

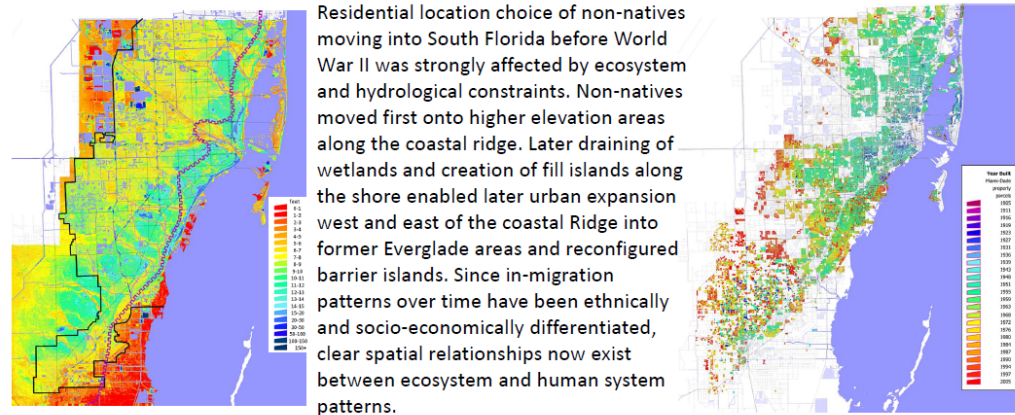
GIS-based modeling of Miami area residential land use as affected by water level 1900-2050

Hugh Gladwin, Peter Craumer, Suzana D Mic

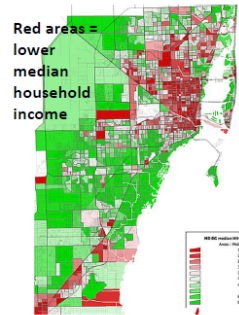
FIU GIS Center GIS Day, Climate Change, November 6, 2015

1. Gladwin and Craumer: Department of Global and Sociocultural Studies, Florida International University
2. Mic: NOAA Southeast Fisheries Science Center, University of Miami

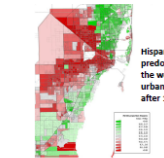
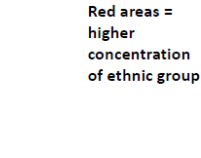
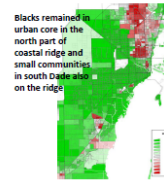
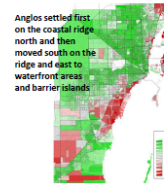
Legacies of 20th century urban growth patterns in South Florida and resultant environmental/social justice implications given SLR *Suzana Mic, Jennifer Wolfe, Hugh Gladwin*



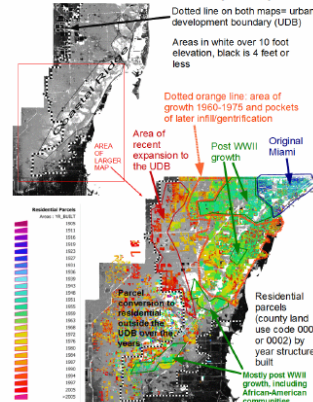
Maps from 2000 US Census block group data



Low income areas persist in many parts of the old urban core on the coastal ridge. In the near future, climate change-induced sea level rise will require difficult choices about what to do to enable lower elevation areas to adapt. Given human system socio-cultural patterning in relation to elevation, ecosystems, and hydrology, these choices will have strong social and environmental justice implications.

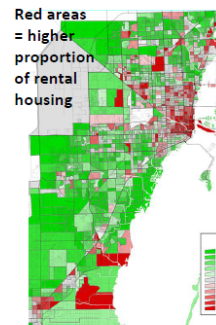


South Miami-Dade summary maps

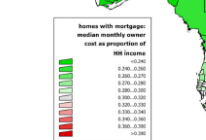


An earlier effort by our group was this poster at FCE LTER All Sci 2011 showing side by side maps of elevation, population spread, socio-economic and ethnic spatial variation for eyeball comparison.

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



Miami-Dade County leads Florida in housing cost burden on its residents

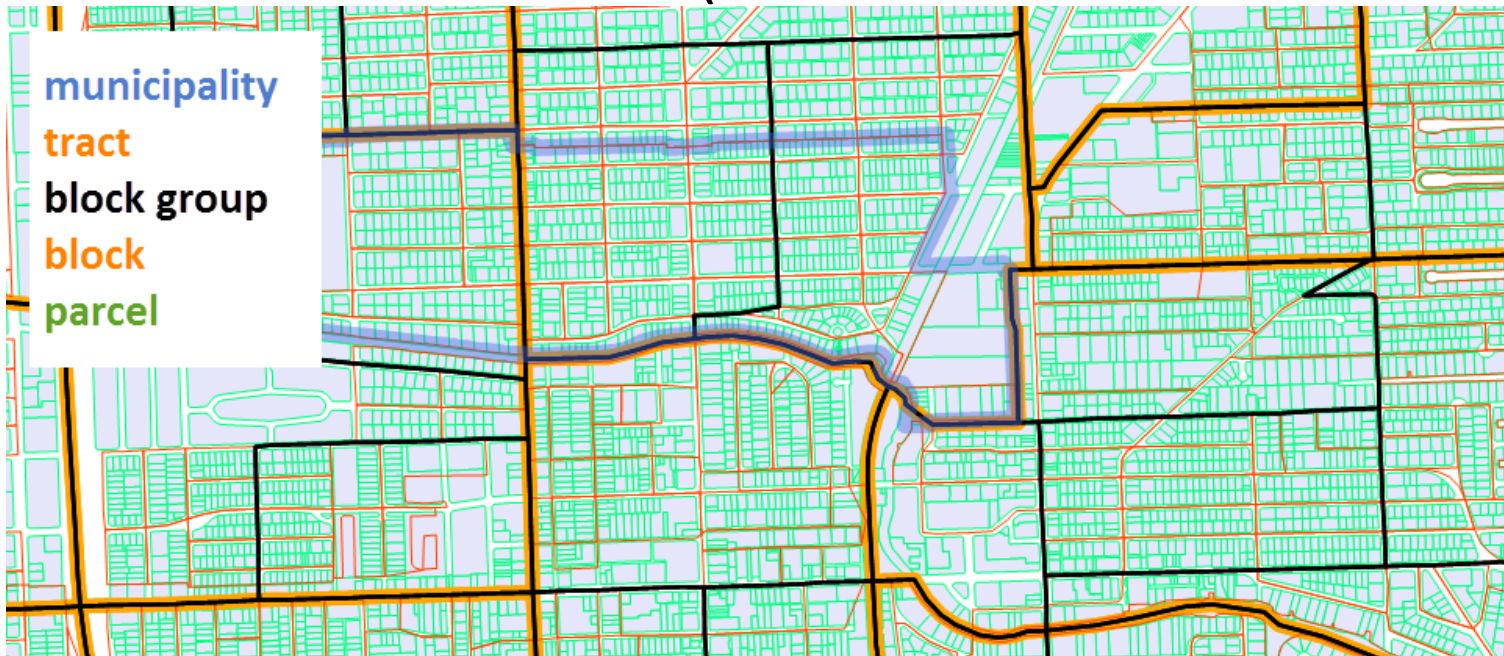


2006-2008 American Community Survey (ACS) estimates
Public Use Microsample Areas (PUMAS)

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**.

