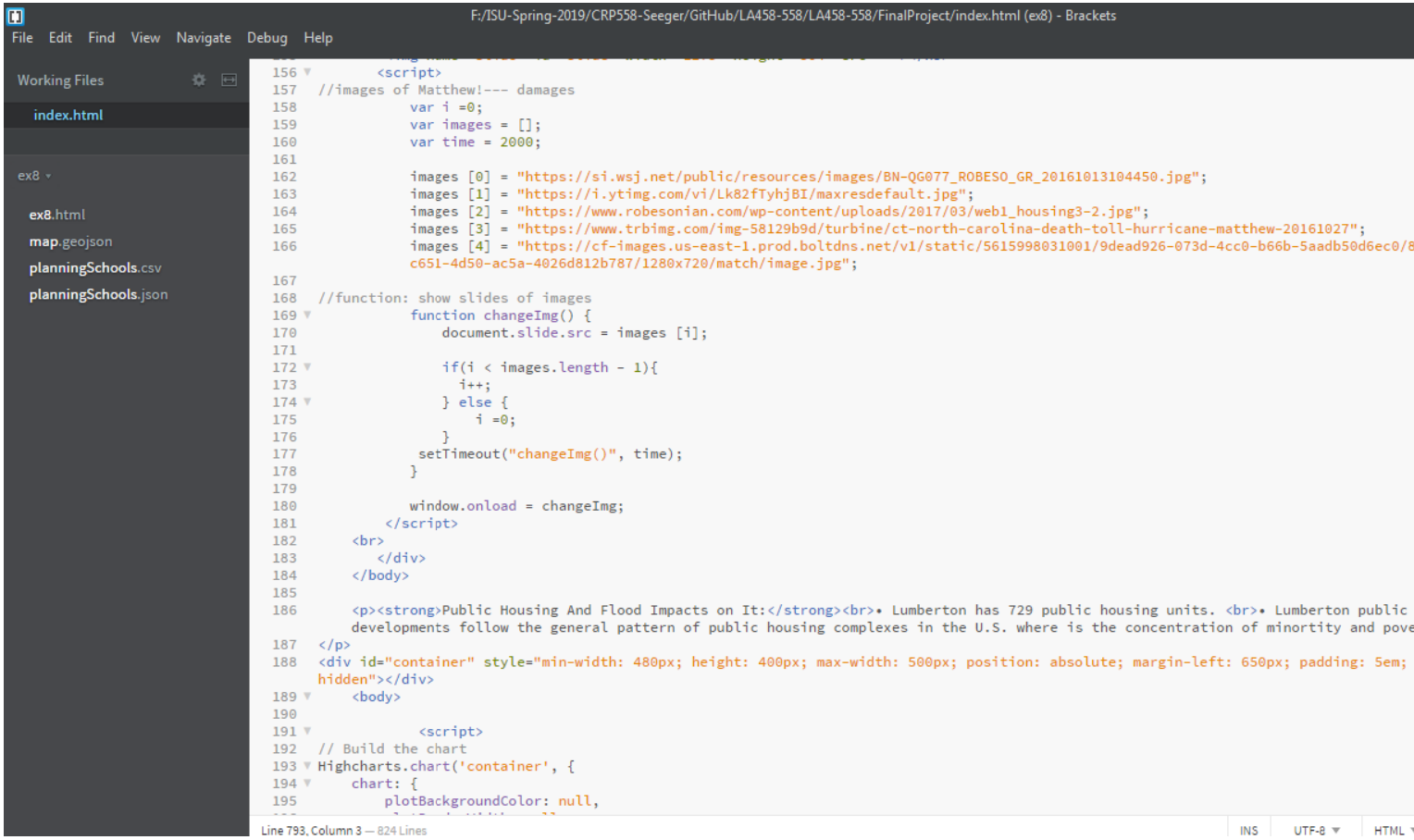
Using containers to have two images and text together in a line!



