GIS-based modeling of Miami area residential land use as affected by water level 1900-2050

Hugh Gladwin, Peter Craumer, Suzana D Mic

FIU GIS Center GIS Day, Climate Change, November 6, 2015

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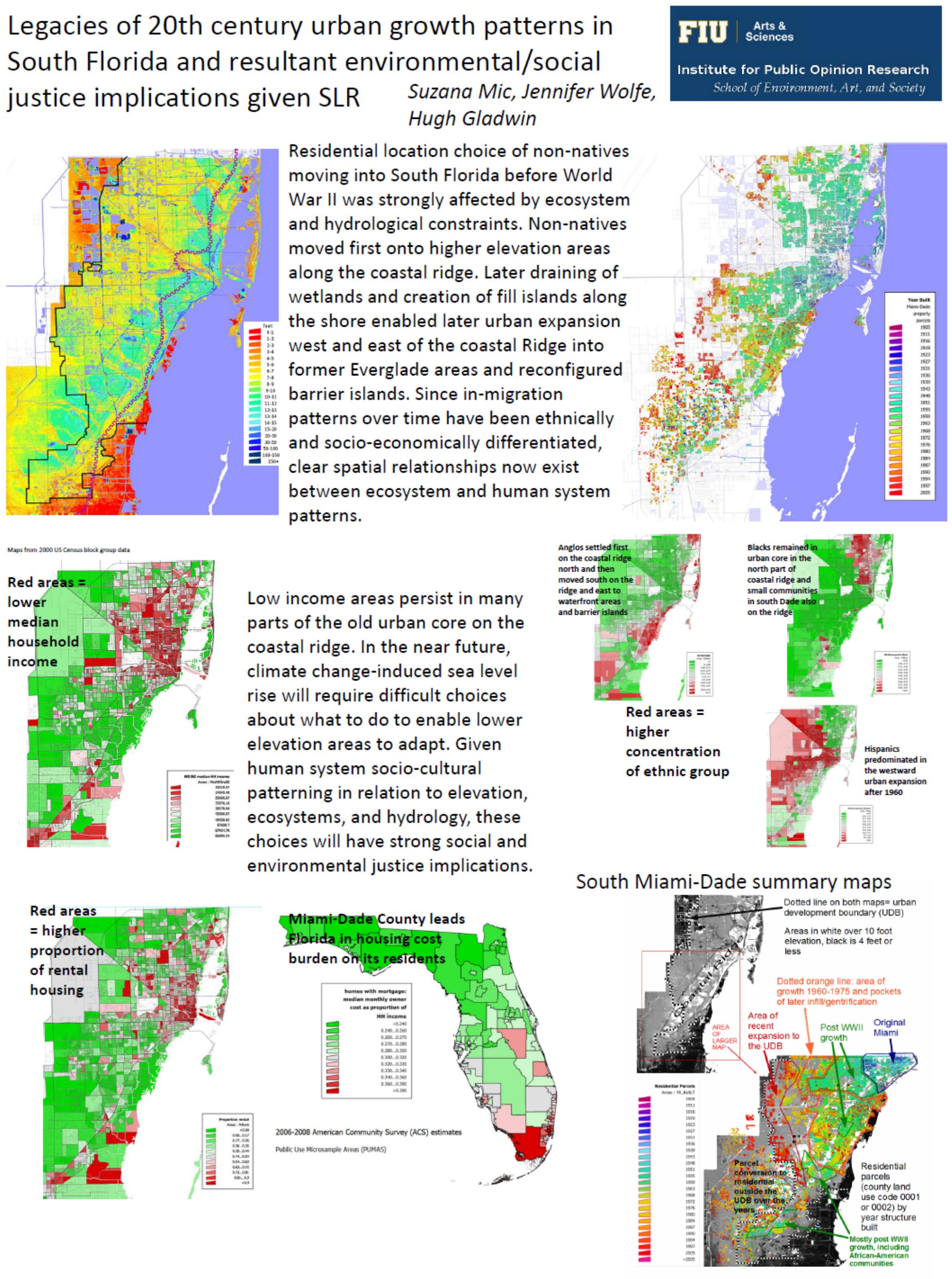
2. Mic: NOAA Southeast Fisheries Science Center, University of Miami



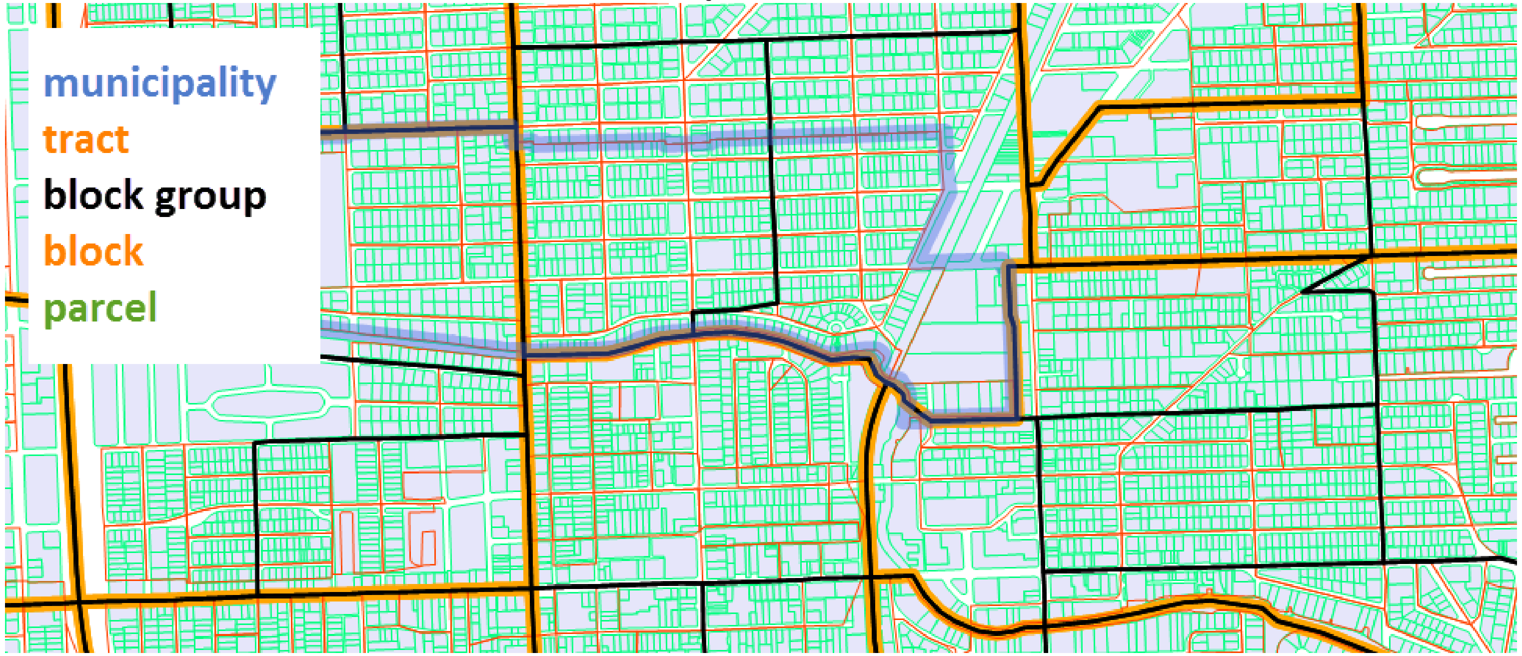
An earlier effort by our group was this poster at FCE LTER All Sci 2011 showing side by side maps of elevation, population spread, socio-economic and ethnic spatial variation for eyeball comparison.

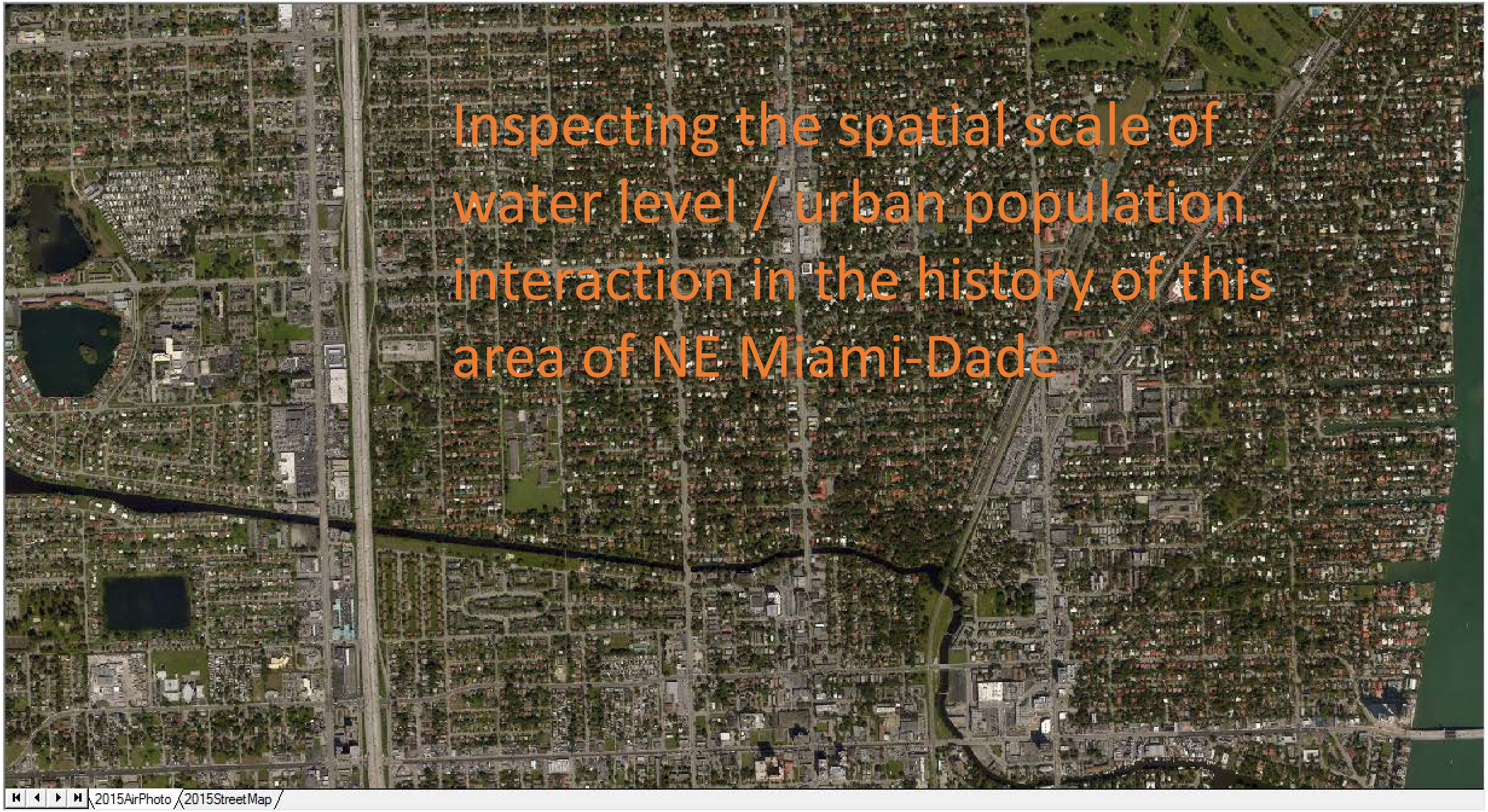
Since then we have been working to better measure these variables in GIS to better model their interactions.

Today we start with the most crucial data question: **what scale?**

Most GIS modeling of urban process has been done at scale of **political jurisdictions**, **zip codes**, or **census block group**.

However what if climate change disturbance affects the urban system in small areas (patches)? If this is the case, how small do we have to go? Down to **blocks**, or further to **parcels**? Problem is the smaller the area (block, parcel) the fewer variables we have data for (otherwise would not maintain confidentiality of data).