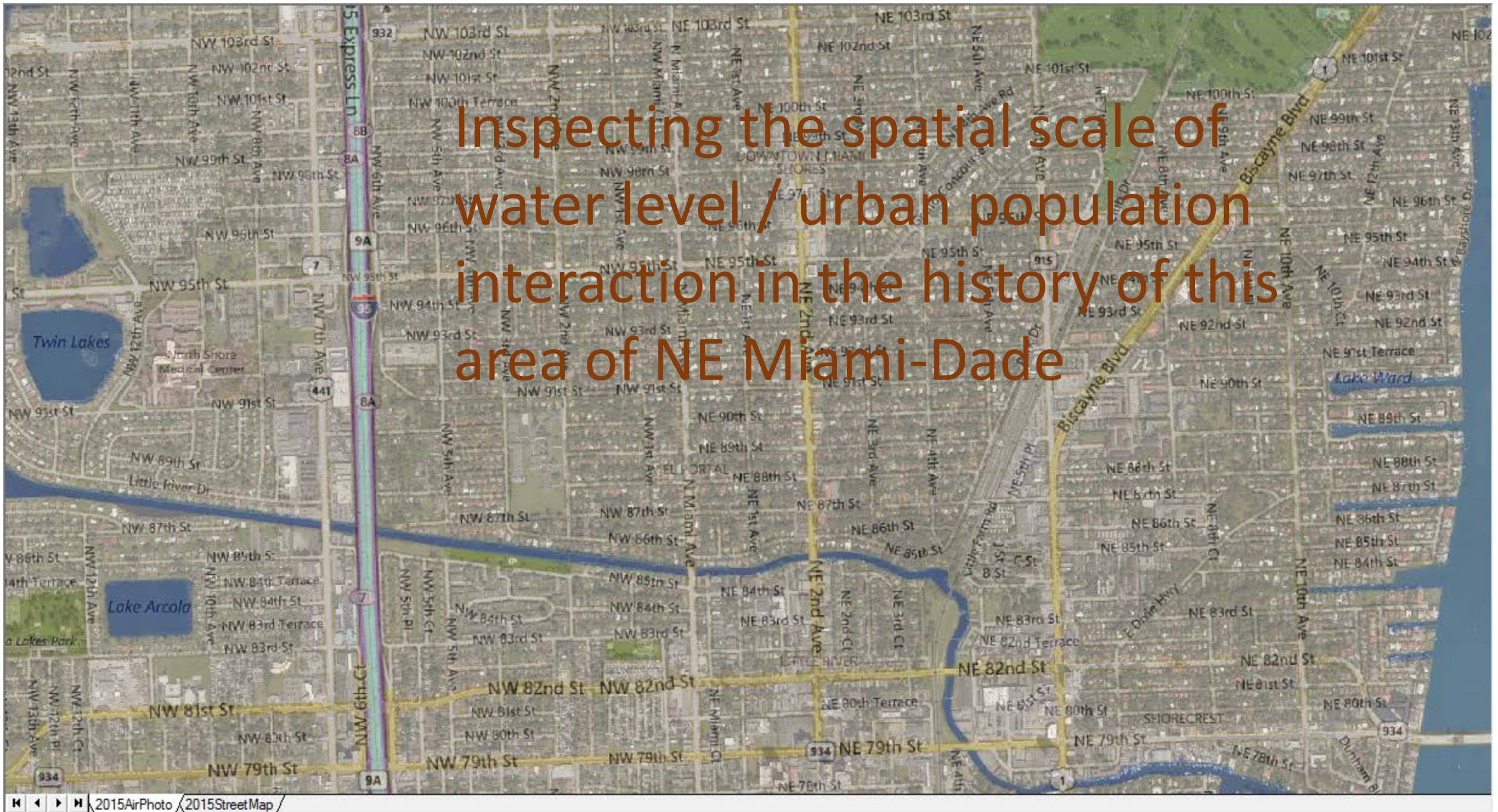
However what if climate change disturbance affects the urban system in small areas (patches)? If this is the case, how small do we have to go? Down to **blocks**, or further to **parcels**? Problem is the smaller the area (block, parcel) the fewer variables we have data for (otherwise would not maintain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





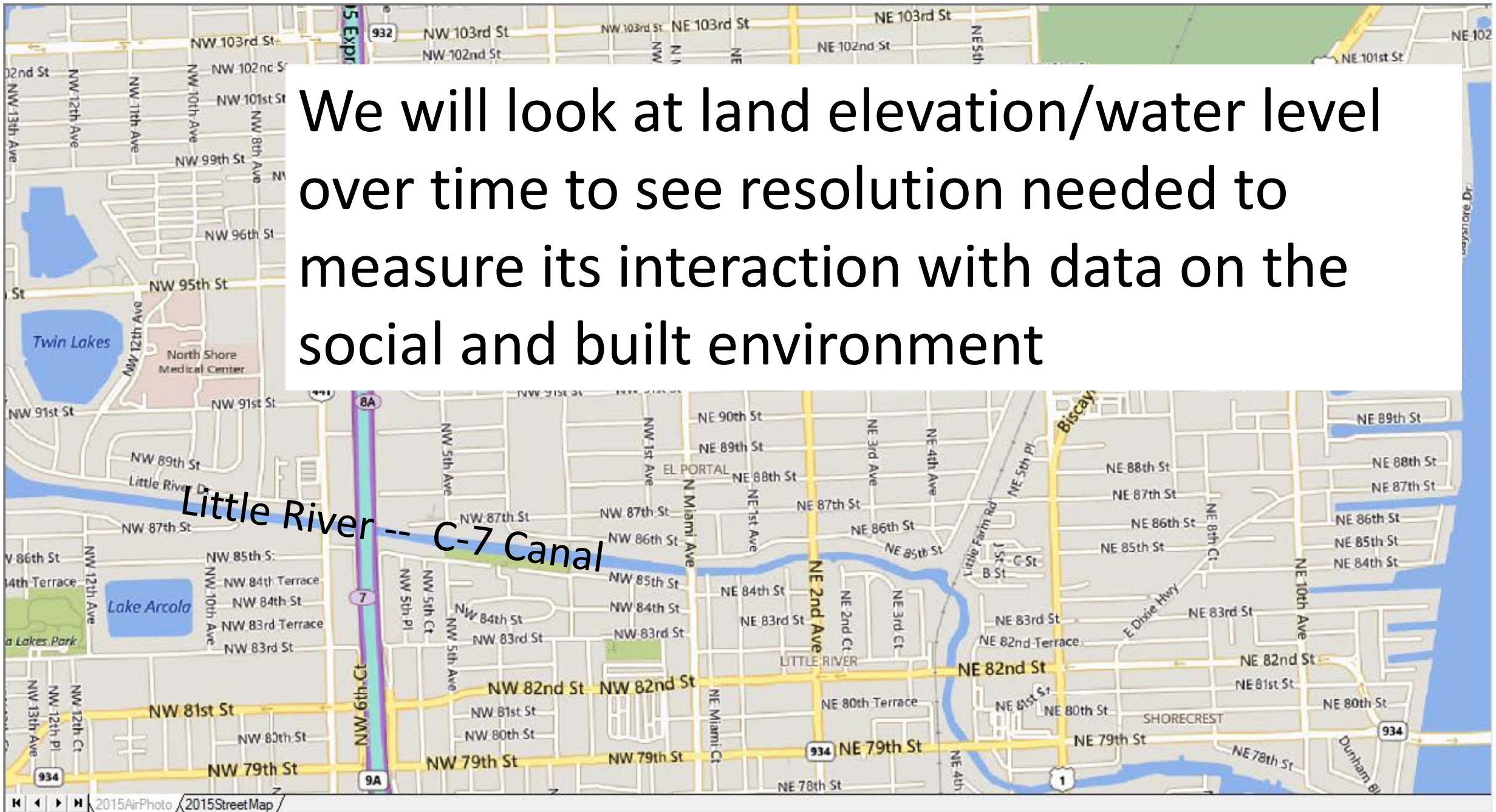
Inspecting the spatial scale of
water level / urban population
interaction in the history of this
area of NE Miami-Dade

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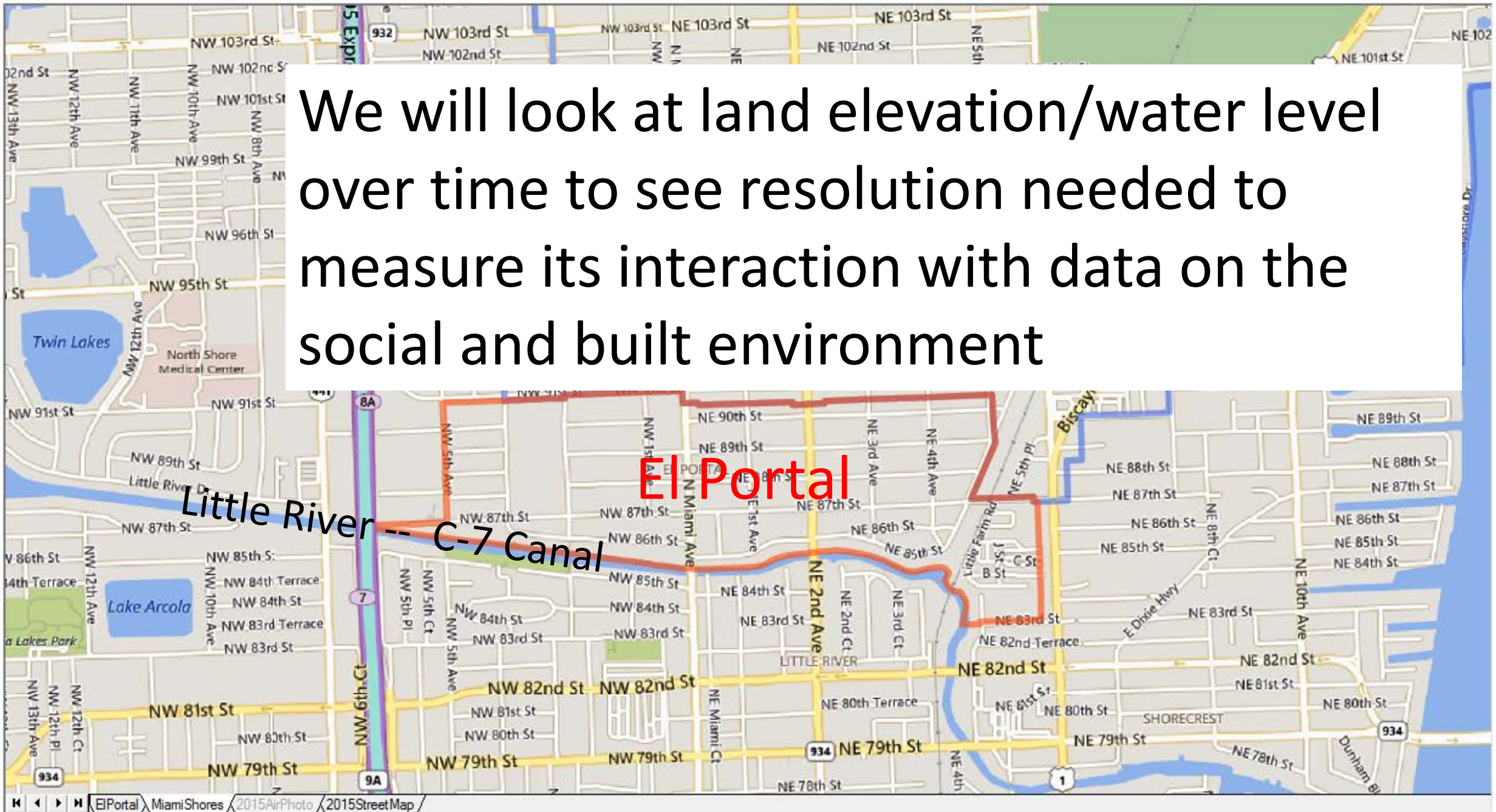