mages Slide Show

aving image slide
now to show some
ictures of the
oods

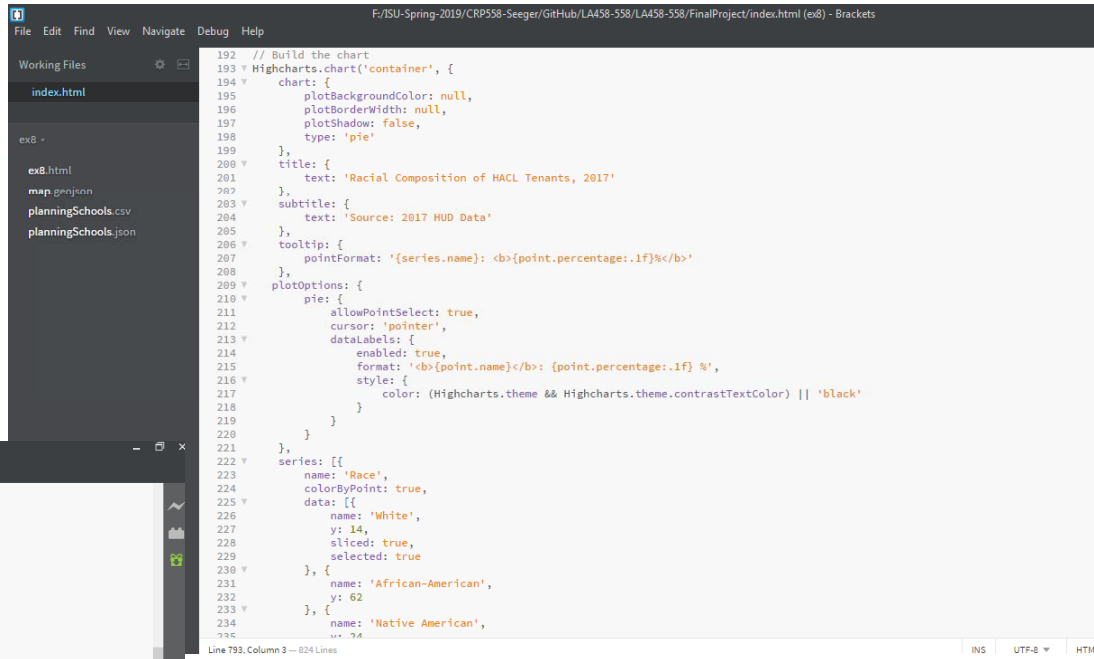
sing Array

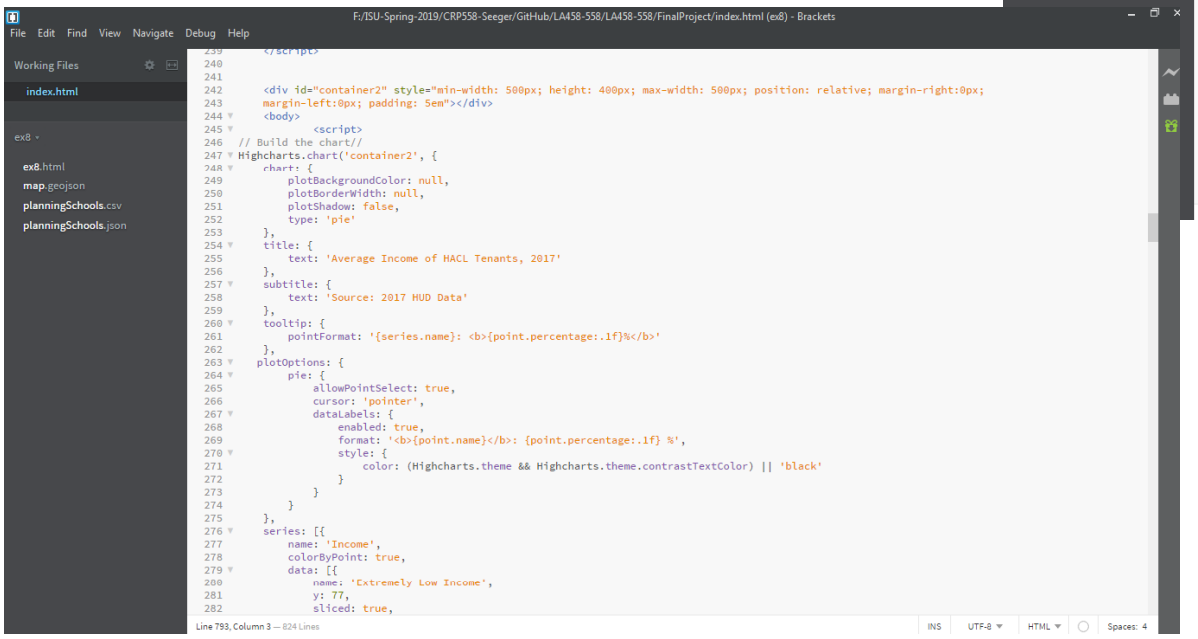


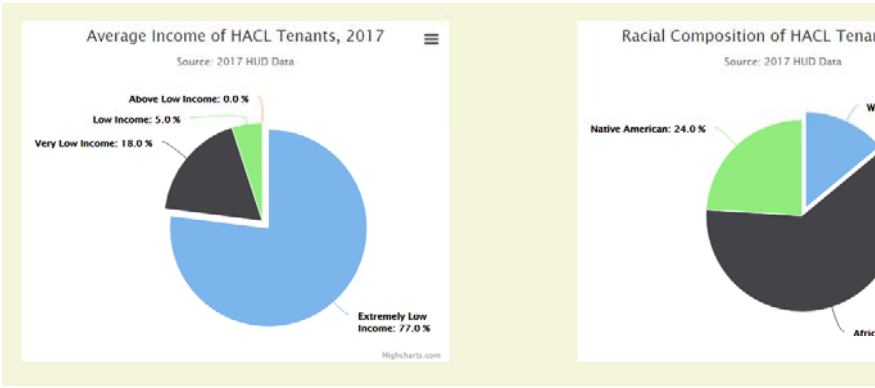
Charts

Using Highchart's pie chart code

Using containers to have the charts in a line



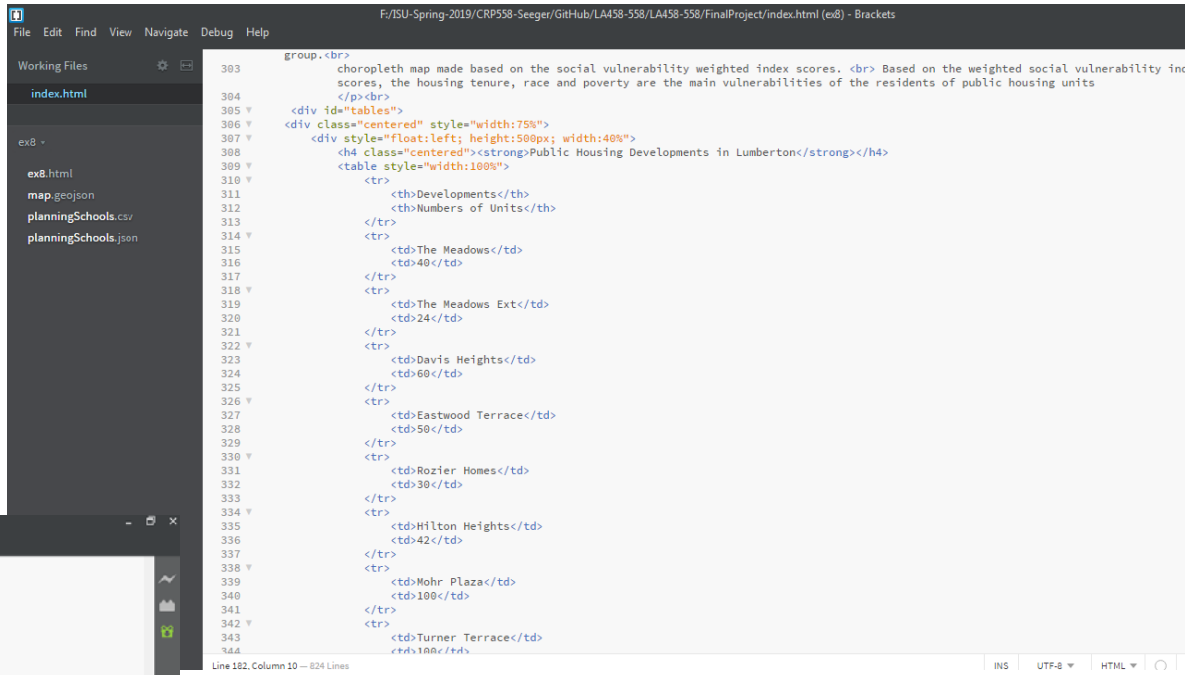


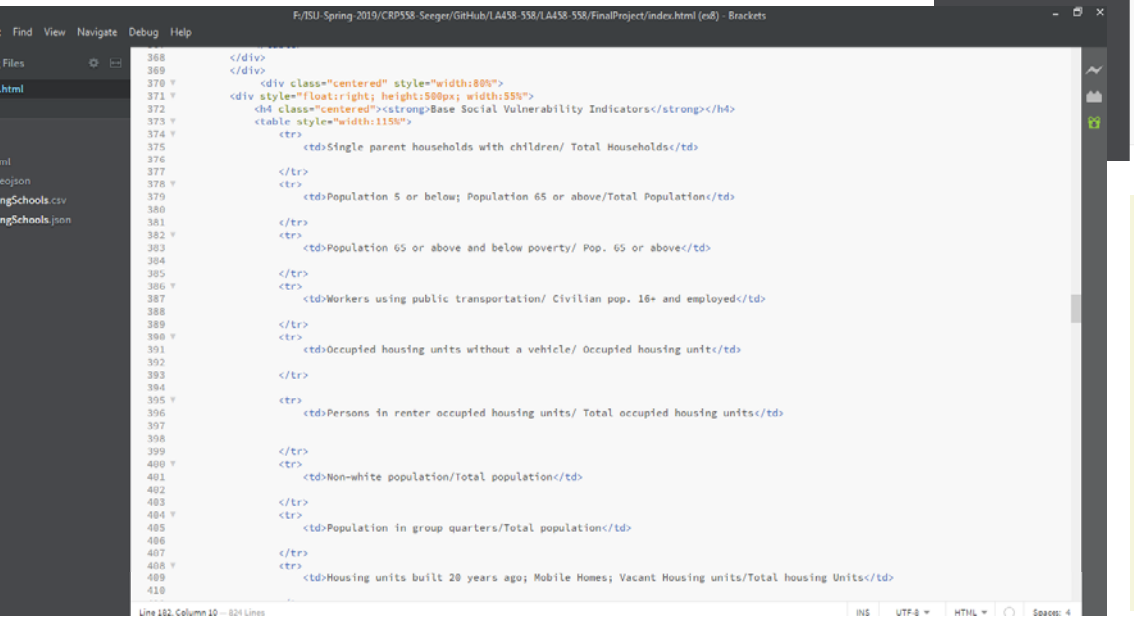


Tables

sing html codes to make bles

sing containers to have the bles in a line





Public Housing Developments in Lumberton

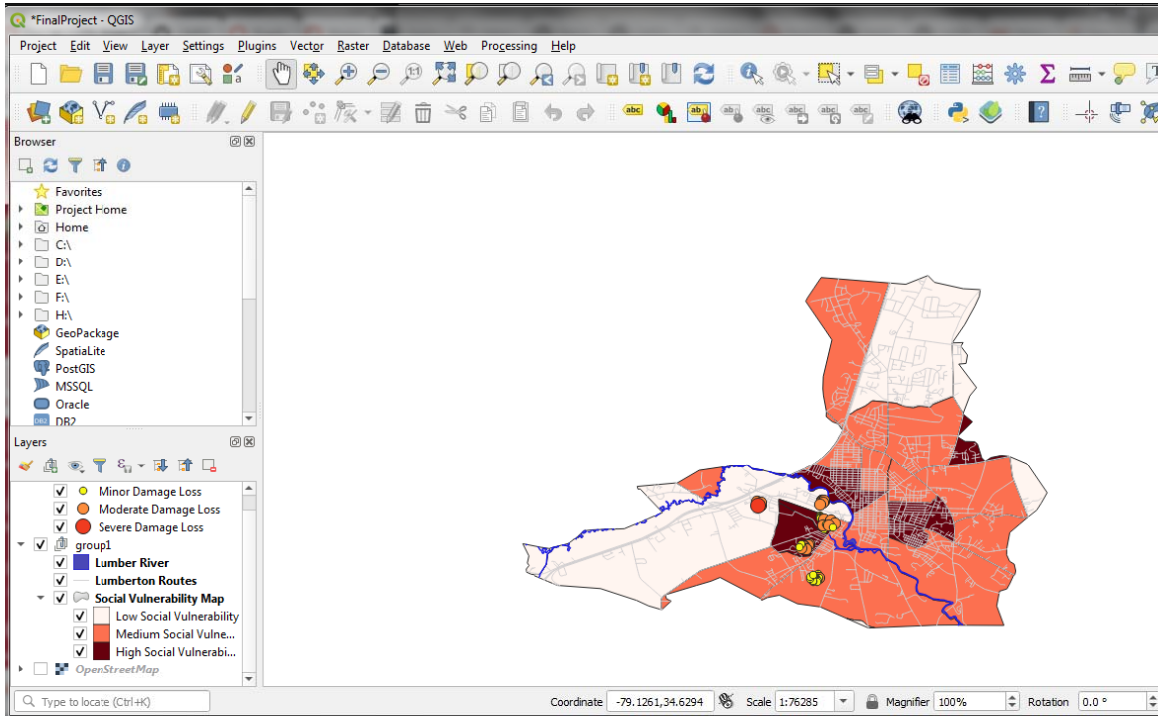
Developments	Numbers of Units
The Meadows	40
The Meadows Ext	24
Davis Heights	60
Eastwood Terrace	50
Rozier Homes	30
Hilton Heights	42
Mohr Plaza	100
Turner Terrace	100
Lumbee Homes	93
Myers Park	30
Tudor Court	60
Weaver Court	100
Total	729

Base Social Vulnerability Indicators

Single parent households with children/ Total Households
Population 5 or below; Population 65 or above/Total Population
Population 65 or above and below poverty/ Pop. 65 or above
Workers using public transportation/ Civilian pop. 16+ and employed
Occupied housing units without a vehicle/ Occupied housing unit
Persons in renter occupied housing units/ Total occupied housing units
Non-white population/Total population
Population in group quarters/Total population
Housing units built 20 years ago; Mobile Homes; Vacant Housing units/Total housing Un
Persons in poverty/Total population
Occupied housing units without a telephone/Total occupied house unit
Population above 25 with less than high school/Total pop above 25
Population 16+ in labor force and unemployed/Pop in Labor force 16+
Population above 5 that speak English not well or not at all/Pop >5