Inspecting the spatial scale of water level / urban population interaction in the history of this area of NE Miami-Dade
2015AirPhoto
2015StreetMap

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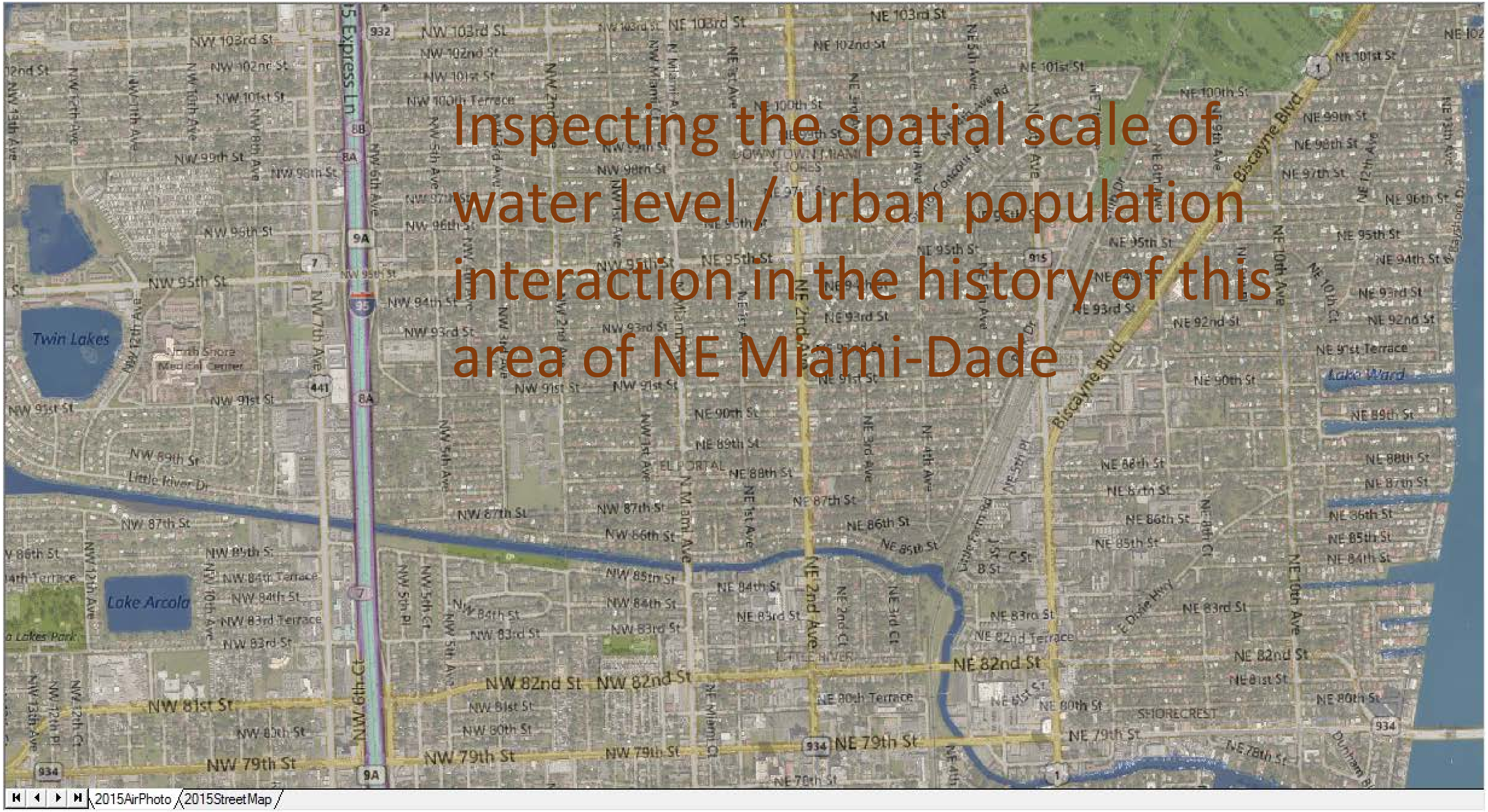
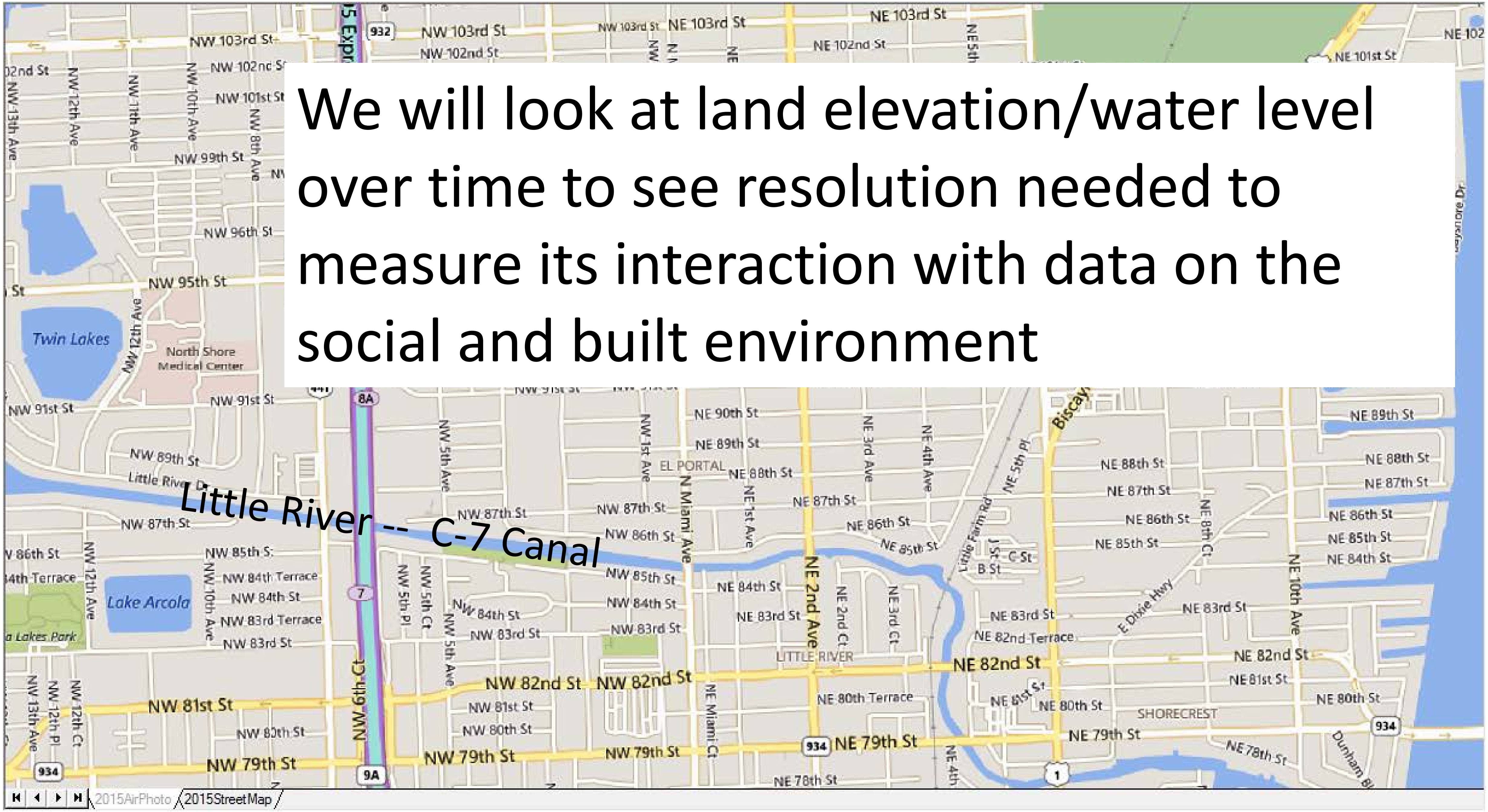


We will look at land elevation/water level over time to see resolution needed to measure its interaction with data on the social and built environment