We will look at land elevation/water level over time to see resolution needed to measure its interaction with data on the social and built environment

Little River -- C-7 Canal



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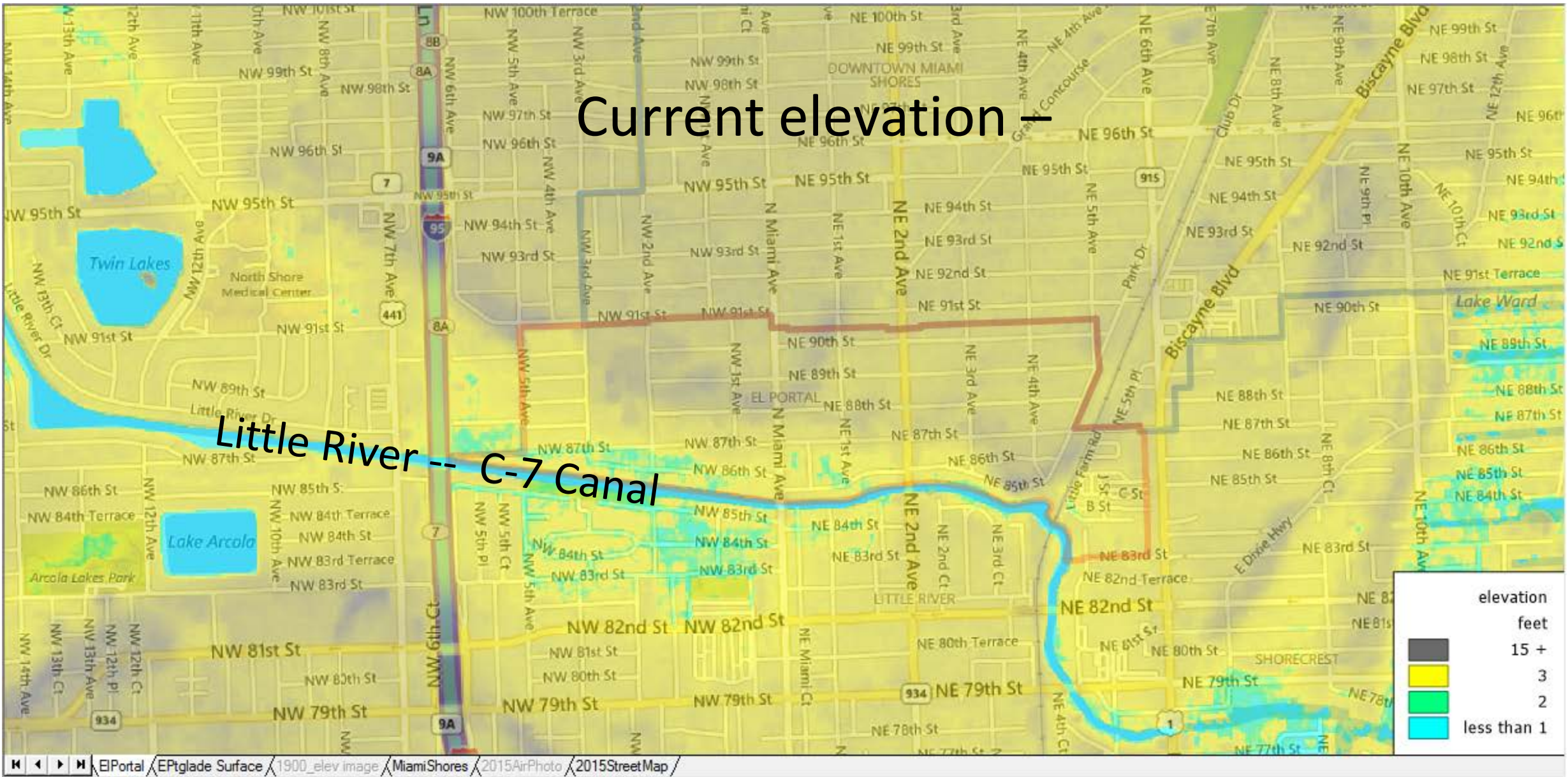
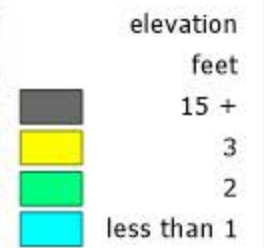
Miami Shores