Maps

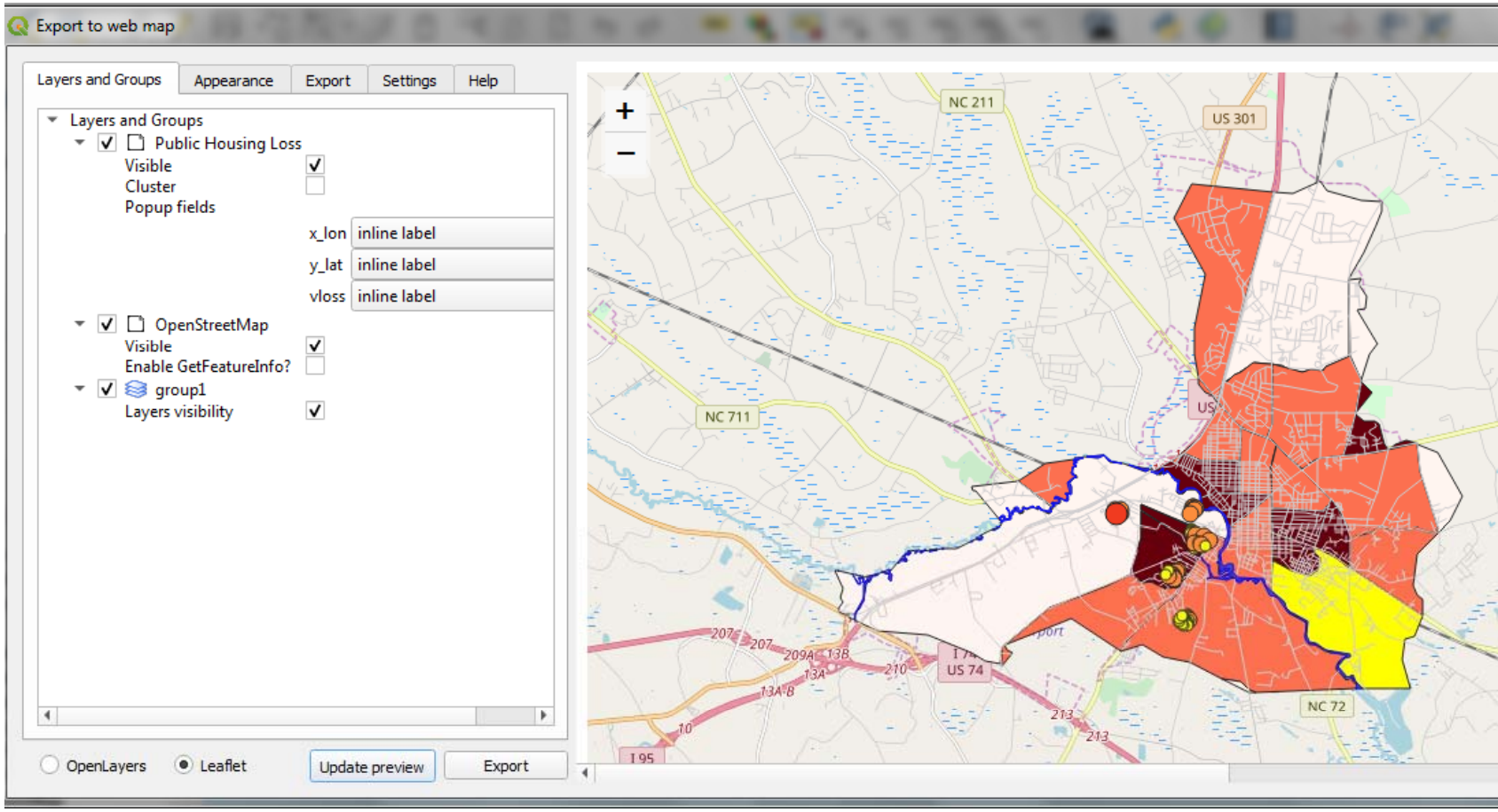
- Joined Excel table to the Block Groups' in QGIS to make Coropleth map
- Export public housing point features and add them to the map
- Add layers such as river, roads, and open street map



Maps

oorting the
flet map in
IS

ng the code
he html file



F:/ISU-Spring-2019/CRP558-Seeger/GitHub/LA458-558/LA458-558/FinalProject/index.html (ex8) - Brackets