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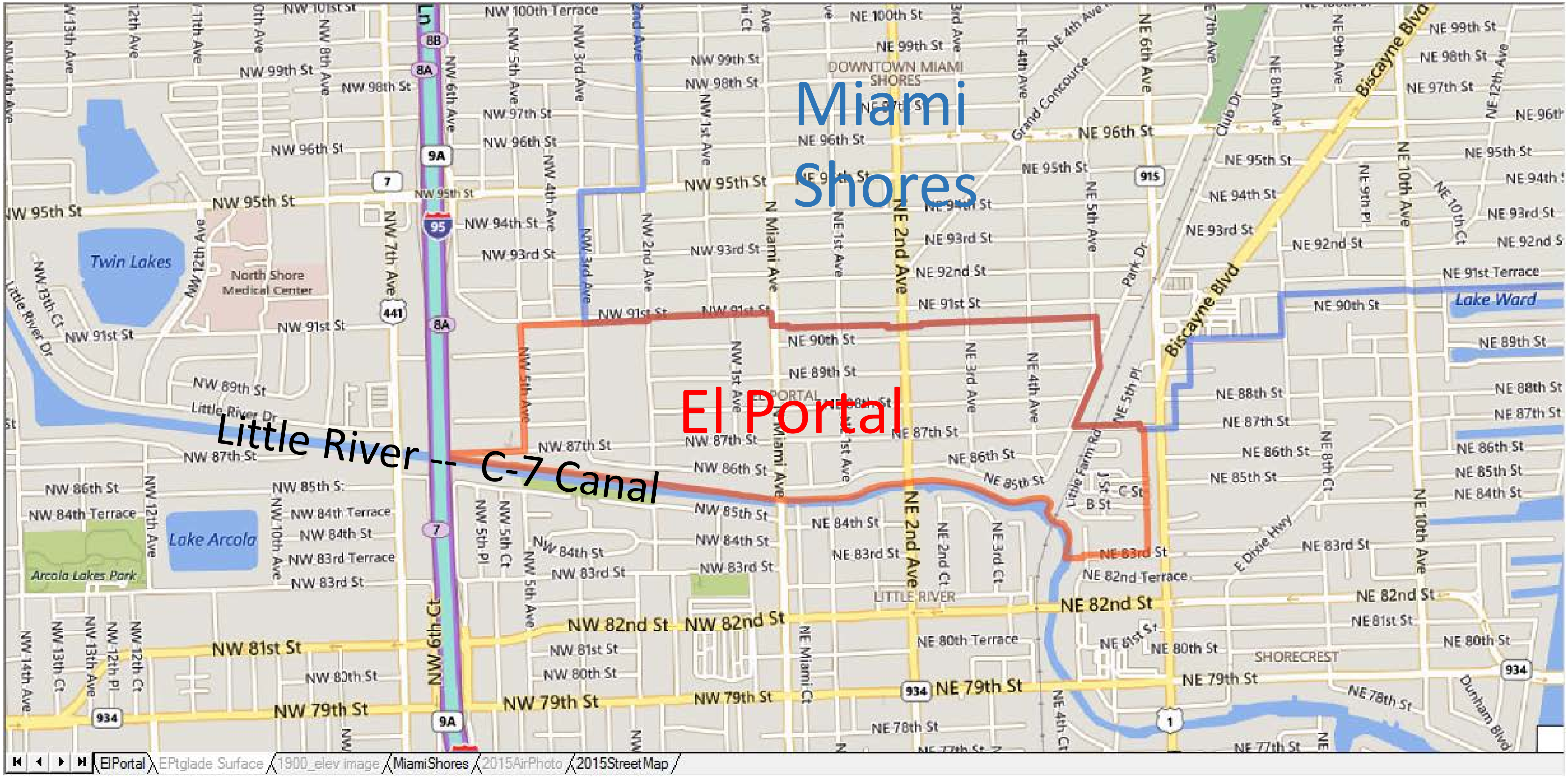
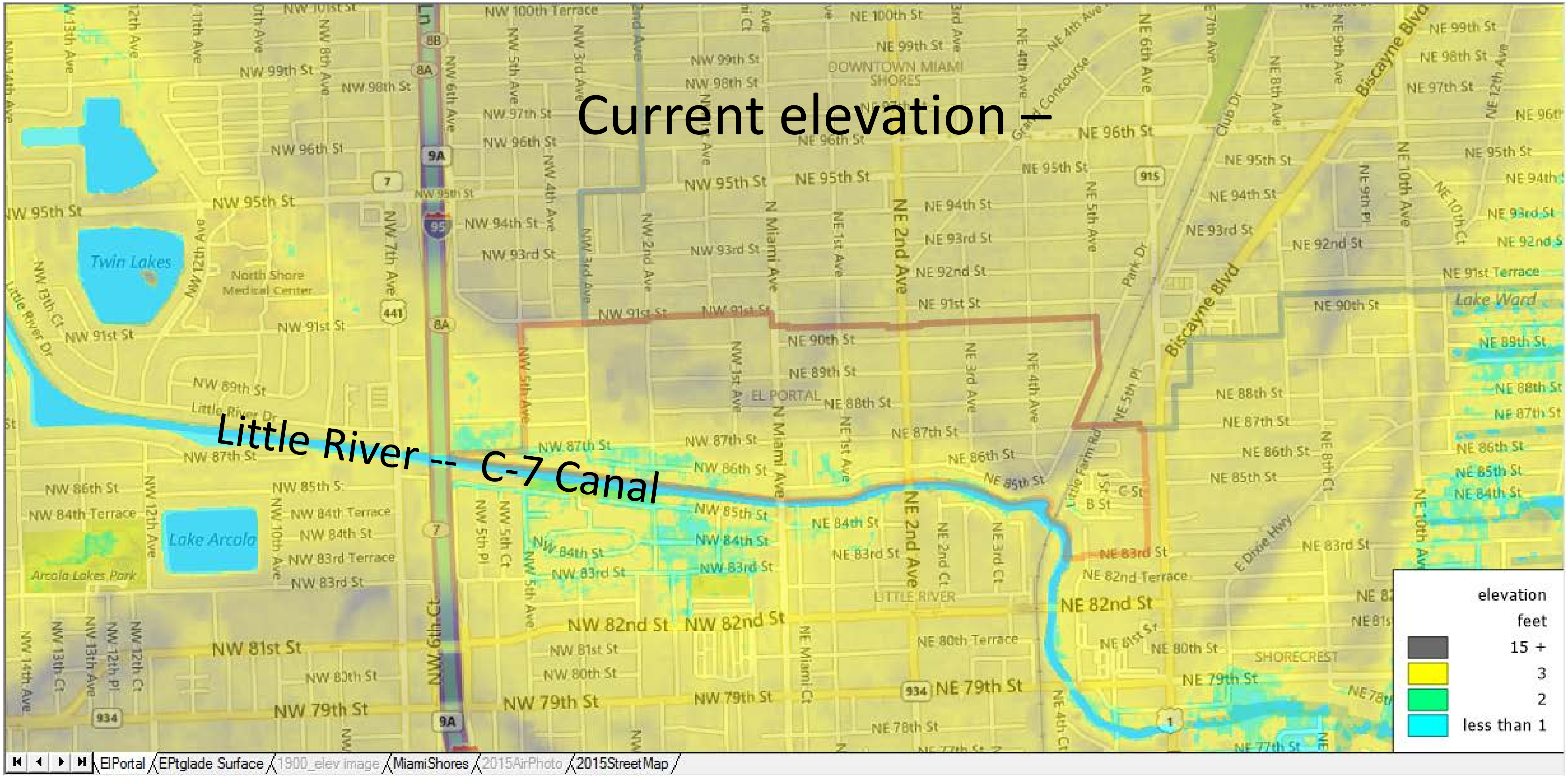
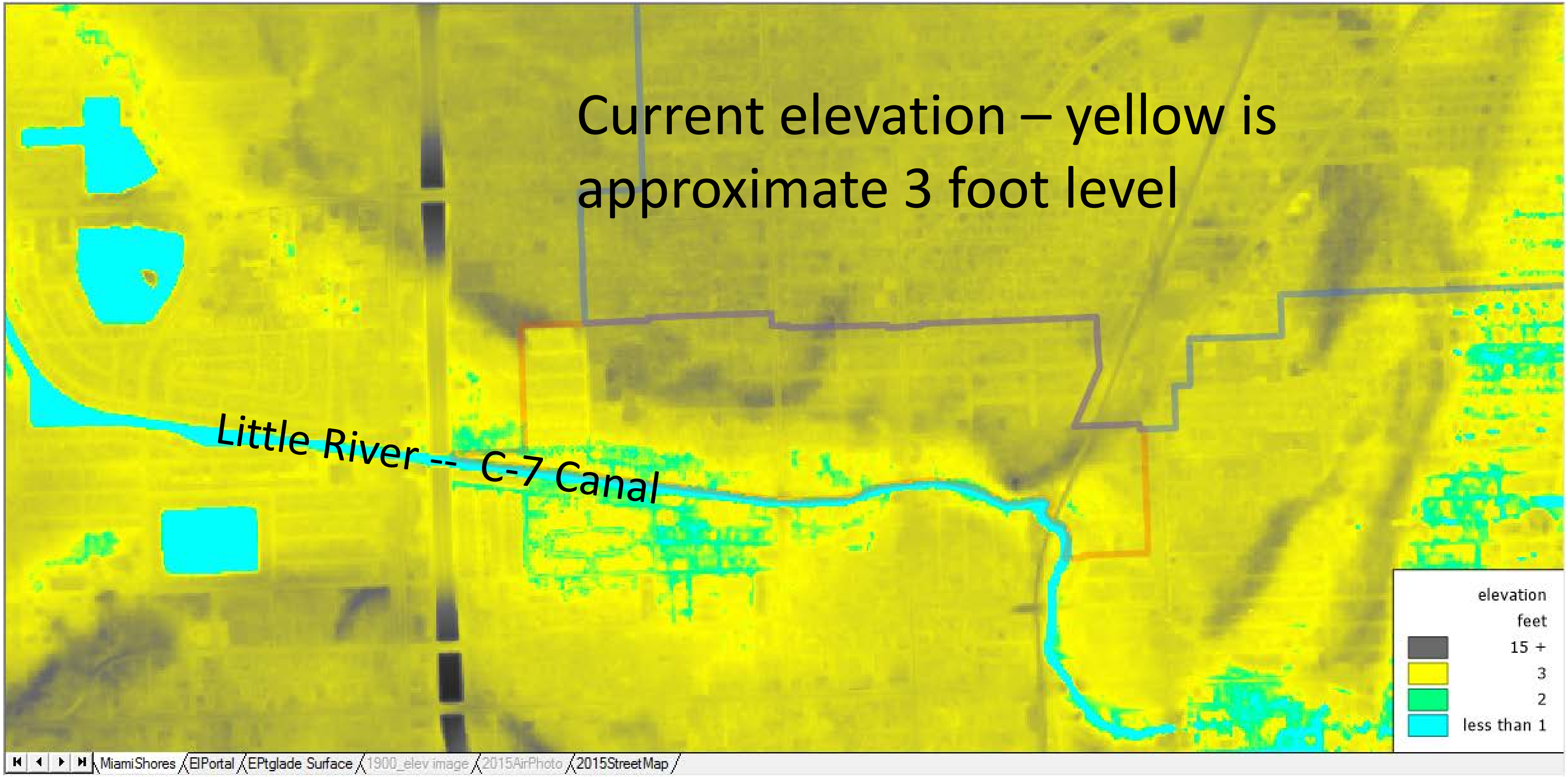
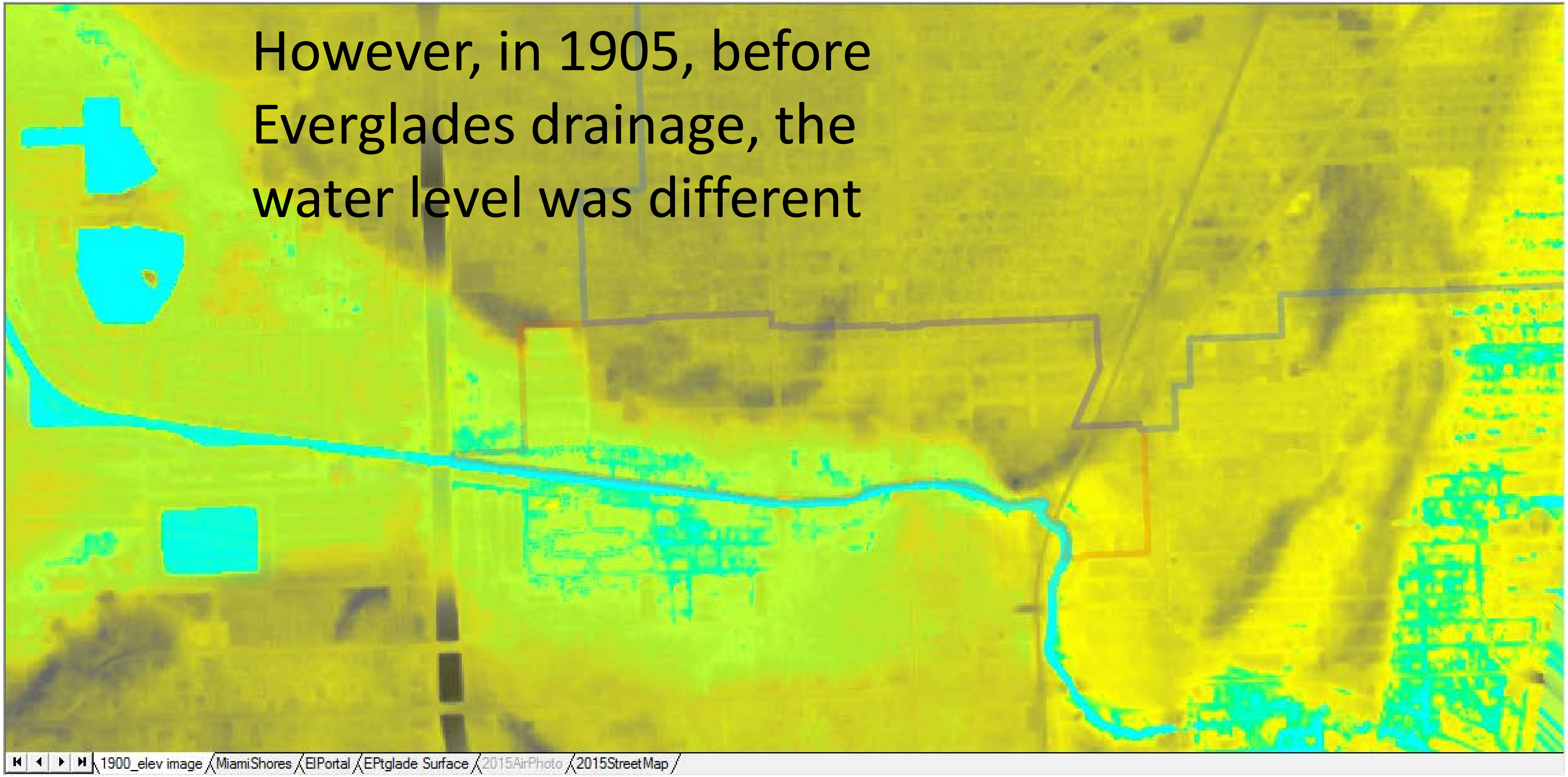

Miami Shores
El Portal
Little River -- C-7 Canal
Twin Lakes
North Shore Medical Center
Lake Arcola
Arcola Lakes Park
Lake Ward
DOWNTOWN MIAMI SHORES
LITTLE RIVER
SHORECREST
Biscayne Blvd
NW 95th St
NE 96th St
NW 82nd St
NE 82nd St
NW 81st St
NW 79th St
NE 79th St
N Miami Ave
NE 2nd Ave
NW 7th Ave
ElPortal
EPtglade Surface
1900_elev image
MiamiShores
2015AirPhoto
2015StreetMap

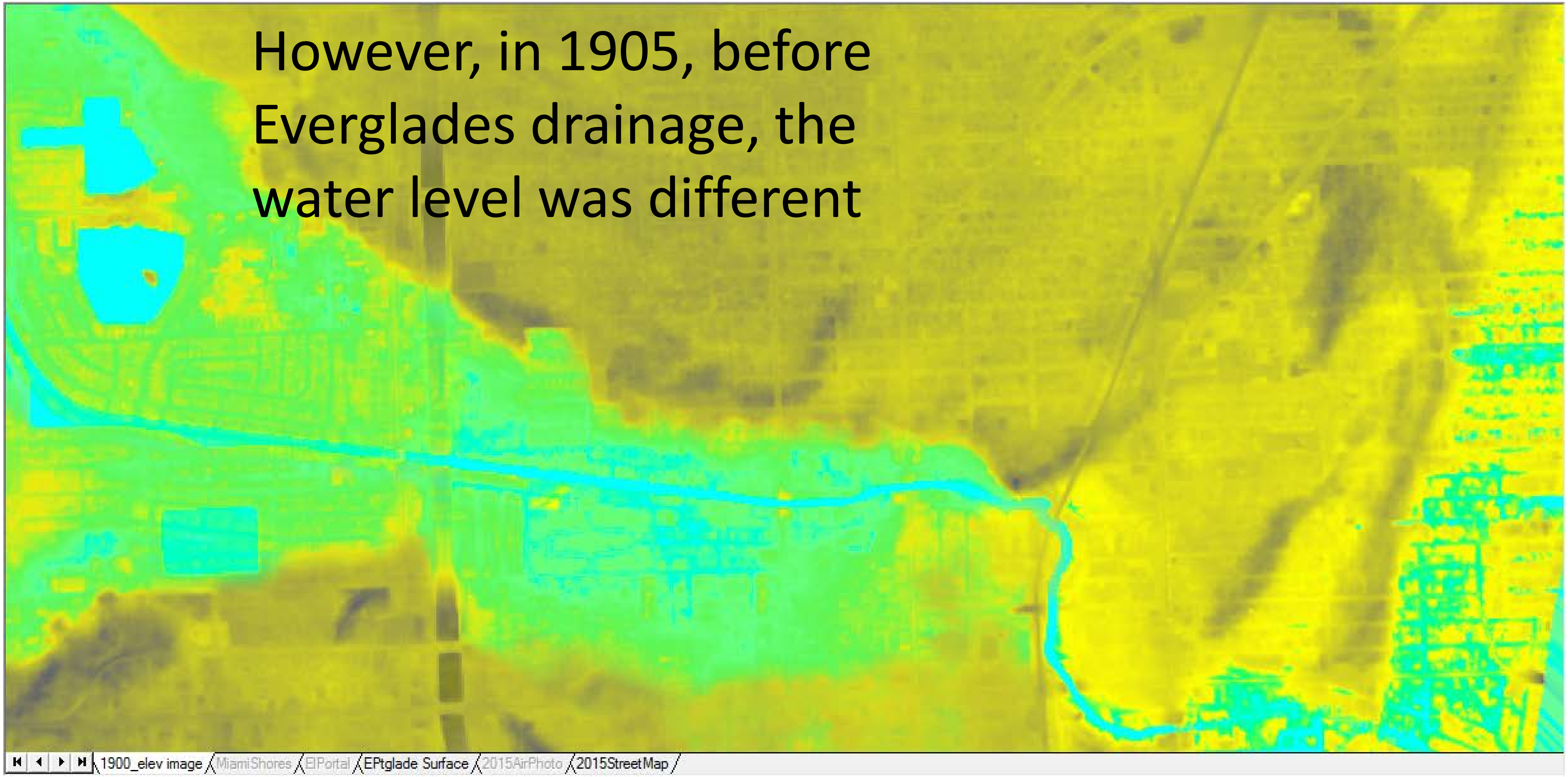
Current elevation –




Current elevation – yellow is approximate 3 foot level
Little River -- C-7 Canal
elevation
feet
15 +
3
2
less than 1
MiamiShores
ElPortal
EPtglade Surface
1900_elev image
2015AirPhoto
2015StreetMap