El Portal

Little River -- C-7 Canal

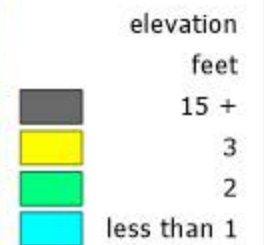
Current elevation —

Little River -- C-7 Canal

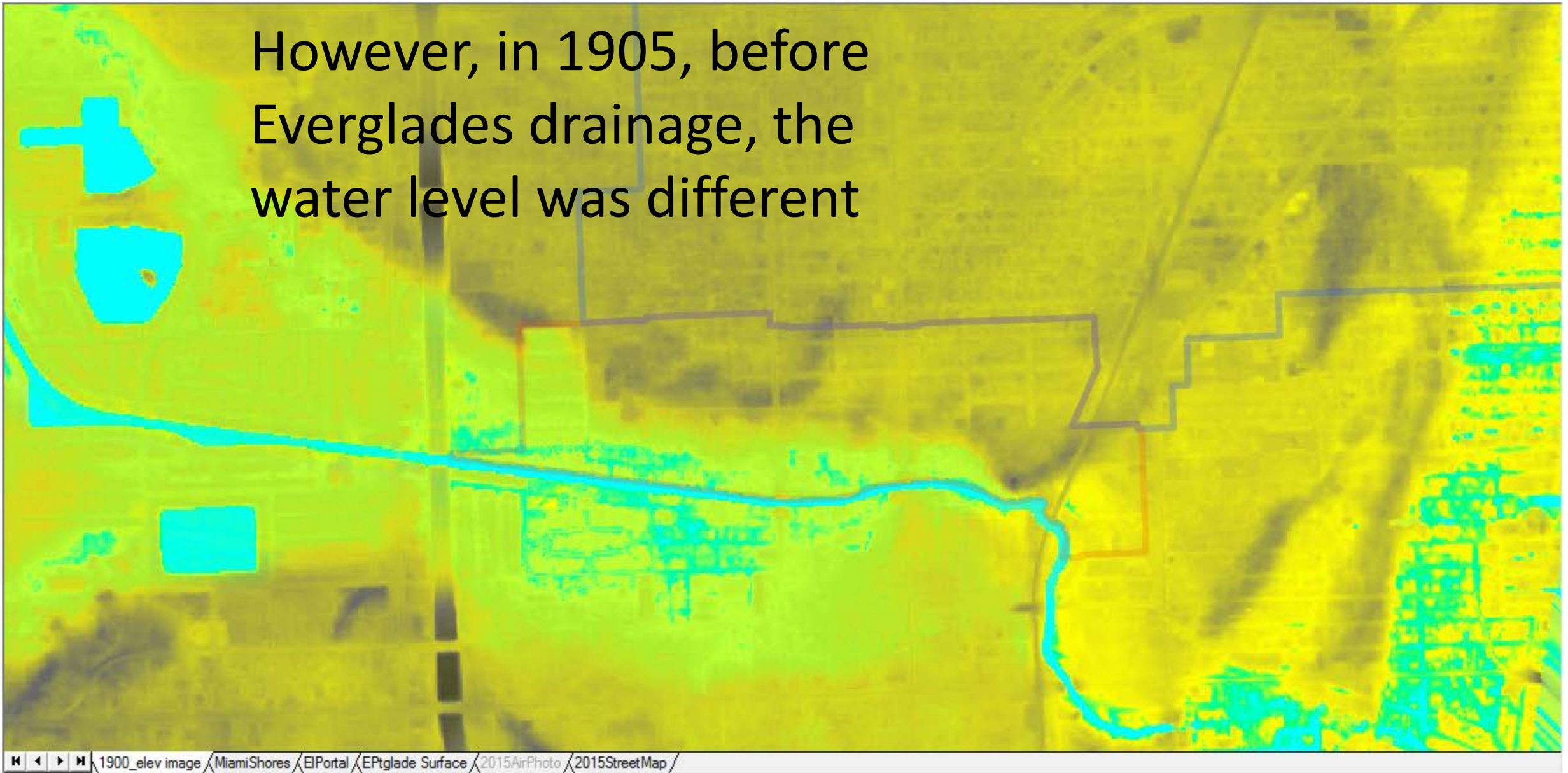


Current elevation – yellow is
approximate 3 foot level

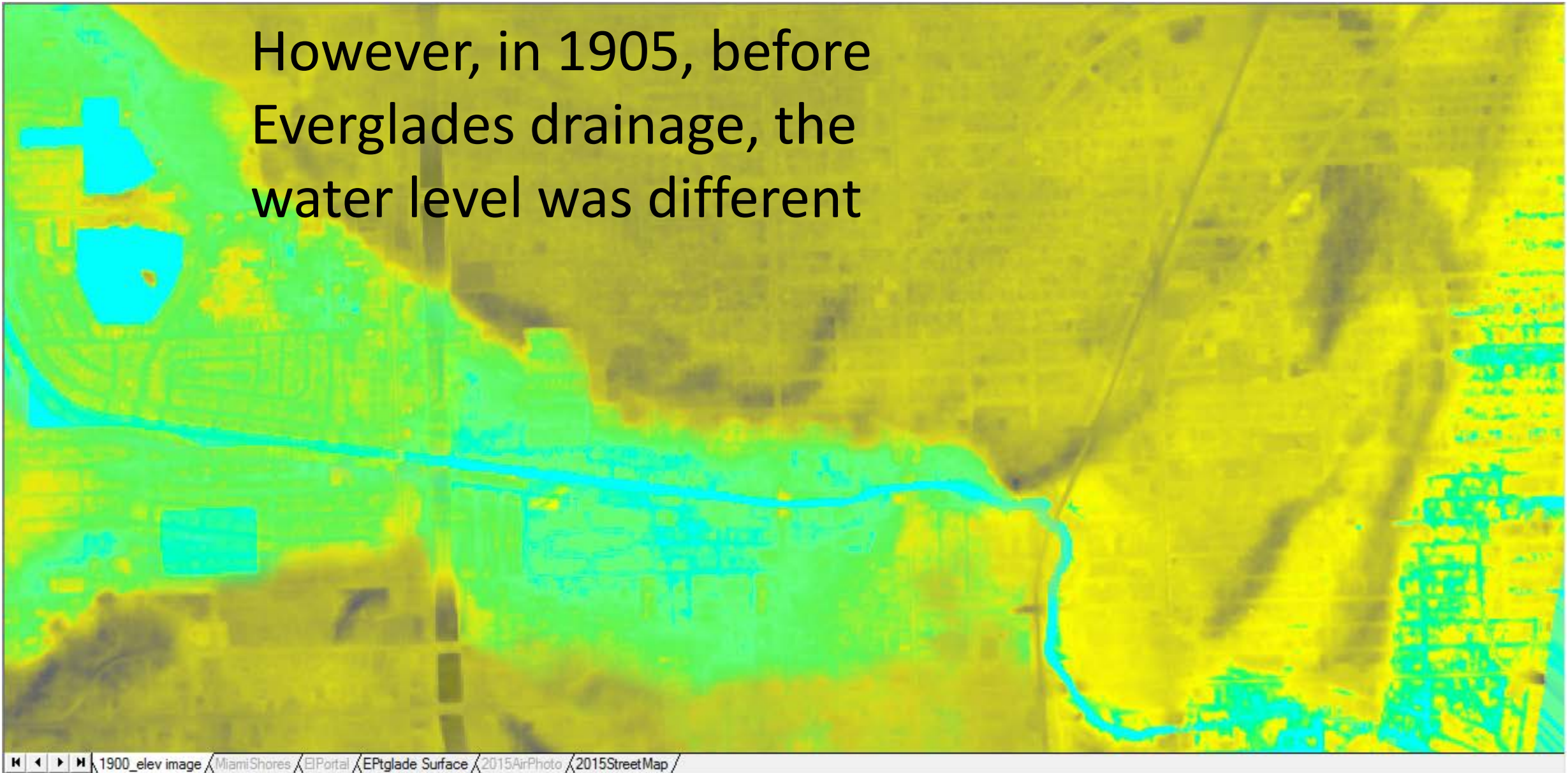
Little River -- C-7 Canal



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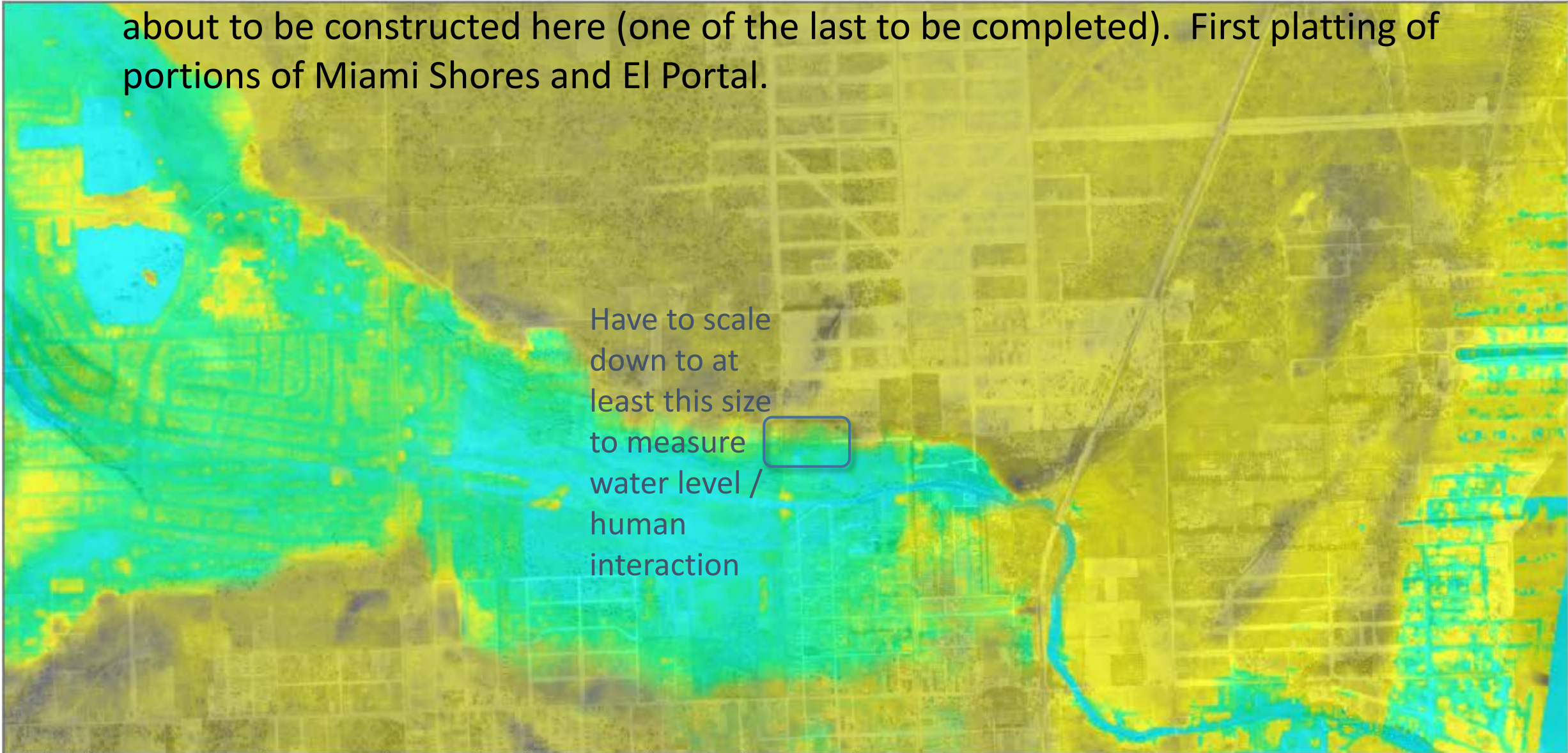
However, in 1905, before
Everglades drainage, the
water level was different

Guesstimate of what water level looked
like in this transverse glade, wet season
6 ft above sea level

Start of Little River rapids.
Would be local flooding
at this water level (is one
foot lower than current
max cat 5 SLOSH storm
surge)



about to be constructed here (one of the last to be completed). First platting of portions of Miami Shores and El Portal.