Find View Navigate Debug Help

Files

.html

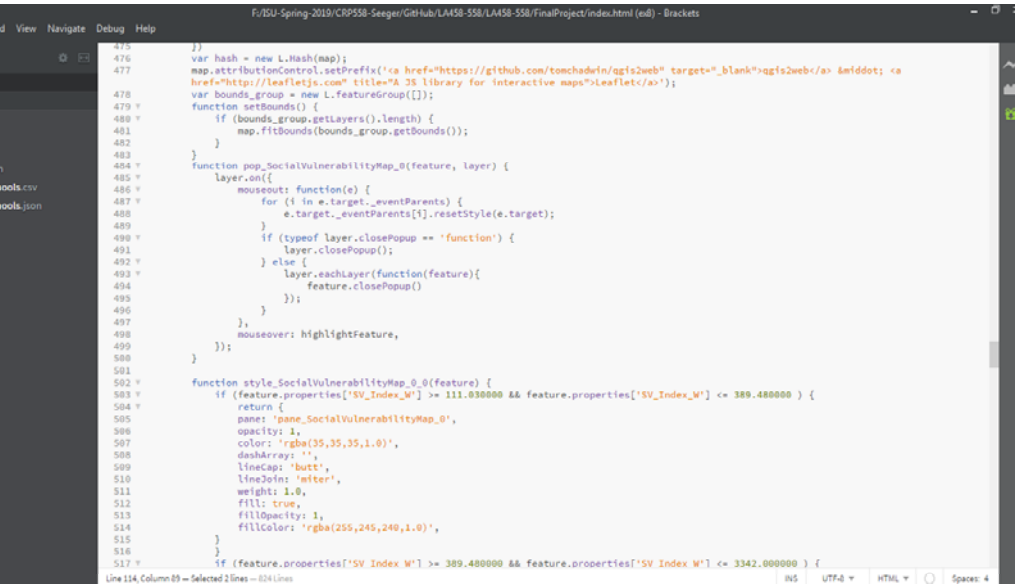
ml
eojson
ngSchools.csv
ngSchools.json

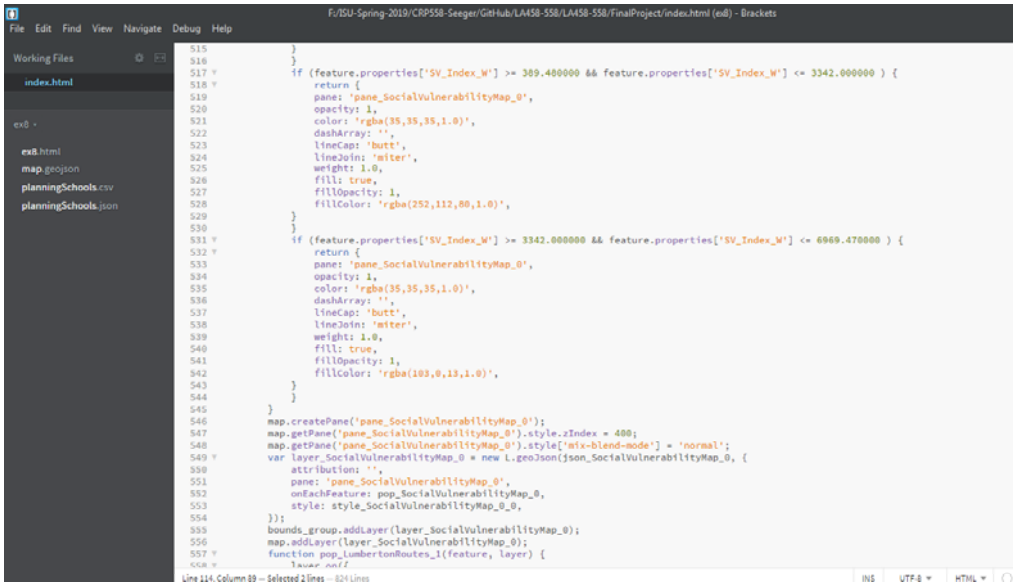
```
<!-- adding maps of QGIS-->
    <body>
   <div id="map"></div>
        <body>
        <script src="js/qgis2web_expressions.js"></script>
        <script src="js/leaflet.js"></script>
        <script src="js/leaflet.rotatedMarker.js"></script>
        <script src="js/leaflet.pattern.js"></script>
        <script src="js/leaflet-hash.js"></script>
        <script src="js/Autolinker.min.js"></script>
        <script src="js/rbush.min.js"></script>
        <script src="js/labelgun.min.js"></script>
        <script src="js/labels.js"></script>
        <script src="data/SocialVulnerabilityMap_0.js"></script>
        <script src="data/LumbertonRoutes_1.js"></script>
        <script src="data/LumberRiver_2.js"></script>
        <script src="data/PublicHousingLoss_4.js"></script>
        <script>
        var highlightLayer;
        function highlightFeature(e) {
            highlightLayer = e.target;

            if (e.target.feature.geometry.type === 'LineString') {
              highlightLayer.setStyle({
                color: '#ffff00',
              });
            } else {
              highlightLayer.setStyle({
                fillColor: '#ffff00',
                fillOpacity: 1
              });
            }
            highlightLayer.openPopup();
        }
        var map = L.map('map', {
            zoomControl:true, maxZoom:28, minZoom:1
        })
        var hash = new L.Hash(map);
        map.attributionControl.setPrefix('<a href="https://github.com/tomchadwin/qgis2web" target="_blank">qgis2web</a> &middot; <a
        href="http://leafletjs.com" title="A JS library for interactive maps">Leaflet</a>');
        var bounds_group = new L.featureGroup([]);
        function setBounds() {
            if (bounds_group.getLayers().length) {
```

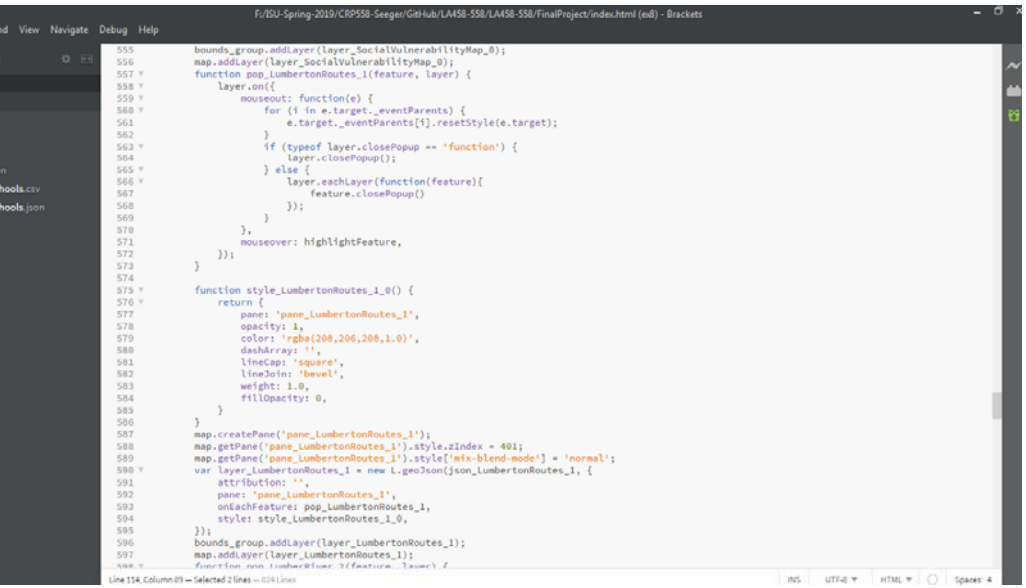
Line 114, Column 89 — Selected 2 lines — 824 Lines INS UTF-8 HTML Space