However, in 1905, before Everglades drainage, the water level was different

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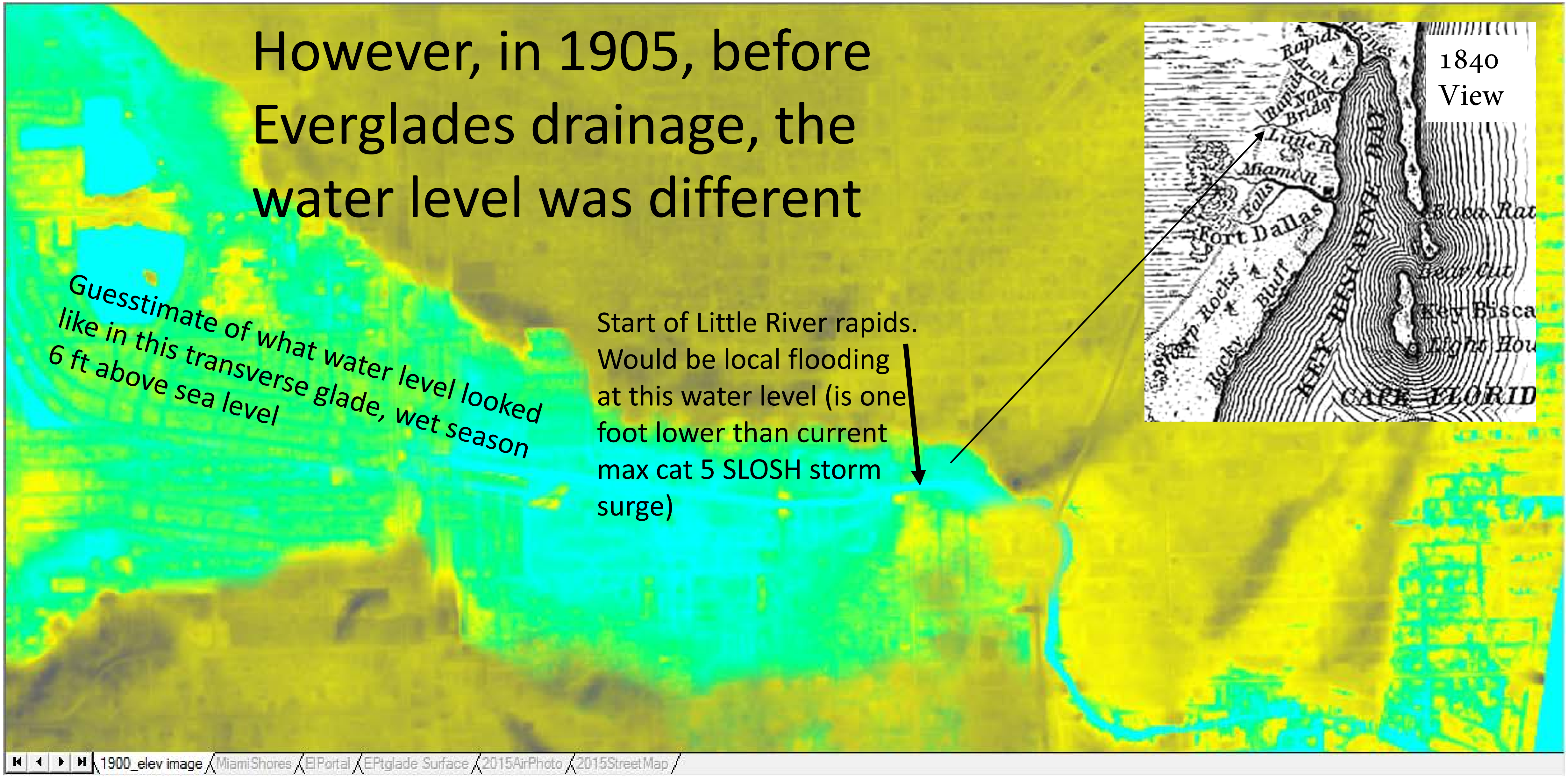
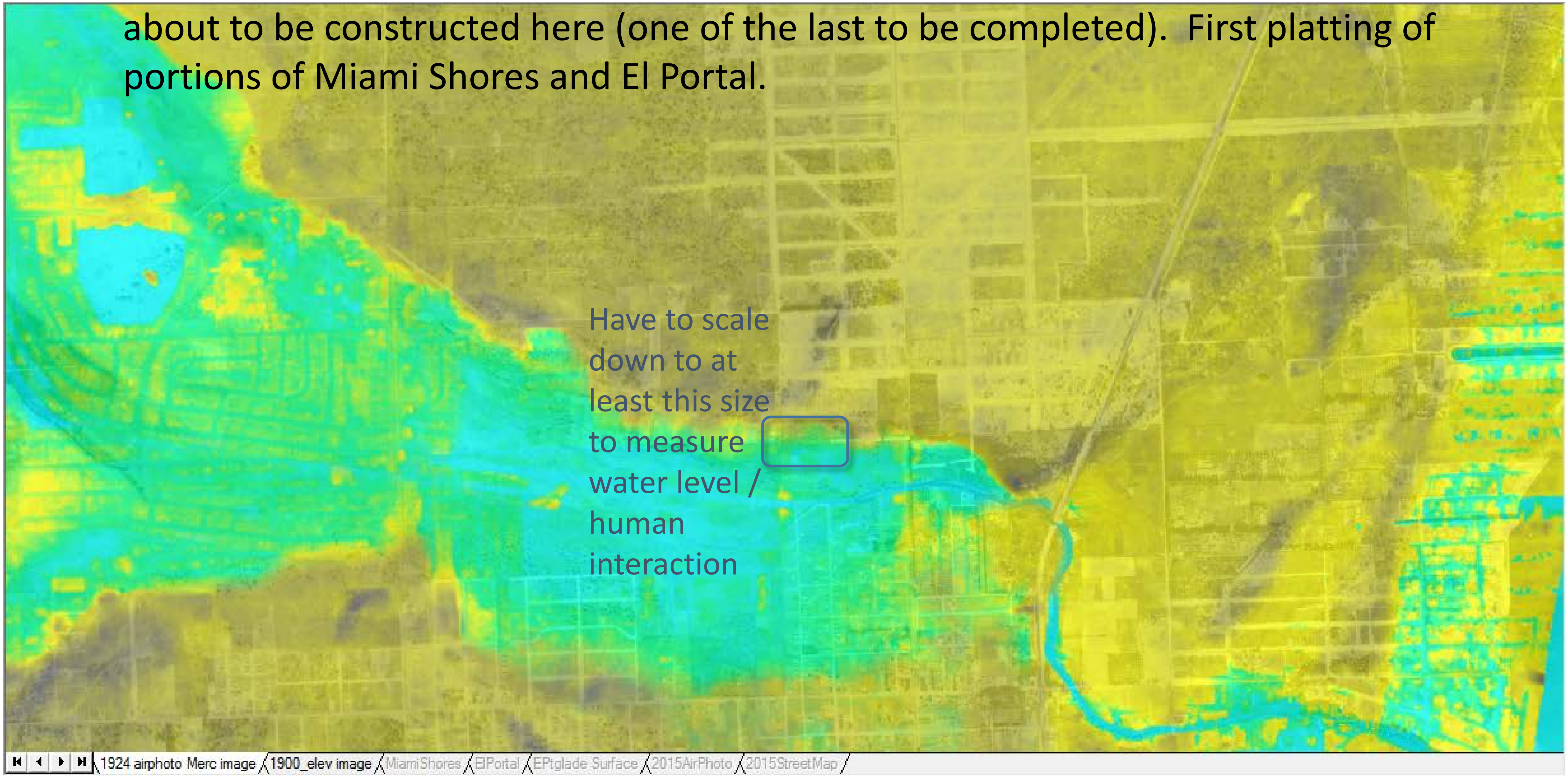


Move forward to 1924. Everglades drainage lowering water levels, C-7 canal about to be constructed here (one of the last to be completed). First platting of portions of Miami Shores and El Portal.



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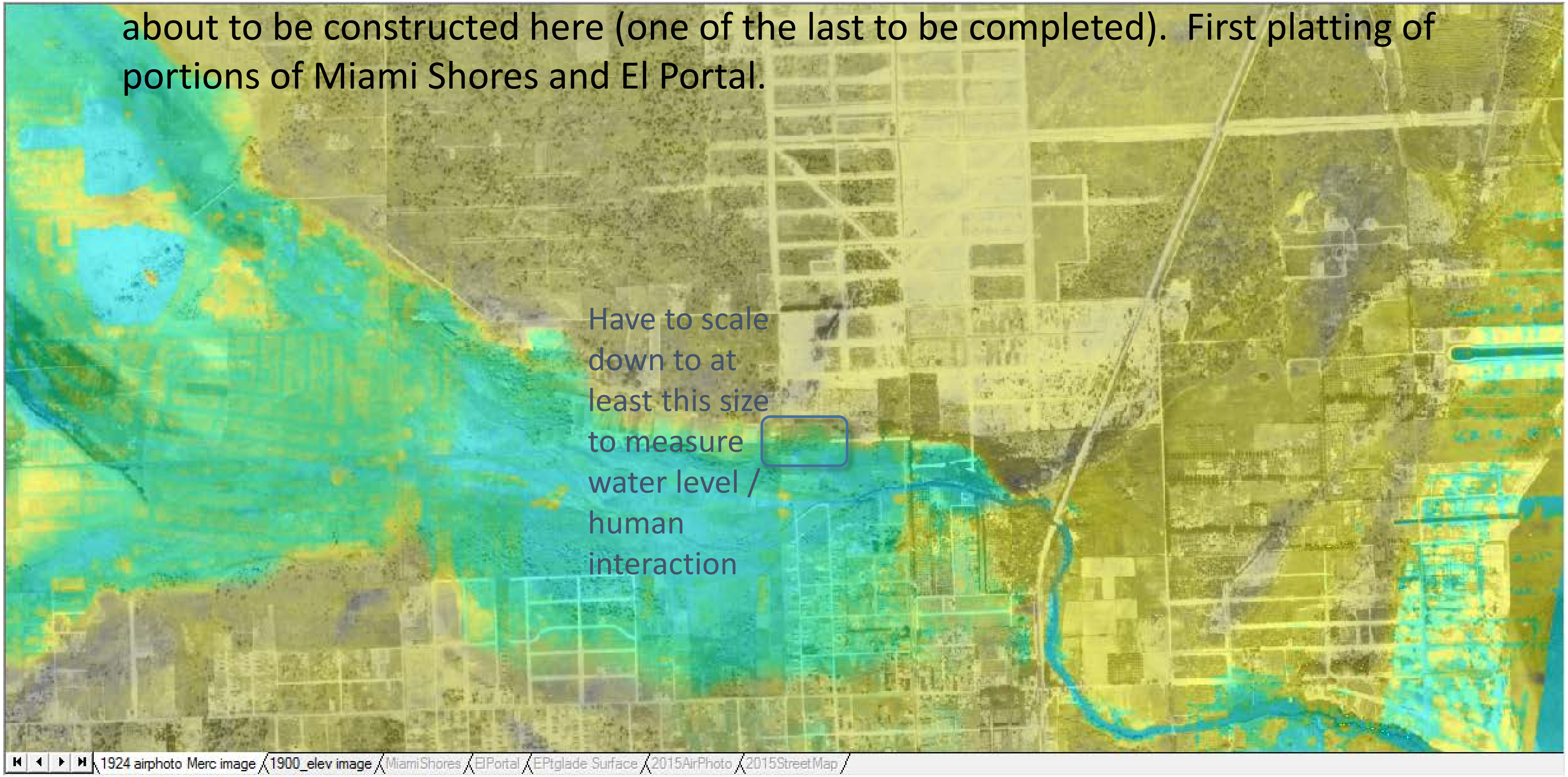