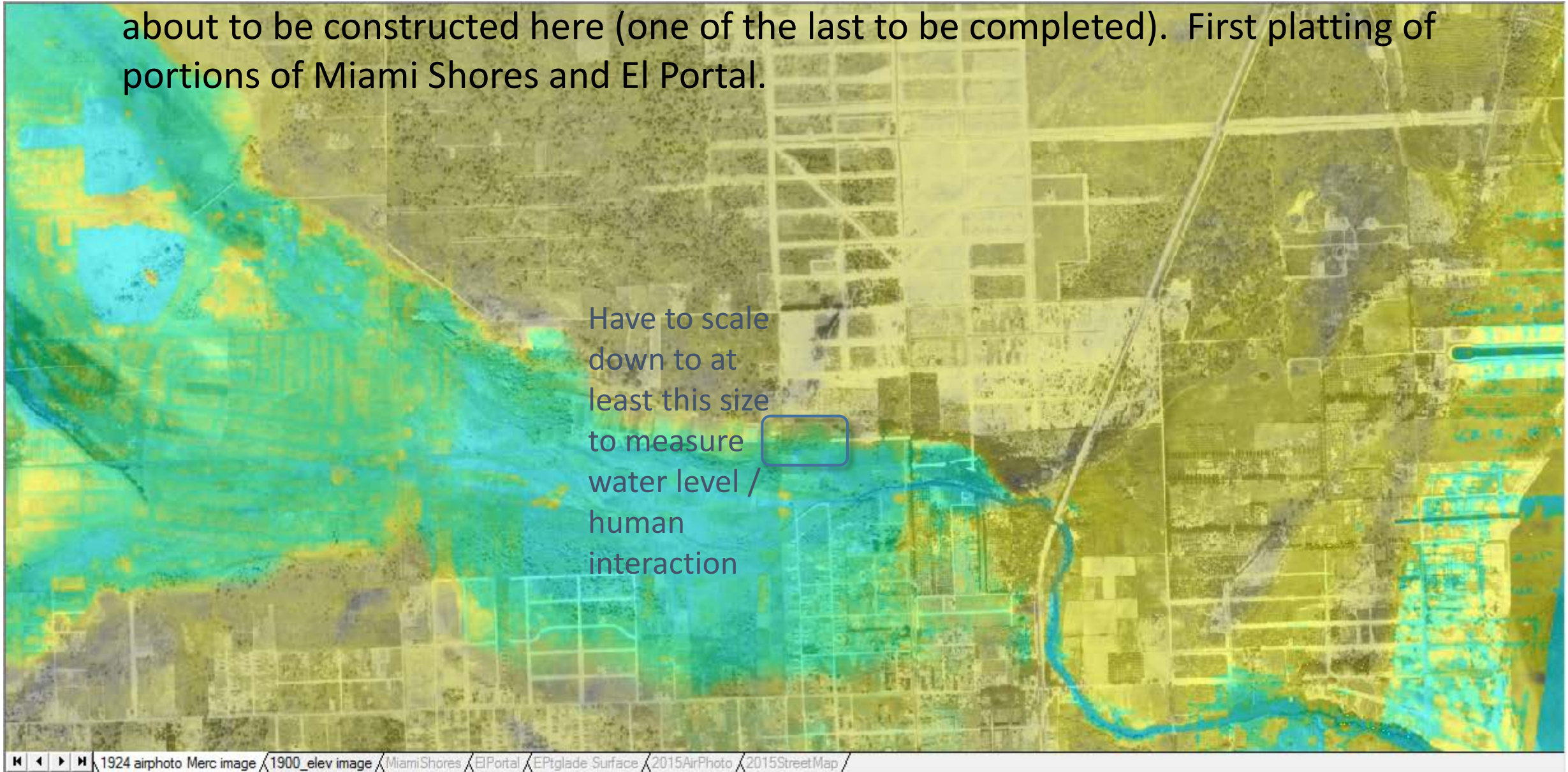
The image is an aerial photograph of a coastal area, likely Miami Shores and El Portal. A large, irregularly shaped area on the left side of the image is highlighted in a bright blue color, contrasting with the surrounding yellowish-brown land. This blue area appears to be a body of water or a wetland. A small, rectangular blue box is drawn on the right side of the blue area, near the center of the image. The text 'Have to scale down to at least this size to measure water level / human interaction' is written in blue, sans-serif font, positioned to the right of the blue box. The text is arranged in five lines: 'Have to scale', 'down to at', 'least this size', 'to measure', and 'water level / human interaction'. The overall image has a grainy, historical quality.

Have to scale down to at least this size to measure water level / human interaction

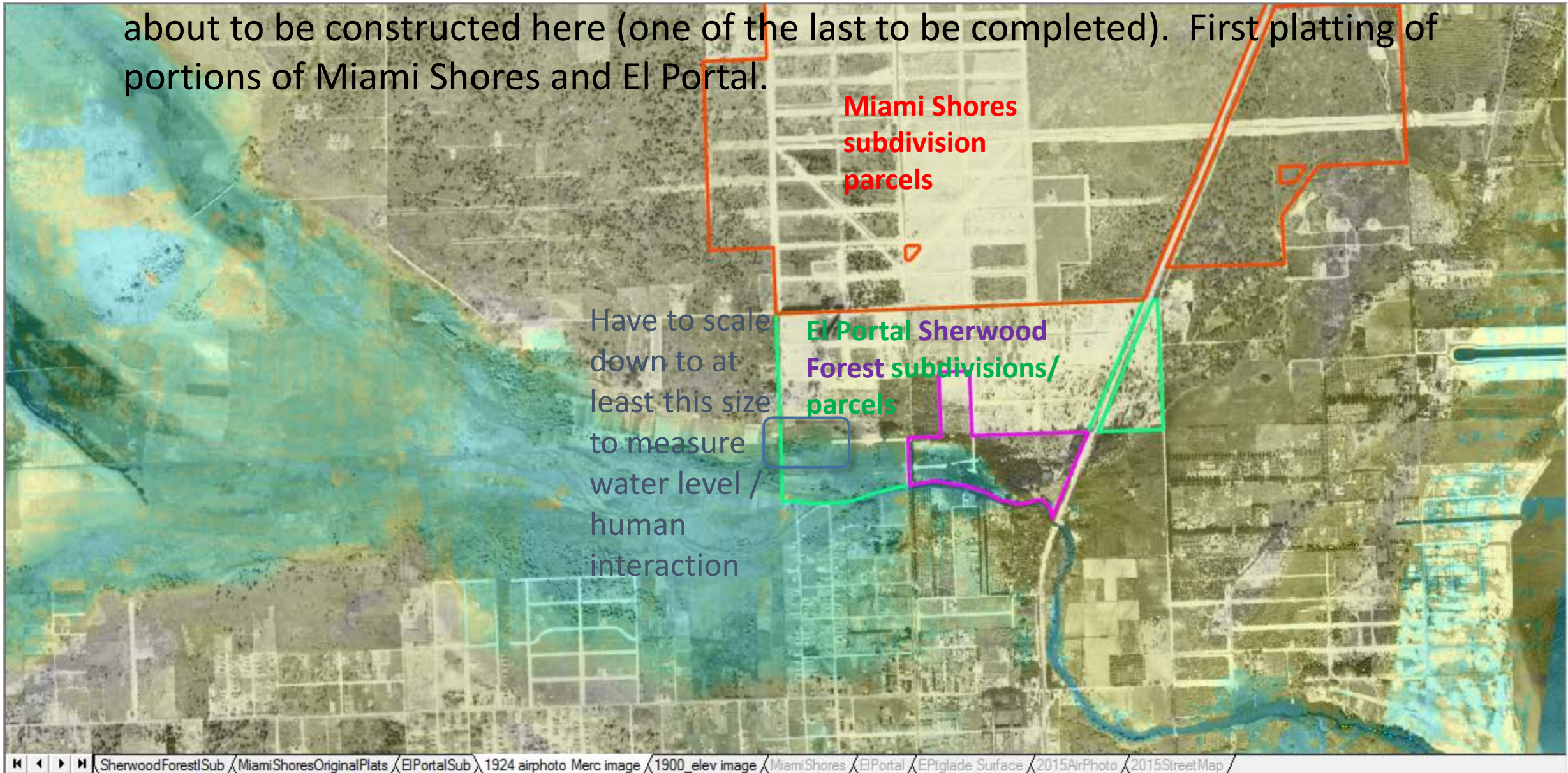


Move forward to 1924. Everglades drainage lowering water levels, C-7 canal about to be constructed here (one of the last to be completed). First platting of portions of Miami Shores and El Portal.