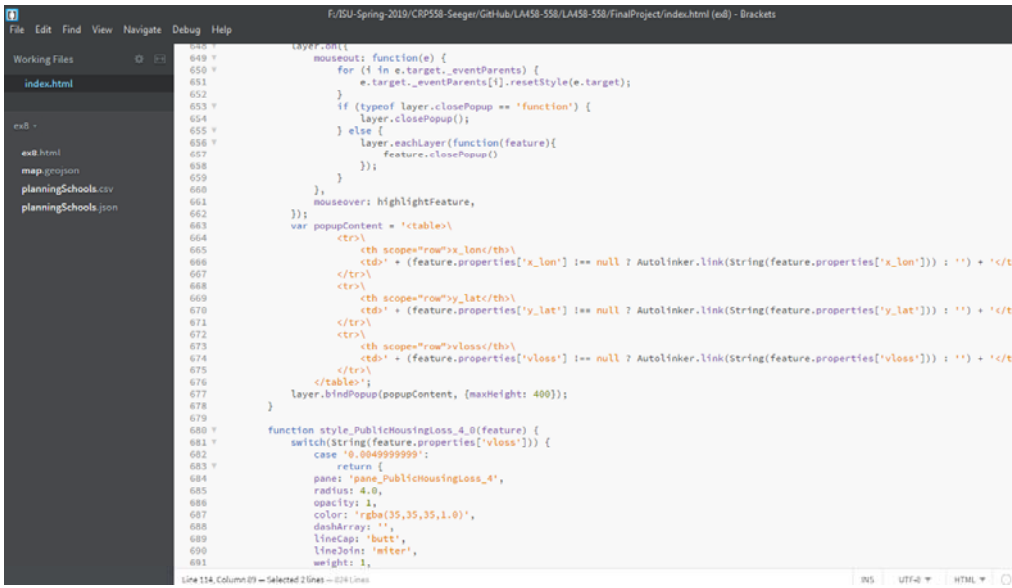
STATE UNIVERSITY

nt of Community and Regional Planning


F:/ISU-Spring-2019/CRP558-Seeger/GitHub/LA458-558/LA458-558/FinalProject/index.html (ex8) - Brackets
var hash = new L.Hash(map);
map.attributionControl.setPrefix('qgis2web · Leaflet');
var bounds_group = new L.featureGroup([]);
function setBounds() {
if (bounds_group.getLayers().length) {
map.fitBounds(bounds_group.getBounds());
}
}
function pop_SocialVulnerabilityMap_0(feature, layer) {
layer.on({
mouseout: function(e) {
for (i in e.target._eventParents) {
e.target._eventParents[i].resetStyle(e.target);
}
if (typeof layer.closePopup == 'function') {
layer.closePopup();
} else {
layer.eachLayer(function(feature){
feature.closePopup()
});
}
},
mouseover: highlightFeature,
});
}
function style_SocialVulnerabilityMap_0_0(feature) {
if (feature.properties['SV_Index_W'] >= 111.030000 && feature.properties['SV_Index_W'] <= 389.480000) {
return {
pane: 'pane_SocialVulnerabilityMap_0',
opacity: 1,
color: 'rgba(35,35,35,1.0)',
dashArray: '',
lineCap: 'butt',
lineJoin: 'miter',
weight: 1.0,
fill: true,
fillOpacity: 1,
fillColor: 'rgba(255,245,240,1.0)',
}
}
if (feature.properties['SV_Index_W'] >= 389.480000 && feature.properties['SV_Index_W'] <= 3342.000000) {