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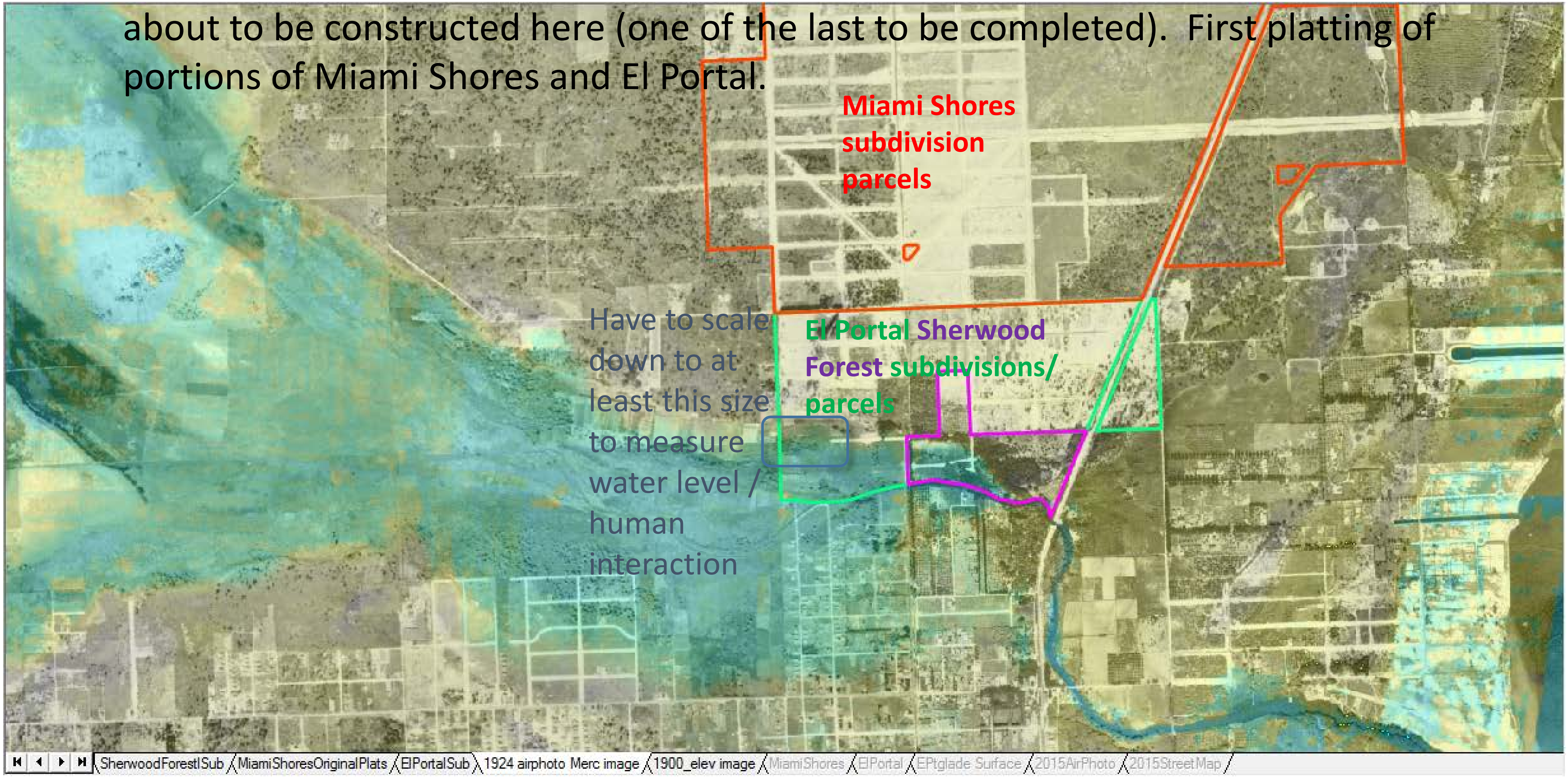

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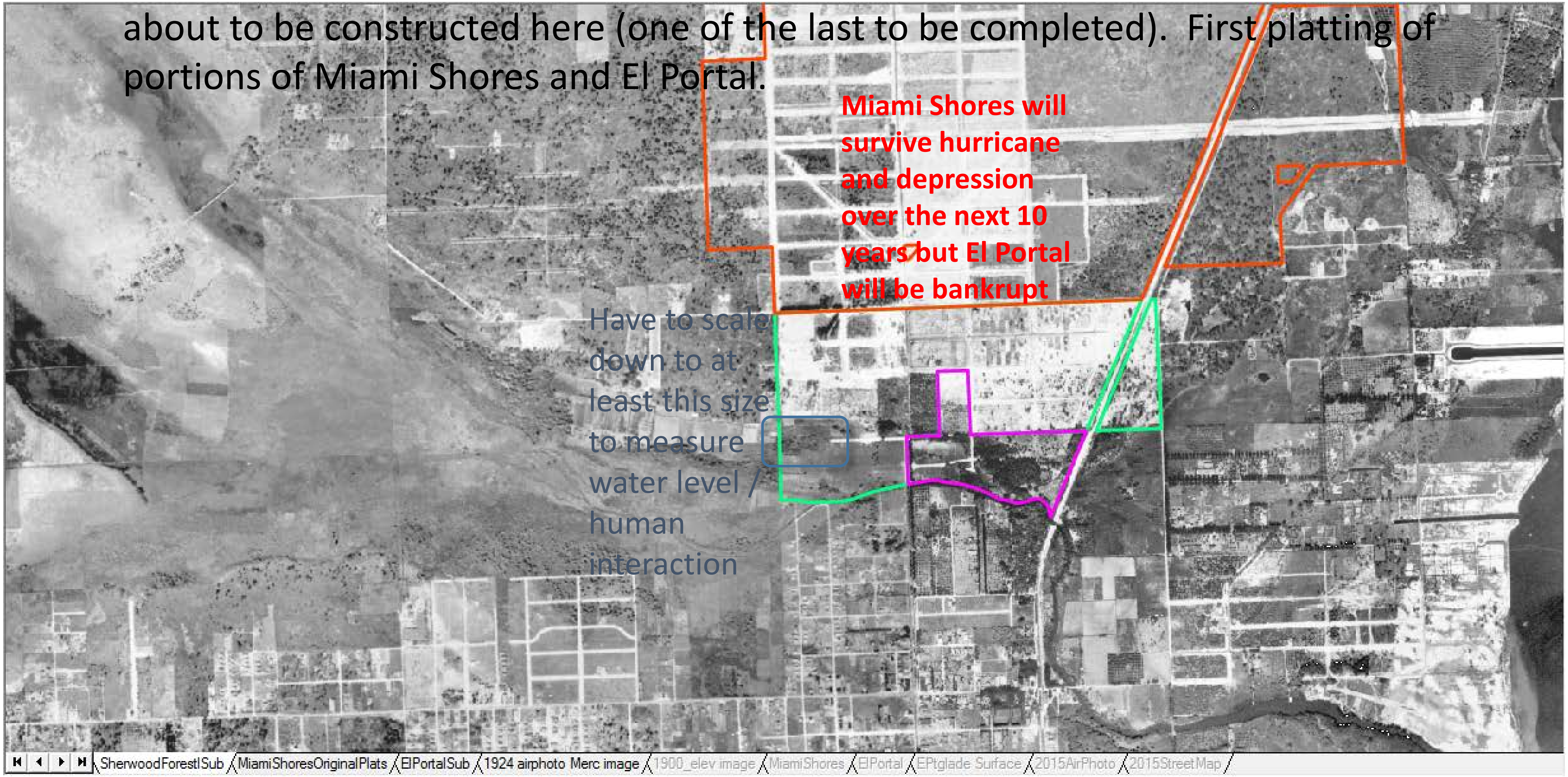
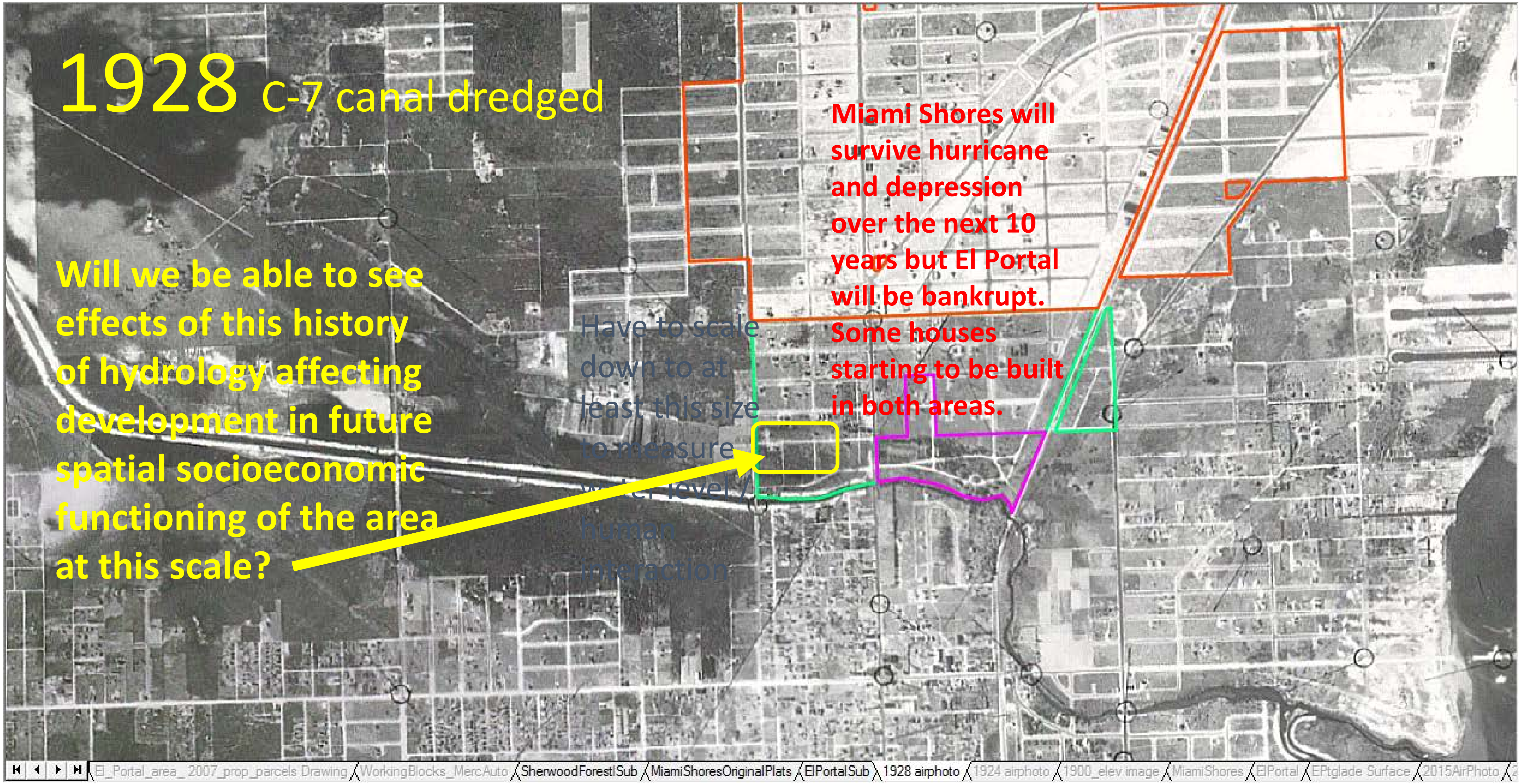
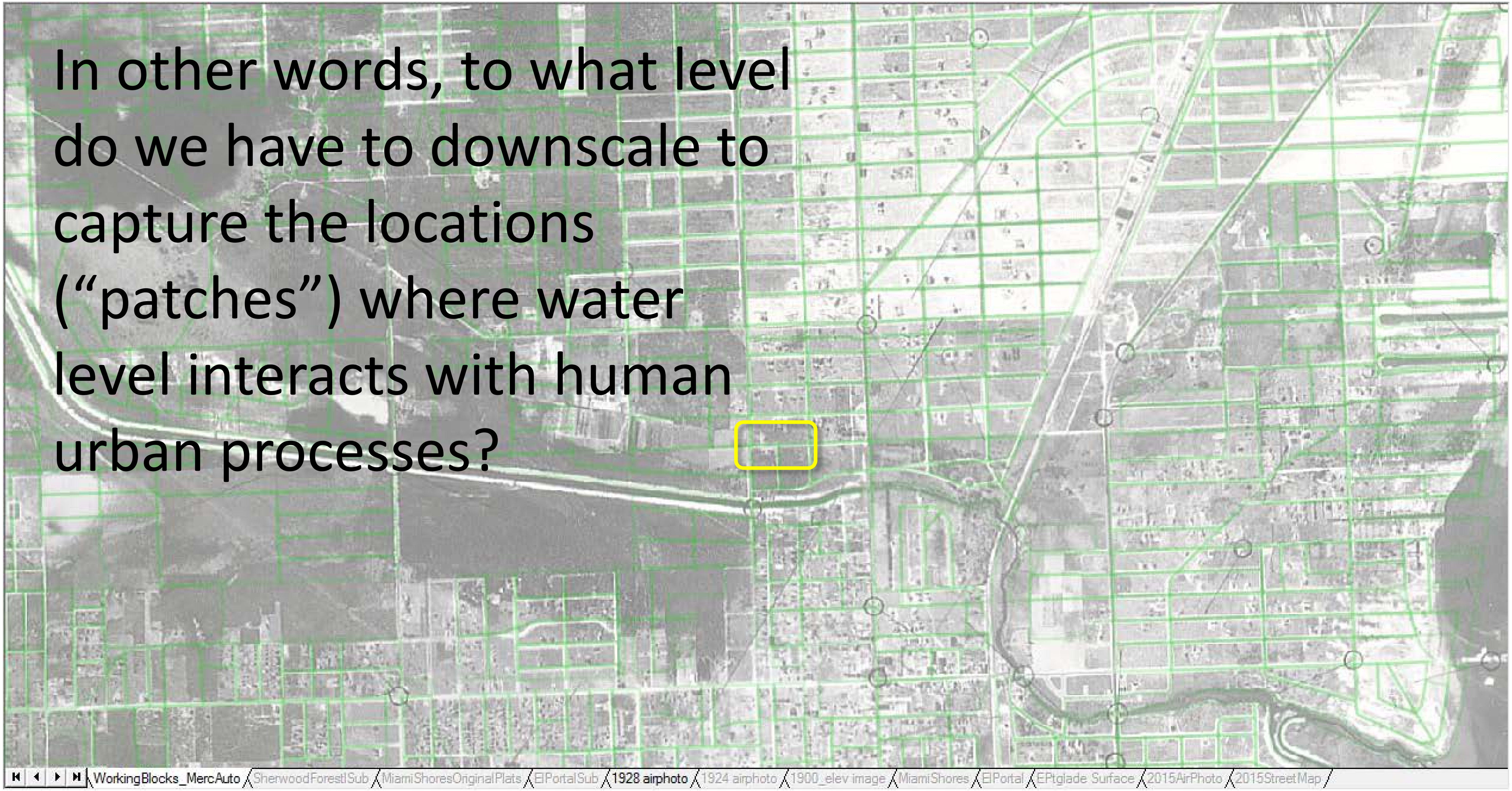