Have to scale
down to at
least this size
to measure
water level /
human
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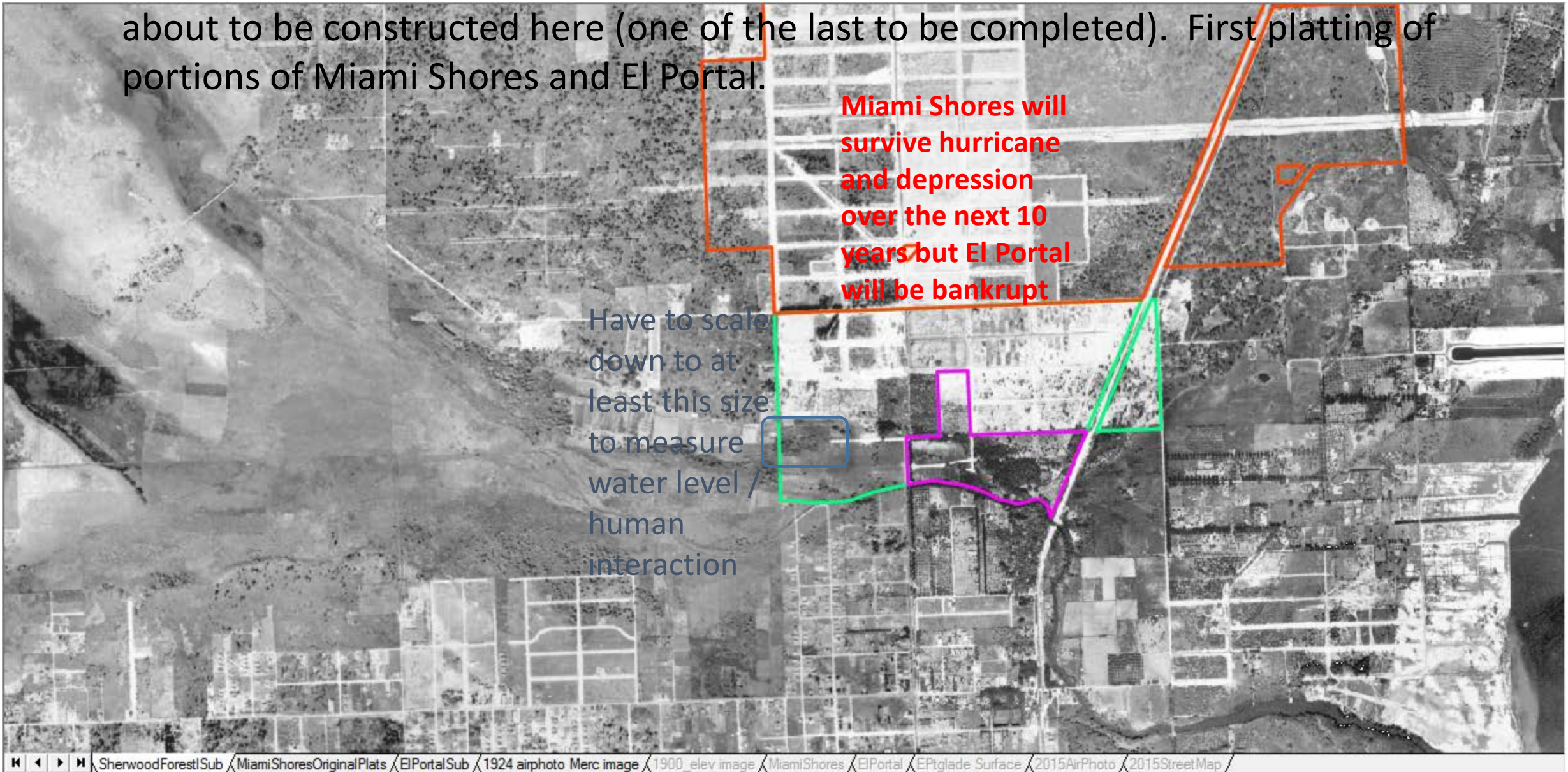
Move forward to 1924. Everglades drainage lowering water levels, C-7 canal about to be constructed here (one of the last to be completed). First platting of portions of Miami Shores and El Portal.



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.

Miami Shores will survive hurricane and depression over the next 10 years but El Portal will be bankrupt

Have to scale down to at least this size to measure water level / human interaction



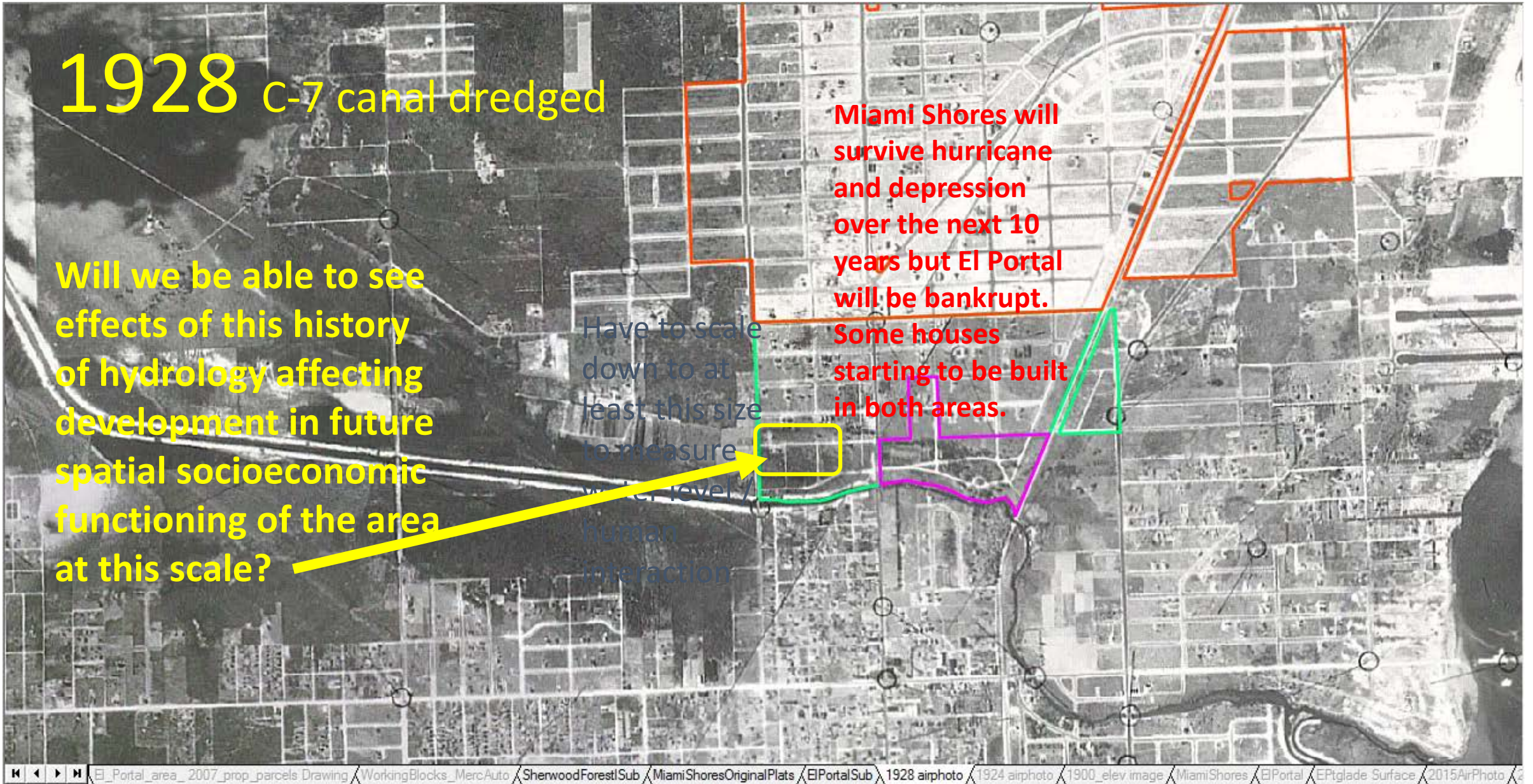
1928 C-7 canal dredged

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.