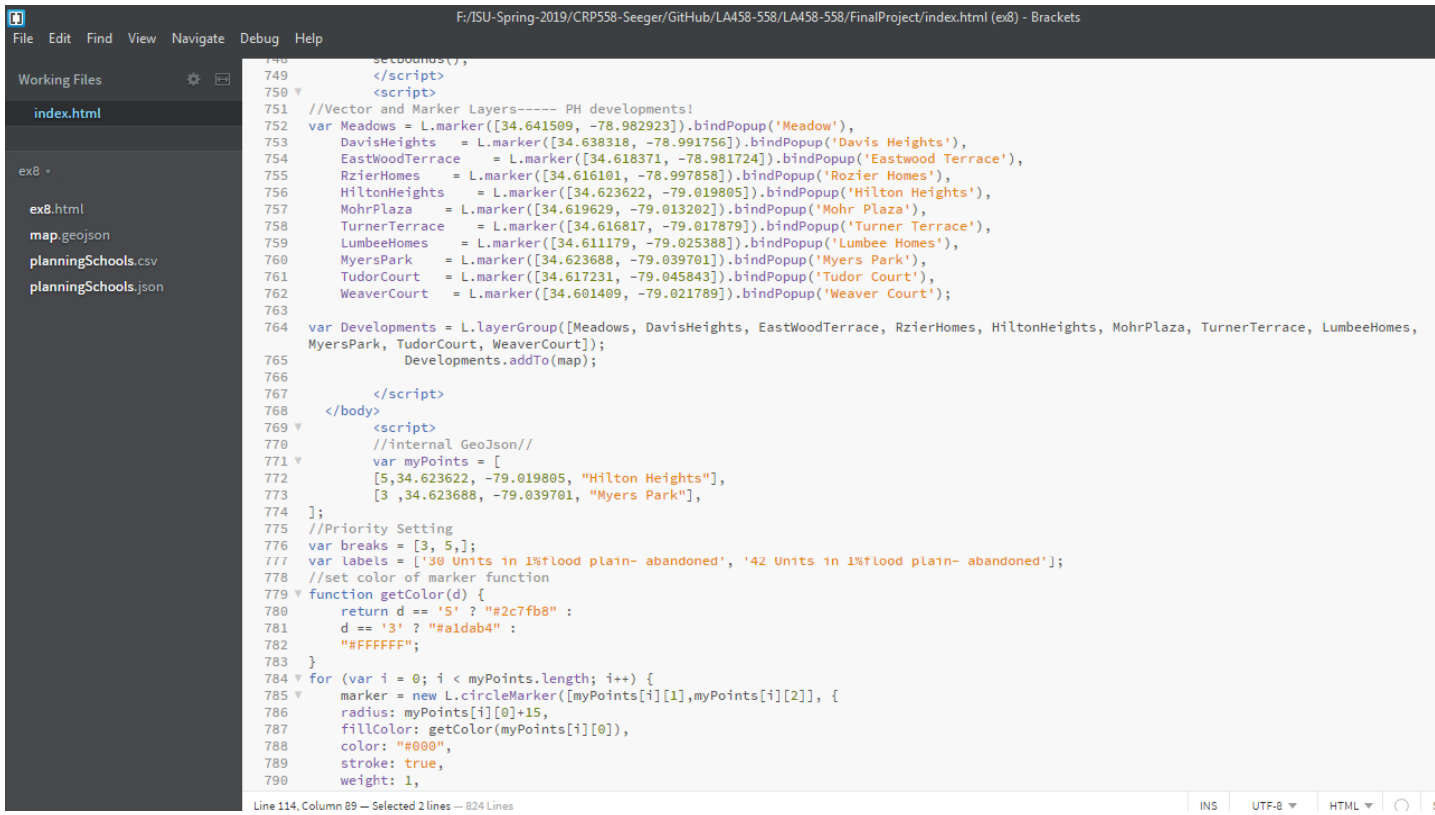

F:/ISU-Spring-2019/CRP558-Seeger/GitHub/LA458-558/LA458-558/FinalProject/index.html (ex8) - Brackets
File Edit Find View Navigate Debug Help
Working Files
index.html
ex8
ex8.html
map.geojson
planningSchools.csv
planningSchools.json
}
if (feature.properties['SV_Index_W'] >= 389.480000 && feature.properties['SV_Index_W'] <= 3342.000000) {
return {
pane: 'pane_SocialVulnerabilityMap_0',
opacity: 1,
color: 'rgba(35,35,35,1.0)',
dashArray: '',
lineCap: 'butt',
lineJoin: 'miter',
weight: 1.0,
fill: true,
fillOpacity: 1,
fillColor: 'rgba(252,112,80,1.0)',
}
}
if (feature.properties['SV_Index_W'] >= 3342.000000 && feature.properties['SV_Index_W'] <= 6969.470000) {
return {
pane: 'pane_SocialVulnerabilityMap_0',
opacity: 1,
color: 'rgba(35,35,35,1.0)',
dashArray: '',
lineCap: 'butt',
lineJoin: 'miter',
weight: 1.0,
fill: true,
fillOpacity: 1,
fillColor: 'rgba(103,0,13,1.0)',
}
}
}
map.createPane('pane_SocialVulnerabilityMap_0');
map.getPane('pane_SocialVulnerabilityMap_0').style.zIndex = 400;
map.getPane('pane_SocialVulnerabilityMap_0').style['mix-blend-mode'] = 'normal';
var layer_SocialVulnerabilityMap_0 = new L.geoJson(json_SocialVulnerabilityMap_0, {
attribution: '',
pane: 'pane_SocialVulnerabilityMap_0',
onEachFeature: pop_SocialVulnerabilityMap_0,
style: style_SocialVulnerabilityMap_0_0,
});
bounds_group.addLayer(layer_SocialVulnerabilityMap_0);
map.addLayer(layer_SocialVulnerabilityMap_0);
function pop_LumbertonRoutes_1(feature, layer) {


F:/ISU-Spring-2019/CRP558-Seeger/GitHub/LA458-558/LA458-558/FinalProject/index.html (ex8) - Brackets
bounds_group.addLayer(layer_SocialVulnerabilityMap_0);
map.addLayer(layer_SocialVulnerabilityMap_0);
function pop_LumbertonRoutes_1(feature, layer) {
layer.on({
mouseout: function(e) {
for (i in e.target._eventParents) {
e.target._eventParents[i].resetStyle(e.target);
}
if (typeof layer.closePopup == 'function') {
layer.closePopup();
} else {
layer.eachLayer(function(feature){
feature.closePopup()
});
}
},
mouseover: highlightFeature,
});
}
function style_LumbertonRoutes_1_0() {
return {
pane: 'pane_LumbertonRoutes_1',
opacity: 1,
color: 'rgba(208,206,208,1.0)',
dashArray: '',
lineCap: 'square',
lineJoin: 'bevel',
weight: 1.0,
fillOpacity: 0,
}
}
map.createPane('pane_LumbertonRoutes_1');
map.getPane('pane_LumbertonRoutes_1').style.zIndex = 401;
map.getPane('pane_LumbertonRoutes_1').style['mix-blend-mode'] = 'normal';
var layer_LumbertonRoutes_1 = new L.geoJson(json_LumbertonRoutes_1, {
attribution: '',
pane: 'pane_LumbertonRoutes_1',
onEachFeature: pop_LumbertonRoutes_1,
style: style_LumbertonRoutes_1_0,
});
bounds_group.addLayer(layer_LumbertonRoutes_1);
map.addLayer(layer_LumbertonRoutes_1);


F:/ISU-Spring-2019/CRP558-Seeger/GitHub/LA458-558/LA458-558/FinalProject/index.html (ex8) - Brackets
File Edit Find View Navigate Debug Help
Working Files
index.html
ex8
ex8.html
map.geojson
planningSchools.csv
planningSchools.json
mouseout: function(e) {
for (i in e.target._eventParents) {
e.target._eventParents[i].resetStyle(e.target);
}
if (typeof layer.closePopup == 'function') {
layer.closePopup();
} else {
layer.eachLayer(function(feature){
feature.closePopup()
});
}
},
mouseover: highlightFeature,
});
var popupContent = '<table>\
<tr>\
<th scope="row">x_lon</th>\
<td>' + (feature.properties['x_lon'] !== null ? Autolinker.link(String(feature.properties['x_lon'])) : '') + '</t
</tr>\
<tr>\
<th scope="row">y_lat</th>\
<td>' + (feature.properties['y_lat'] !== null ? Autolinker.link(String(feature.properties['y_lat'])) : '') + '</t
</tr>\
<tr>\
<th scope="row">vloss</th>\
<td>' + (feature.properties['vloss'] !== null ? Autolinker.link(String(feature.properties['vloss'])) : '') + '</t
</tr>\
</table>';
layer.bindPopup(popupContent, {maxHeight: 400});
}
function style_PublicHousingLoss_4_0(feature) {
switch(String(feature.properties['vloss'])) {
case '0.0049999999':
return {
pane: 'pane_PublicHousingLoss_4',
radius: 4.0,
opacity: 1,
color: 'rgba(35,35,35,1.0)',
dashArray: '',
lineCap: 'butt',
lineJoin: 'miter',
weight: 1,