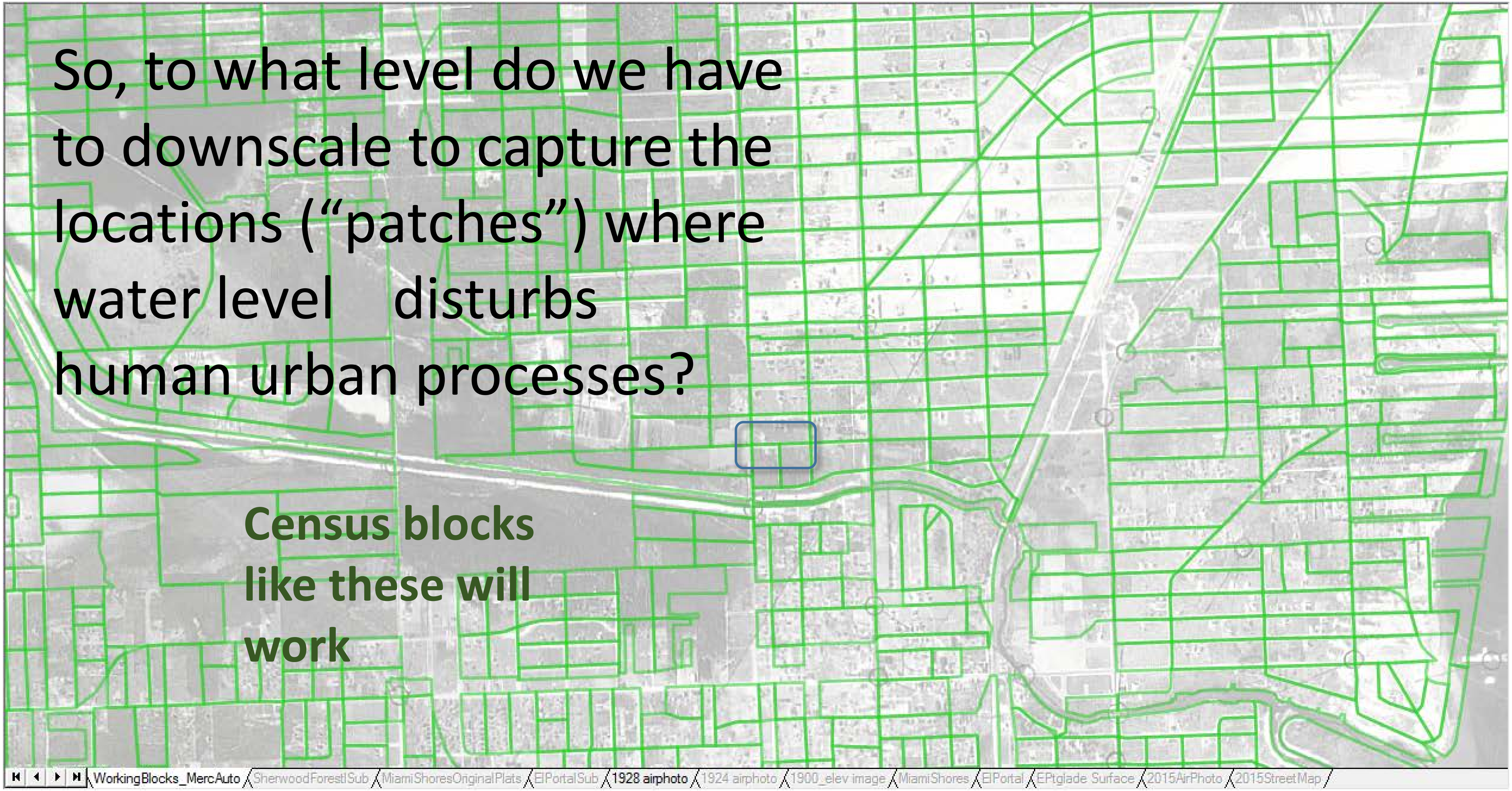
1928 C-7 canal dredged
Will we be able to see effects of this history of hydrology affecting development in future spatial socioeconomic functioning of the area at this scale?
Have to scale down to at least this size to measure water level / human interaction
Miami Shores will survive hurricane and depression over the next 10 years but El Portal will be bankrupt. Some houses starting to be built in both areas.
El_Portal_area_2007_prop_parcels Drawing
WorkingBlocks_MercAuto
SherwoodForestISub
MiamiShoresOriginalPlats
ElPortalSub
1928 airphoto
1924 airphoto
1900_elev image
MiamiShores
ElPortal
EPtglade Surface
2015AirPhoto

In other words, to what level do we have to downscale to capture the locations (“patches”) where water level interacts with human urban processes?

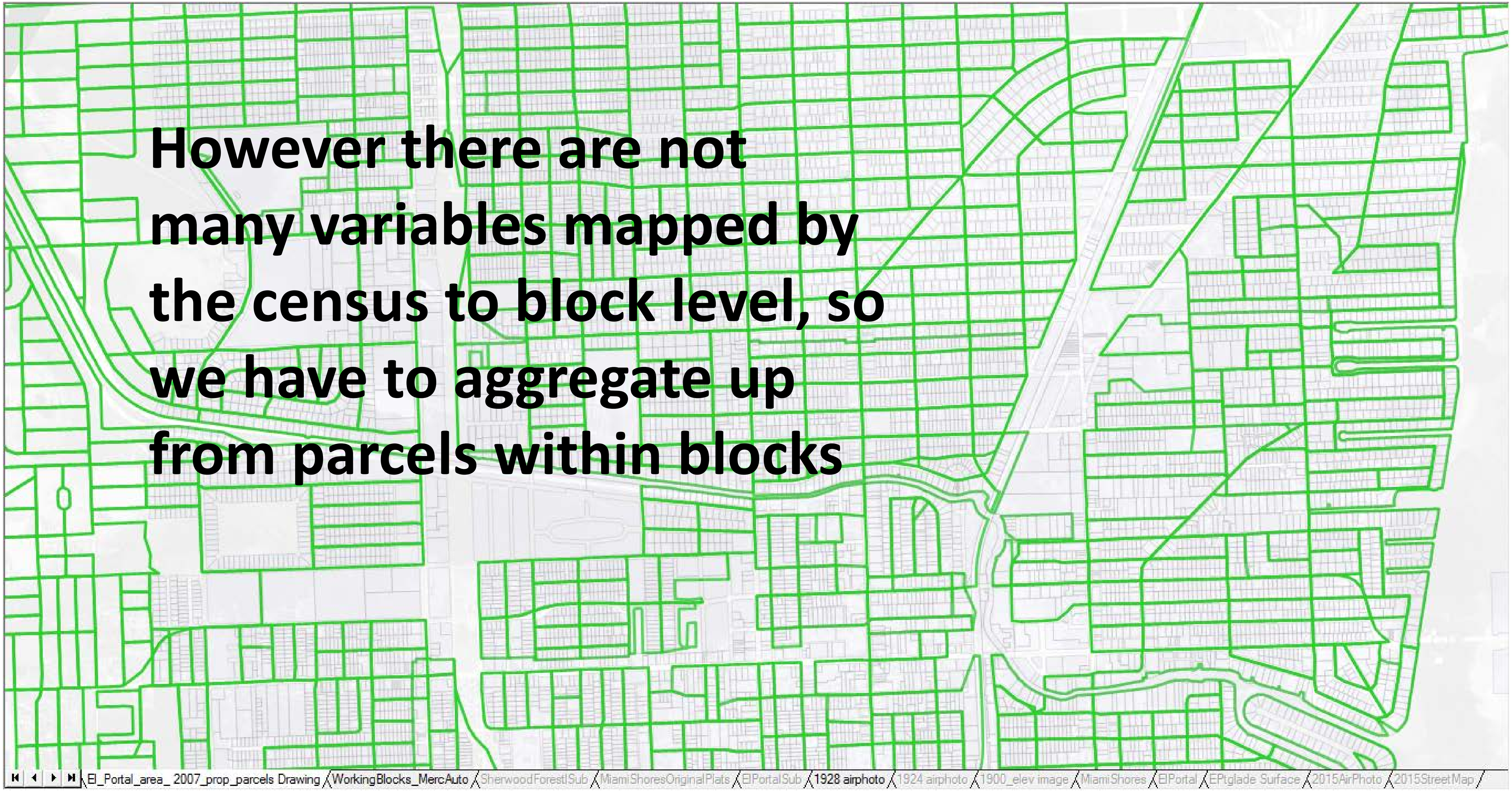


So, to what level do we have to downscale to capture the locations (“patches”) where water level disturbs human urban processes?

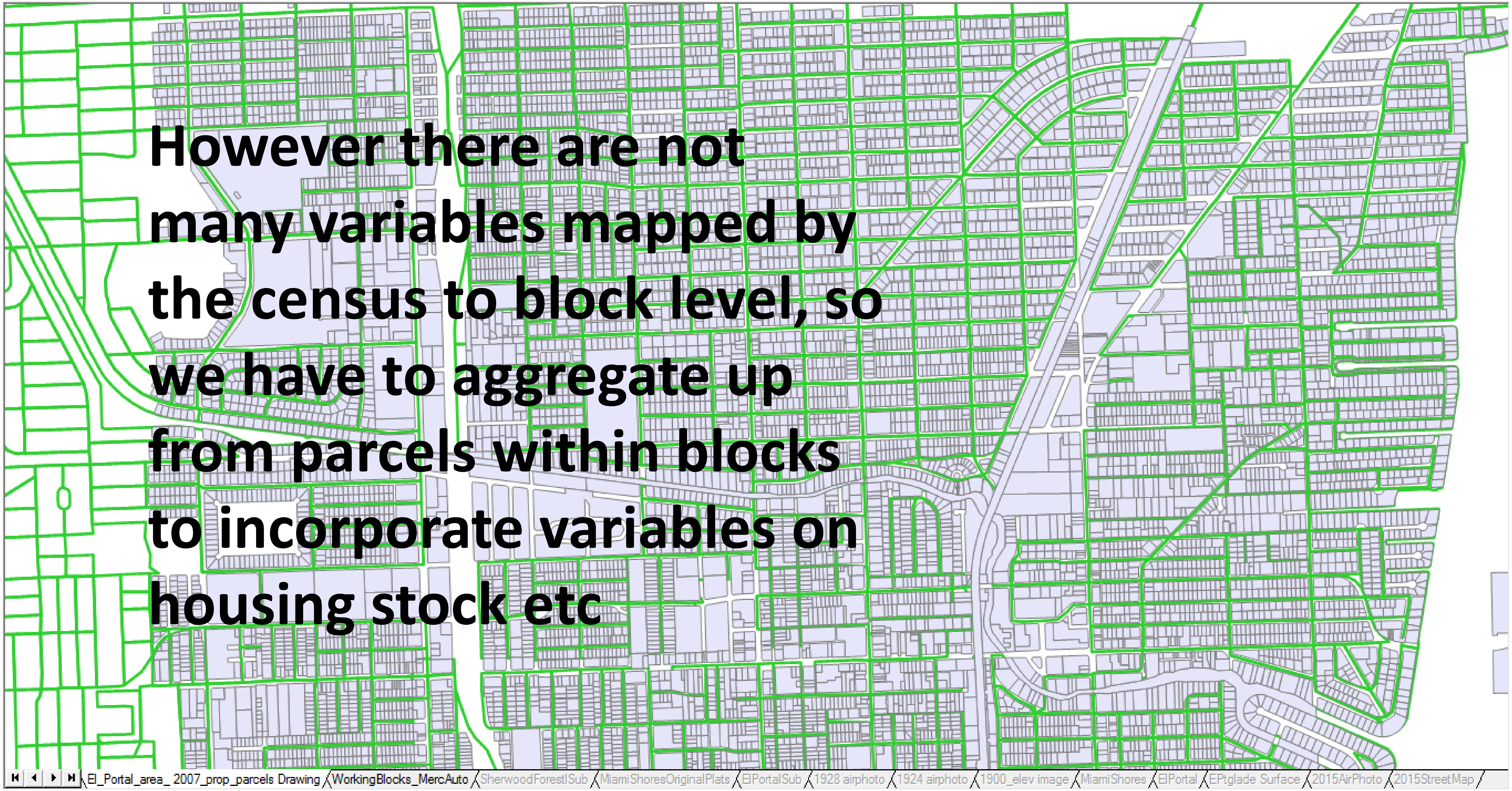
Census blocks like these will work



However there are not many variables mapped by the census to block level, so we have to aggregate up from parcels within blocks