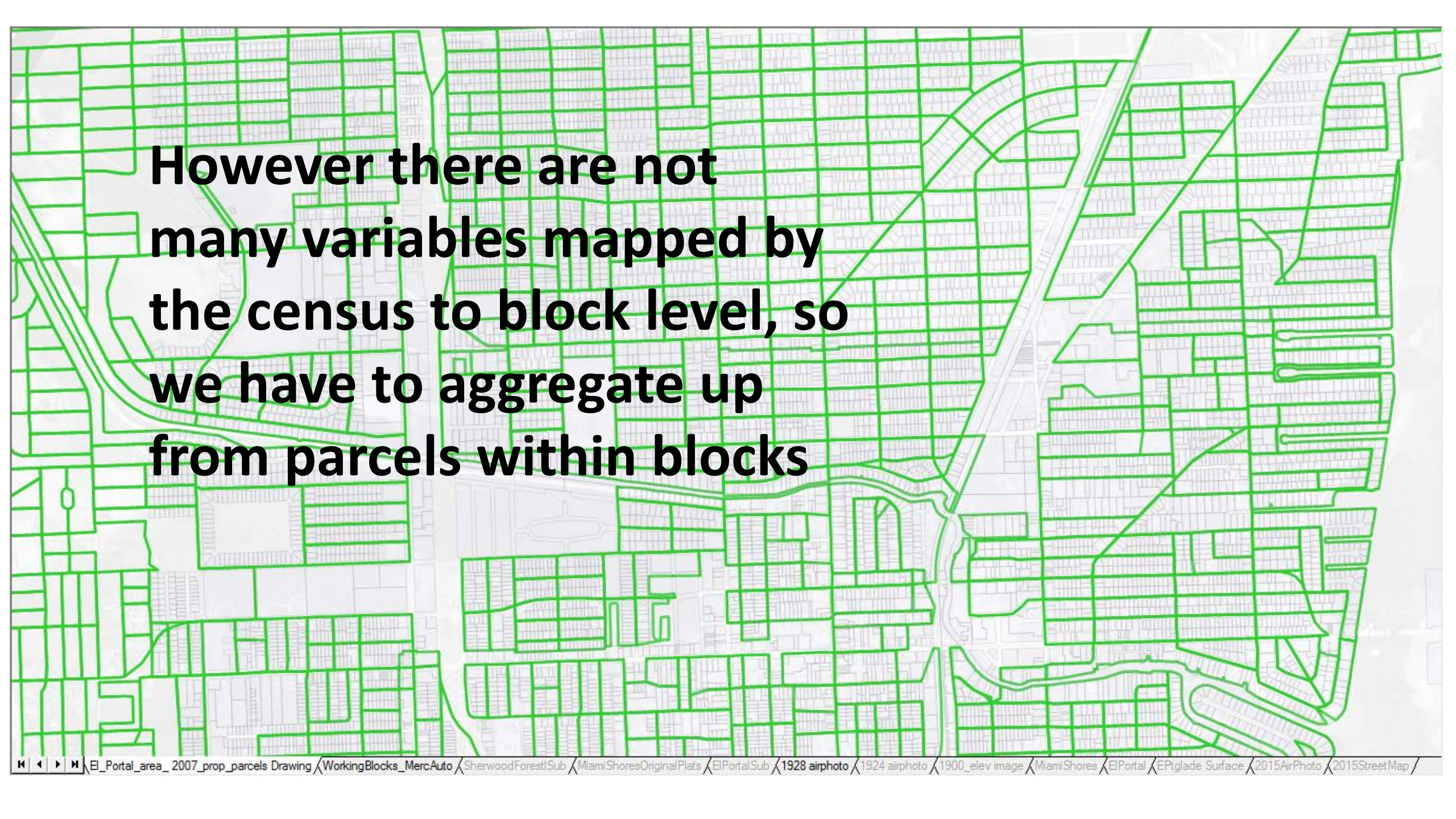
In other words, to what level
do we have to downscale to
capture the locations
("patches") where water
level interacts with human
urban processes?



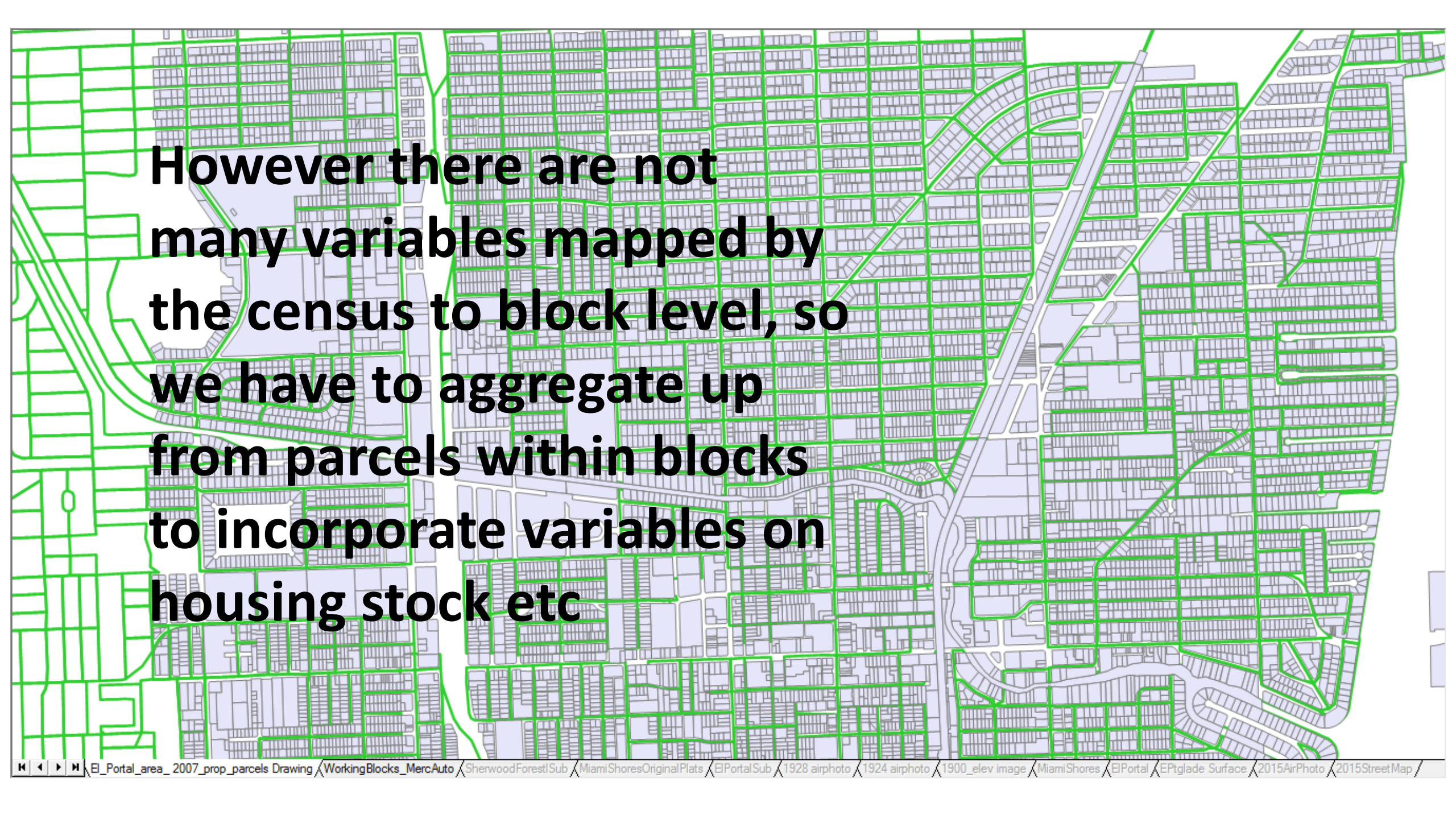
So, to what level do we have to downscale to capture the locations (“patches”) where water level disturbs human urban processes?

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

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
zerohtg
version
geometry

BLOCKS

Aggregated
from parcels

From parcel elevation

Block data

PARCELS

Tables (2)