Public Housing Developments Location

- Using vector and markers
- Using array



Abandoned Public Housing Developments

g Internal
son

ng legend

F:/ISU-Spring-2019/CRP558-Seeger/GitHub/LA458-558/LA458-558/FinalProject/index.html (ex8) - Brackets

File Edit Find View Navigate Debug Help

Working Files

index.html

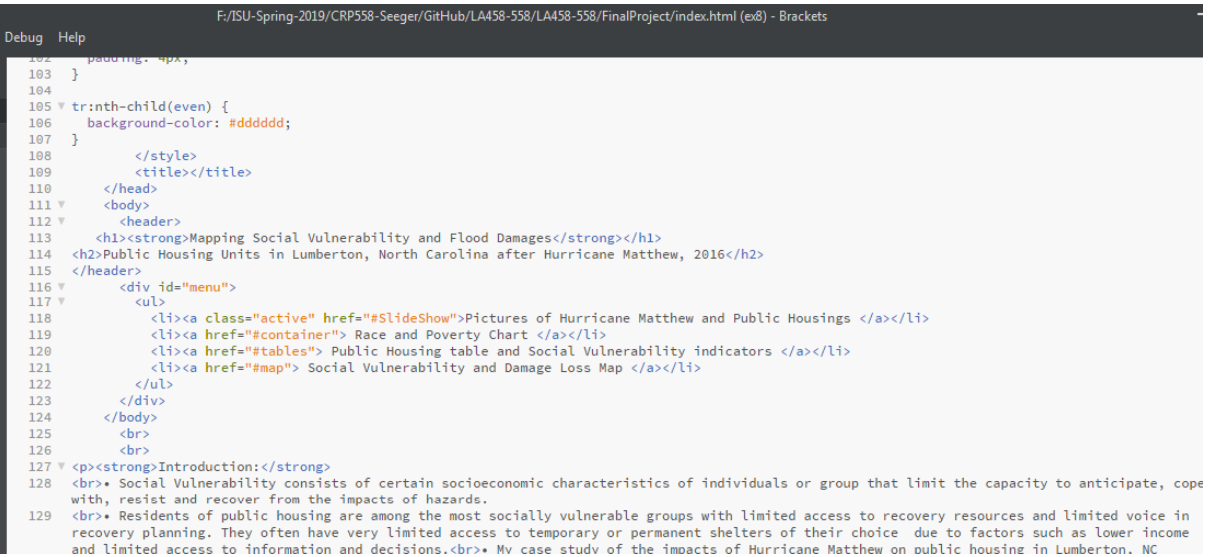
ex8

ex8.html
map.geojson
planningSchools.csv
planningSchools.json

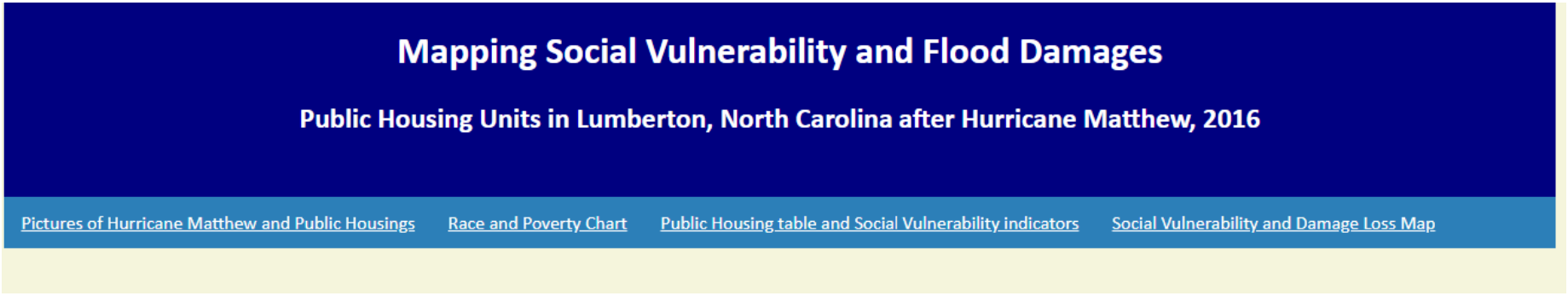
```
768     </body>
769         <script>
770         //internal GeoJson//
771         var myPoints = [
772         [5,34.623622, -79.019805, "Hilton Heights"],
773         [3 ,34.623688, -79.039701, "Myers Park"],
774 ];
775 //Setting
776 var breaks = [3, 5,];
777 var labels = ['30 Units in 1%flood plain- abandoned', '42 Units in 1%flood plain- abandoned'];
778 //set color of marker function
779 function getColor(d) {
780     return d == '5' ? "#2c7fb8" :
781     d == '3' ? "#a1dab4" :
782     "#FFFFFF";
783 }
784 for (var i = 0; i < myPoints.length; i++) {
785     marker = new L.circleMarker([myPoints[i][1],myPoints[i][2]], {
786     radius: myPoints[i][0]+15,
787     fillColor: getColor(myPoints[i][0]),
788     color: "#000",
789     stroke: true,
790     weight: 1,
791     opacity: 1,
792     fillOpacity: 0.8
793 })
794 .bindPopup(myPoints[i][2]) //note there is no comma here
795 .addTo(map);
796 }
797
798 var legend = L.control({position: 'bottomleft'});
799 legend.onAdd = function (map) {
800     var div = L.DomUtil.create('div', 'info legend');
801     // loop through items and generate legend items each
802      div.innerHTML += "<b> Abandoned Developments </b> <br>"
803
804     for (var i = 0; i <breaks.length; i++){
805     div.innerHTML +=
806         '<i style="background:' + getColor(breaks[i]) + ' "></i> ' + labels[i] + (breaks ? '' + '<br>' : '');
807         }
808     return div;
809      };
810      legend.addTo(map);
```

Line 793, Column 3 — 824 Lines INS UTF-8 HTML

Conclusion



- Using QGIS, web mapping
  html coding I attempted t
  present my project.
- I used some links at the to
  my web page to make it e
  for a visitor to navigate th
  the page.



Thank You!