However there are not many variables mapped by the census to block level, so we have to aggregate up from parcels within blocks to incorporate variables on housing stock etc



BLOCKS

Tables (1)
- workingblocks-LL_11-5-2015
  - Columns (46)
    - OID
    - GEOID10
    - GISJOIN
    - blockseq
    - tot_pop
    - tot_hhs
    - avgjv
    - avgresu
    - avglivarea
    - avglvsq
    - avgnbldg
    - avgyear
    - oldestyr
    - newestyr
    - avghgt
    - highest
    - lowest
    - tot_pop_bvc
    - white_alone
    - black_afam_alone
    - tot_pop3
    - not_hispanic
    - hispanic
    - median_age_both_sexes
    - tot_hhs2
    - family_hhs
    - husbandwife_family
    - other_family
    - male_hher_no_wife_prsnt
    - female_hher_no_husband_prsnt
    - nonfamily_hhs
    - hher_living_alone
    - hher_not_living_alone
    - tot_housing_units
    - tot_housing_units2
    - occupied
    - vacant
    - tot_occupied_housing_units
    - owned_with_mortgage_or_loan
    - owned_free_and_clear
    - renter_occupied
    - tot_vacant_housing_units
    - JVperRes
    - zerohgt
    - version
    - geometry

Aggregated from parcels (avgjv – newestyr, JVperRes)

From parcel elevation (avghgt, highest, lowest)

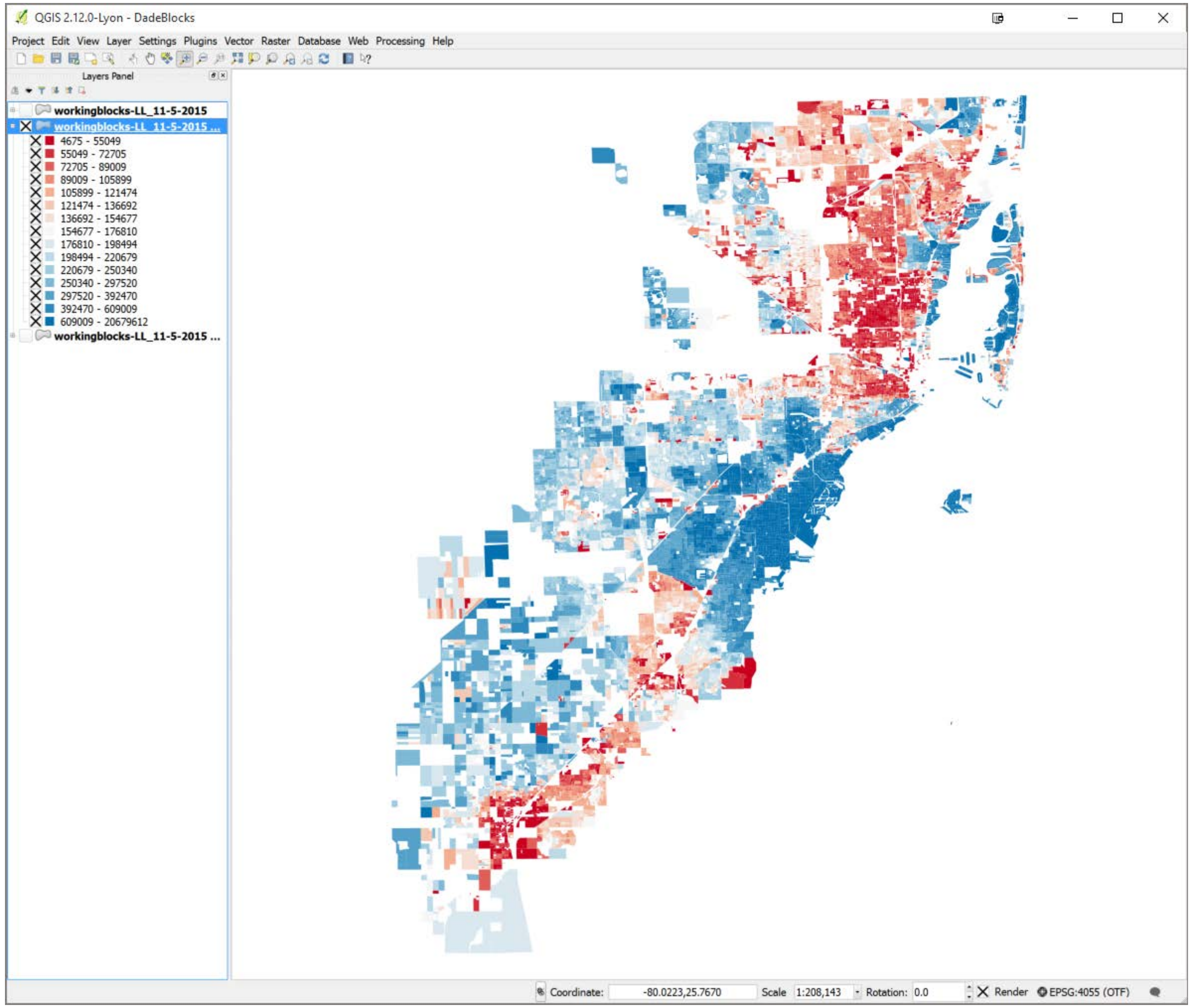
Block data

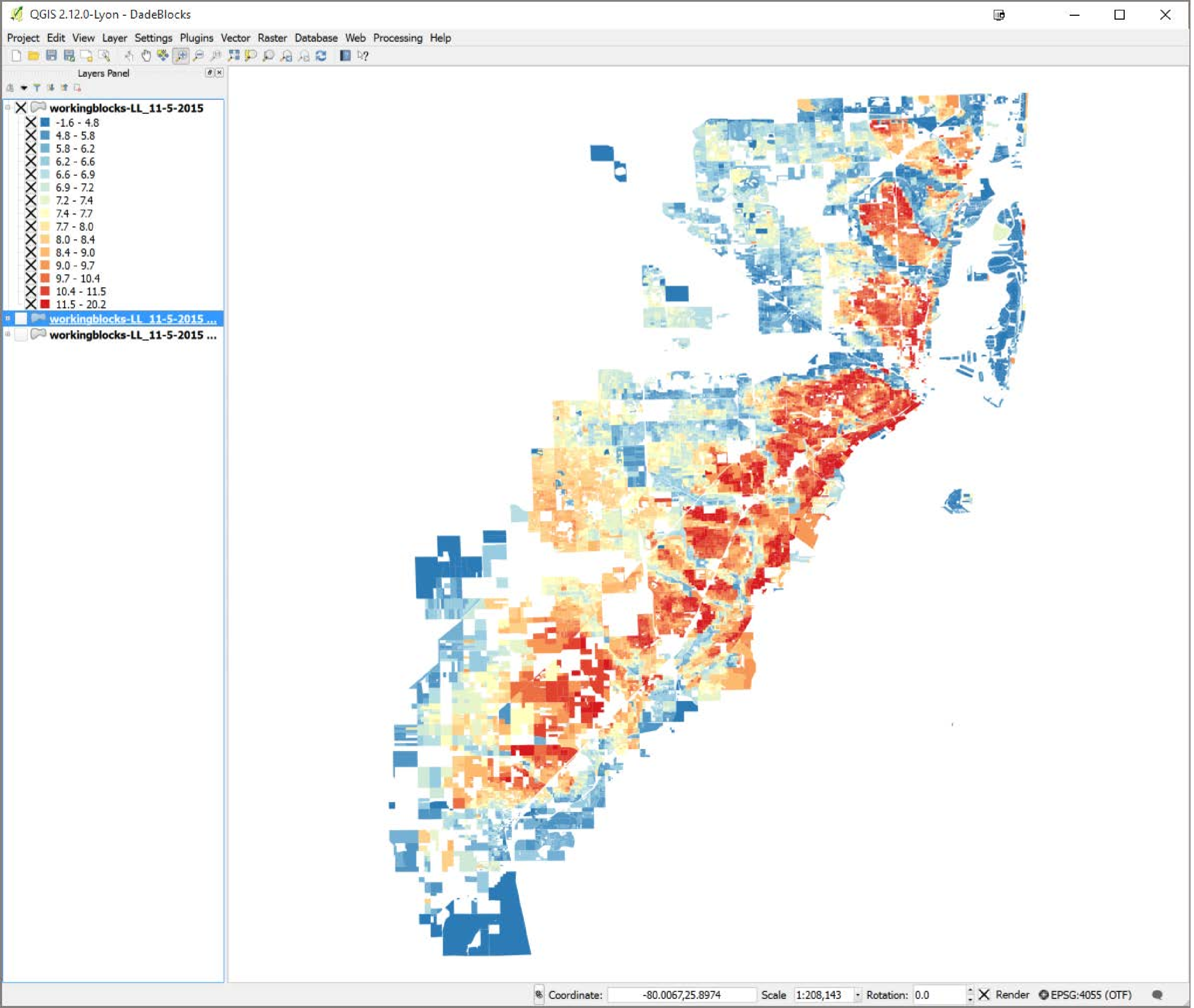
PARCELS

Aggregated from parcels ← PARCELS

Tables (2)
- Mdpropdat
  - Columns (25)
    - ogc_fid
    - co_no
    - asmnt_yr
    - jv
    - lnd_val
    - parcel_id
    - bas_strt
    - grp_no
    - dor_uc
    - jv_hmstd
    - lnd_sqfoot
    - eff_yr_blt
    - act_yr_blt
    - tot_lvg_area
    - no_buldng
    - no_res_unts
    - sale_prc1
    - sale_yr1
    - sale_prc2
    - sale_yr2
    - census_bk
    - phy_addr1
    - phy_addr2
    - phy_city
    - phy_zipcd

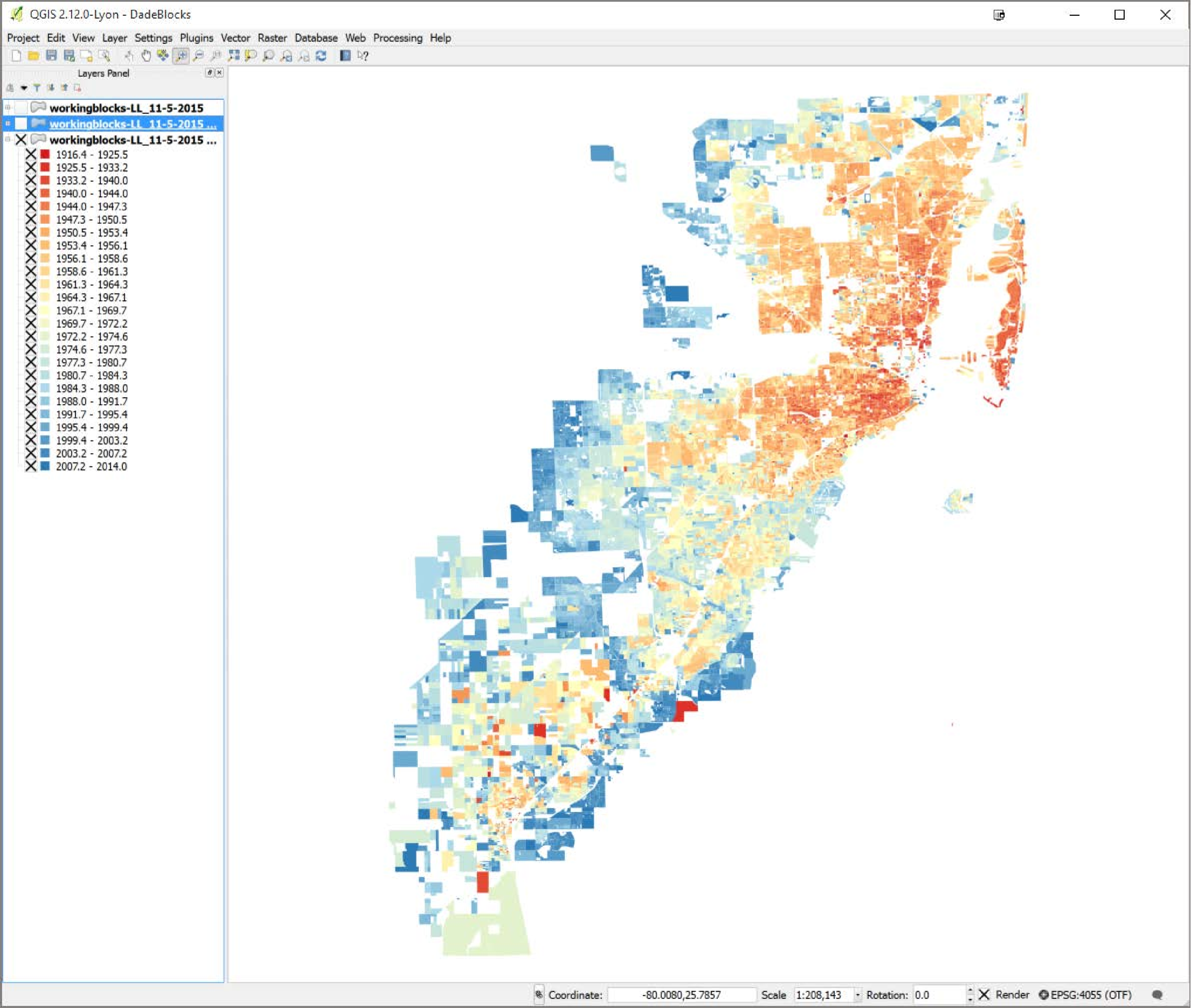
Map some of these variables





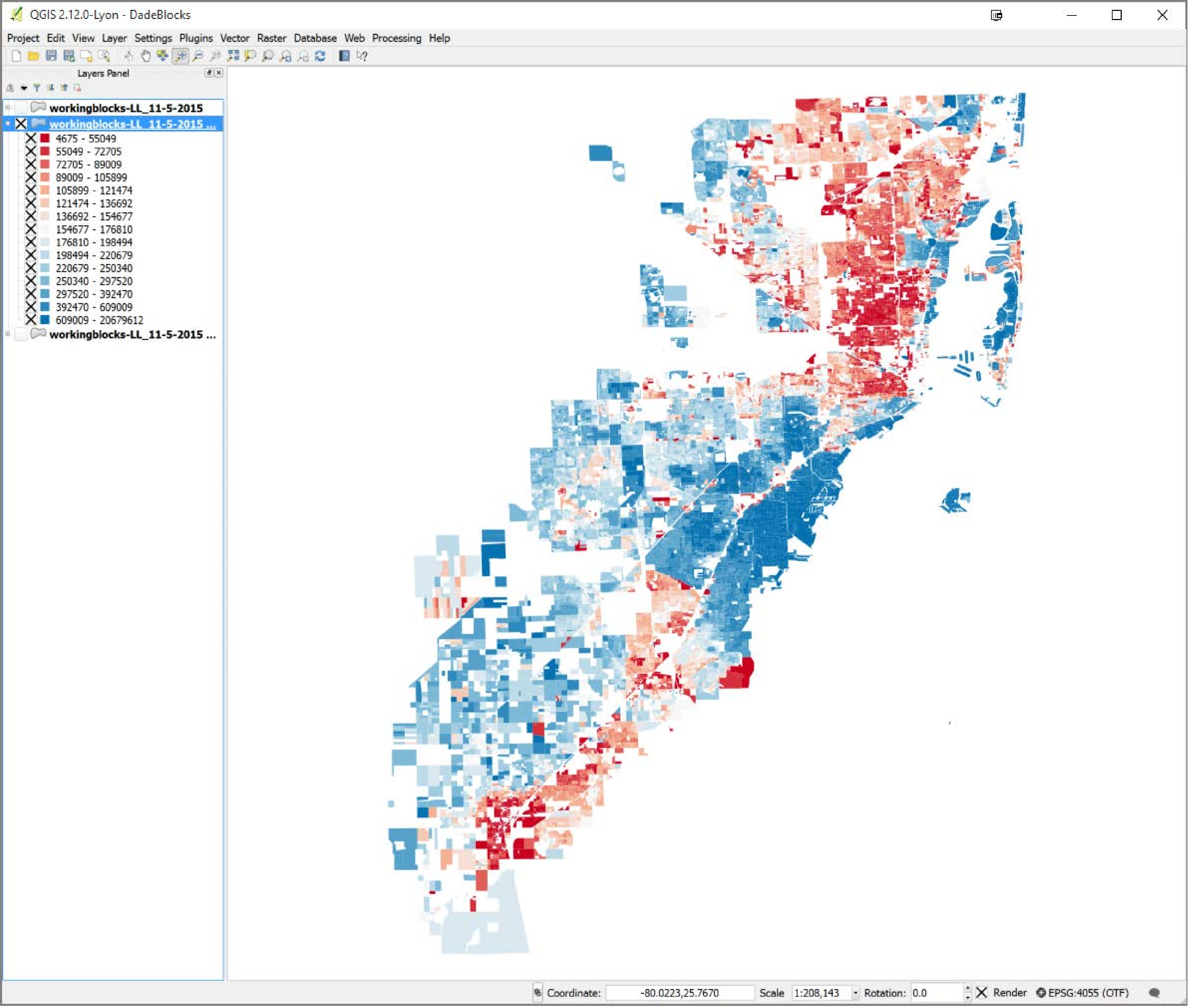
Mean of parcel elevations in block

NATURAL ENVIRONMENT



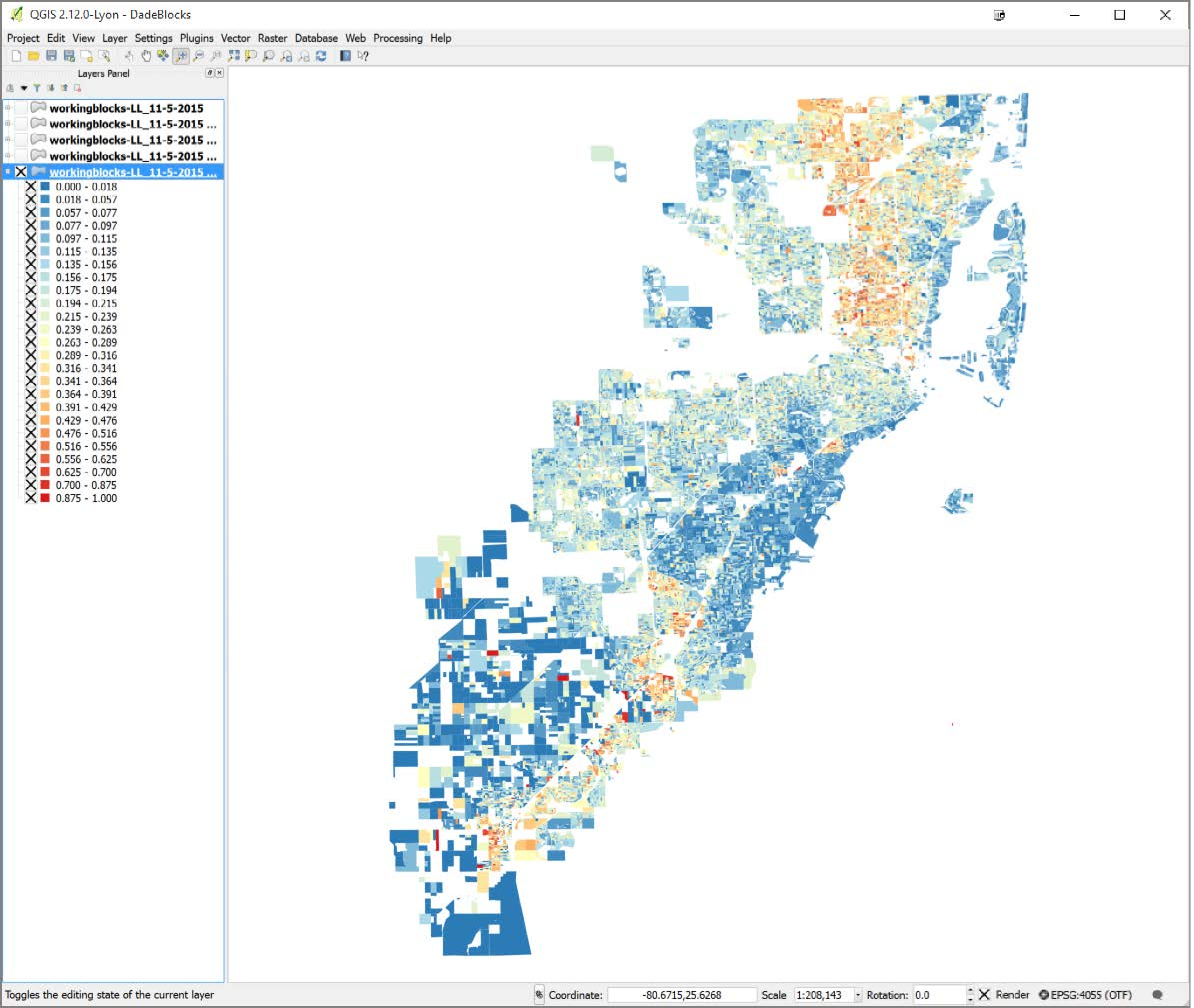
Mean year built of residences in block

BUILT ENVIRONMENT



Mean of market value of residential parcels in block (per living unit)

ECONOMIC ENVIRONMENT



Proportion of households in block with single female household head

SOCIAL ENVIRONMENT

The last variable, proportion of households in block with **single female household head**, is a potential indicator of the presence of factors underlying households having **high vulnerability to displacement**

```
gen fhh = female_hher_no_husband_prsnt/ tot_housing_units
gen vacrate = vacant/ tot_housing_units
gen rentrate = renter_occupied / tot_occupied_housing_units
gen pblack = black_afam_alone / tot_pop_bvc

regress fhh rentrate jvperres vacrate avgyear pblack
dependent variable = fhh female householder no husband prsnt/ tot_housing_units

      Source |       SS       df       MS              Number of obs =   23929
-------------+------------------------------           F(  5, 23923) = 1864.92
       Model |  111.125682     5  22.2251365           Prob > F      =  0.0000
    Residual |  285.101481 23923  .011917464           R-squared     =  0.2805
-------------+------------------------------           Adj R-squared =  0.2803
       Total |  396.227163 23928  .016559143           Root MSE      =  .10917

------------------------------------------------------------------------------
         fhh |      Coef.   Std. Err.      t    P>|t|
-------------+----------------------------------------------------------------
    rentrate |   .0683367   .0027373    24.96   0.000   proportion rentals / housing units
    jvperres |  -2.28e-08   1.53e-09   -14.90   0.000   avg parcel market value in block
     vacrate |  -.2565924   .0079804   -32.15   0.000   vacancy rate (low=high housing demand)
     avgyear |   .0003544   .0000396     8.94   0.000   age of housing stock
      pblack |   .1899812   .0023595    80.52   0.000   proportion African-American/Black
       _cons |  -.5561625    .078207    -7.11   0.000
------------------------------------------------------------------------------
```

Notice its relationship with other variables in our dataset

Yes we know about the ecological correlation issue so we are not bragging about this R^2

Next data & GIS tasks for modeling location of vulnerability to displacement:

- Develop decision tree models using these variables to map households to potential displacement locations and test with historical GIS data from post-Hurricane Andrew (1990 census, 1991 & 1995 parcel data).
- We still could use a lot more variables if we can downsample them from larger spatial units (zips, tracts, pumas, etc). Our current focus is on census block group variables. We are working with a large table of raw counts (~1600 fields) from https://www.census.gov/geo/maps-data/data/tiger-data.html and a procedure to code summary variables as needed (see example next slide).
- Since our current set of block level variables correlate with many of these higher level ones, we can use them as a decision training set to extend dasymmetric mapping methods via decision trees + data mining using random forest.

Example of summary block group variables used in recent study of hurricane socioeconomic vulnerability in another state coded from large table of counts.

median gross rent as a percentage of household income	**proportion female householder no husband present households**
median home value	**proportion household received food stamps-snap in the past 12 months**
median household income	**proportion household with one or more disabled person**
median household income Black or African American	**proportion households with no or only one vehicle available**
median household income White	**proportion households with no vehicle available**
median number of rooms in home	**proportion housing units owner occupied**
median year householder moved into unit	**proportion with disability female 16-64**
per capita income	**proportion with disability male 16-64**
proportion of children under 10 years old	**proportion with no health insurance coverage 18 to 34 years**
proportion of elders 75 and older	**proportion with no health insurance coverage 35 to 64 years**
proportion married-couple family households	**proportion with no health insurance coverage children under 18**
proportion African American Black	**proportion with no health insurance coverage over 64 years**
proportion Hispanic	**total population of block group**
proportion college or equiv or more education	
proportion highest education 8th grade or less	

With this approach we can continue with our main work of understanding current and potential climate change effects on urban processes of displacement and gentrification

Example Potential Indicators for Analyzing Gentrification and Displacement (Zuk et al 2015)

- Change in property values and rents
- Investment in the neighborhood
- Disinvestment
- Change in tenure and demography
- Investment potential
- Reasons for moving in or out of neighborhood

References

Suzana Mic, Jennifer Wolfe, Hugh Gladwin. 2011. "Legacies of 20th century urban growth patterns in South Florida and resultant environmental/social justice implications given SLR". Poster for 2011 FCE LTER All Scientists Meeting, Florida Coastal Everglades Long-term Ecological Research (FCE-LTER).

Zuk, M, A Bierbaum, K Chapple, K Gorska, A Loukaitou-Sideris, P Ong, and T Thomas. 2015. “Gentrification, Displacement and the Role of Public Investment: A Literature Review.” Federal Reserve Bank of San Francisco, Community Development Working Paper, p. 36. http://www.frbsf.org/community-development/publications/working-papers/2015/august/gentrification-displacement-role-of-public-investment/.