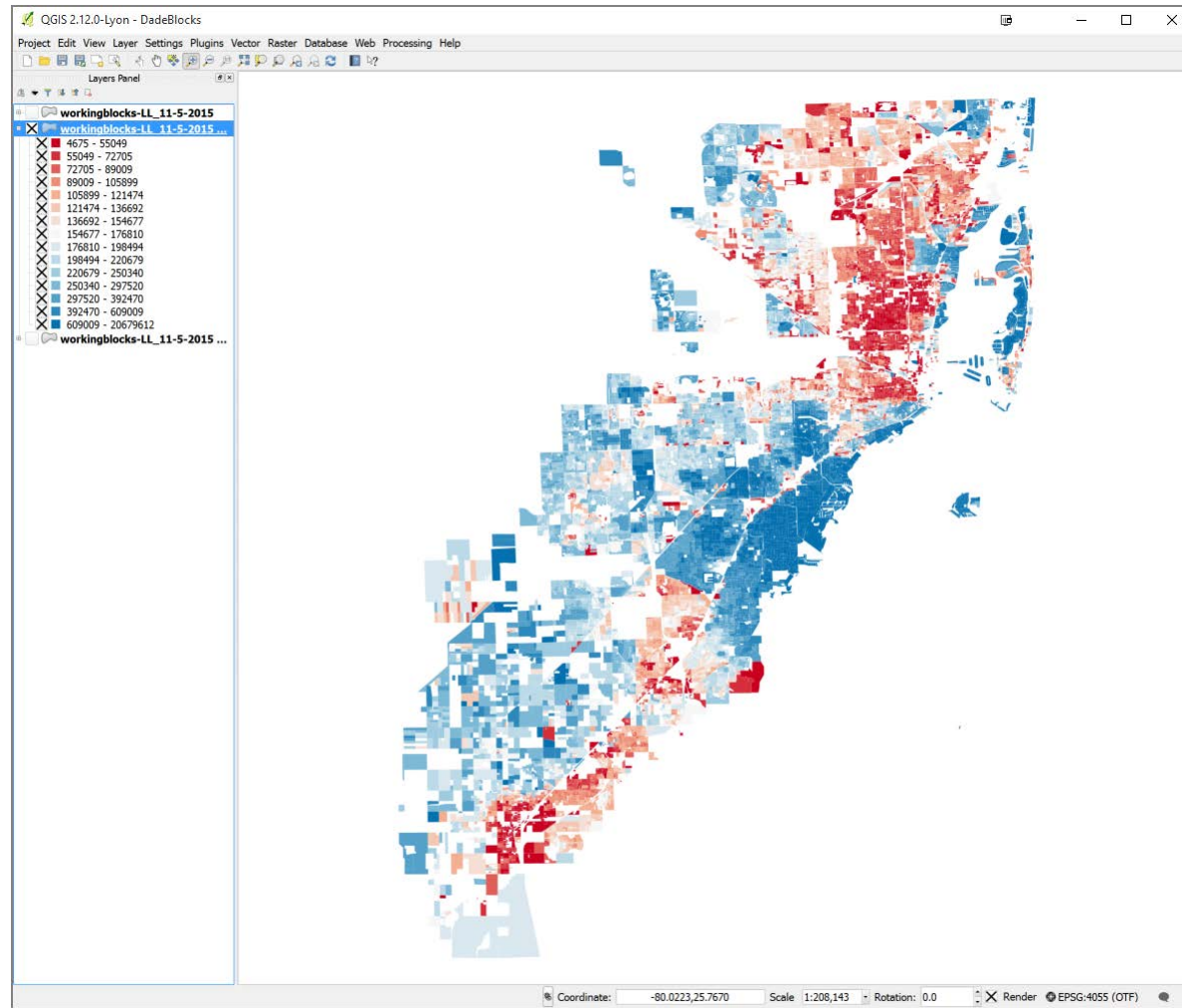
Mdpropdat

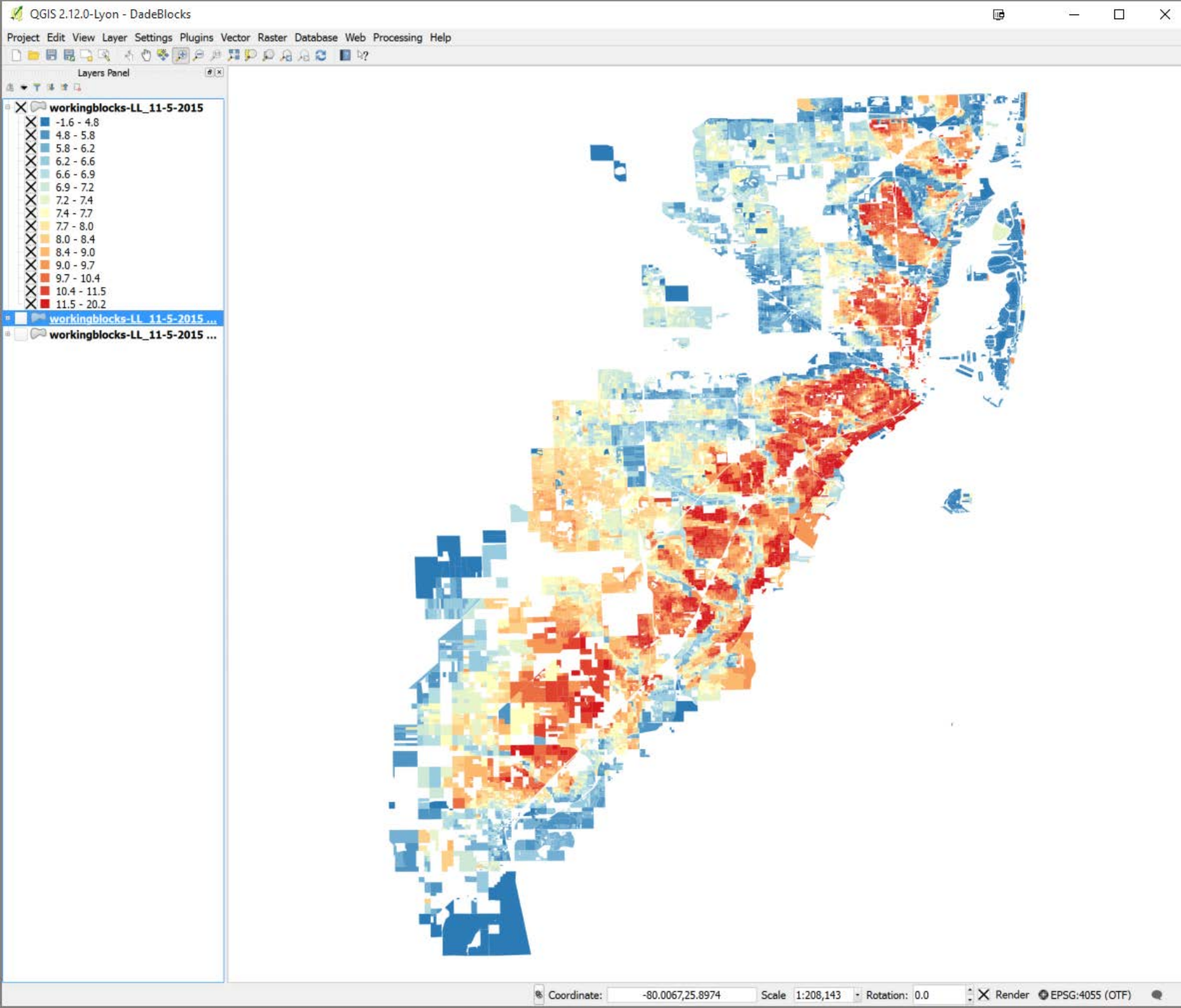
Columns (25)

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_buldn
no_res_unts
sale_prc1
sale_yr1
sale_prc2
sale_yr2
census_bk
phy_addr1
phy_addr2
phy_city
phy_zipcd



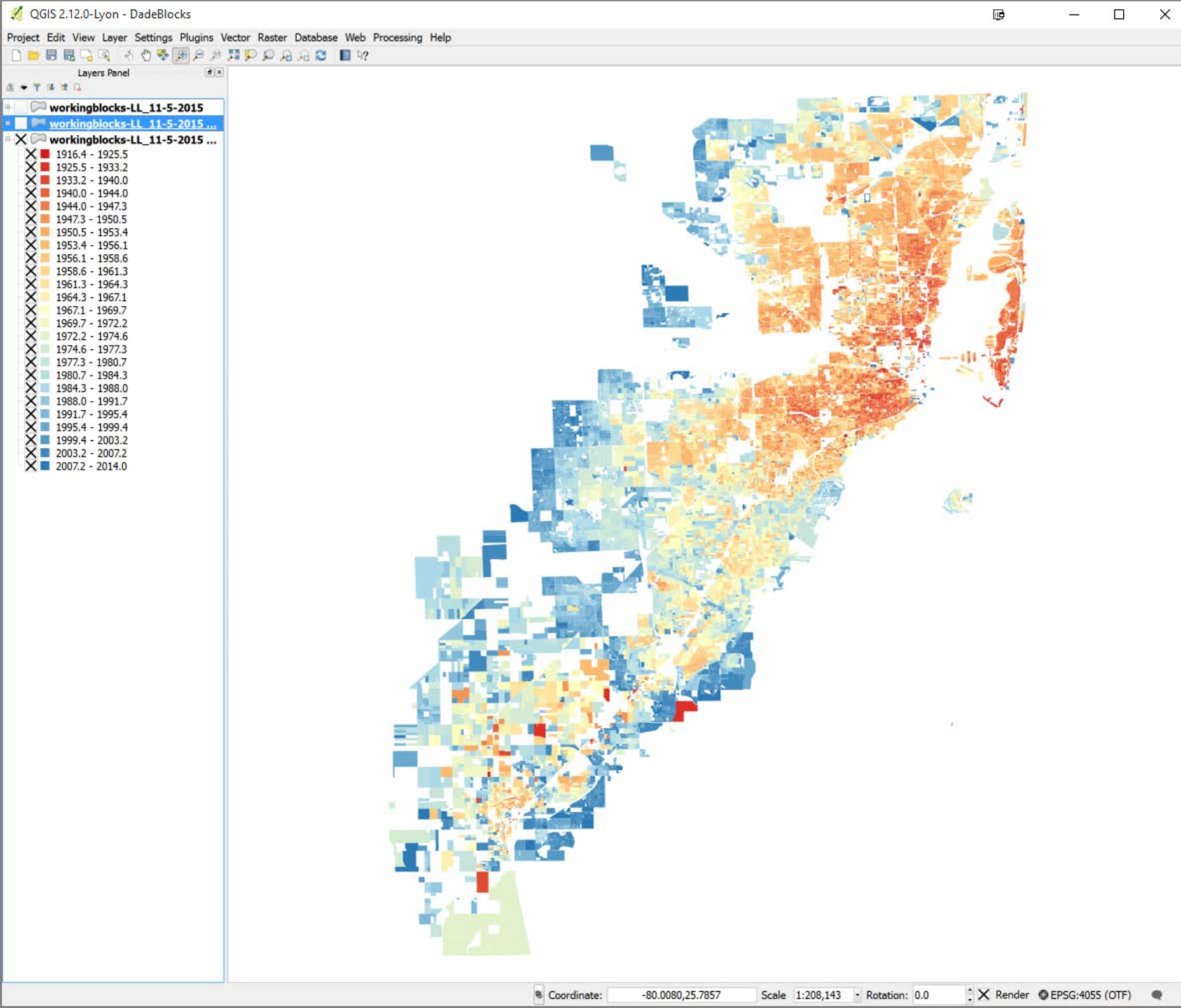
Map some of these variables





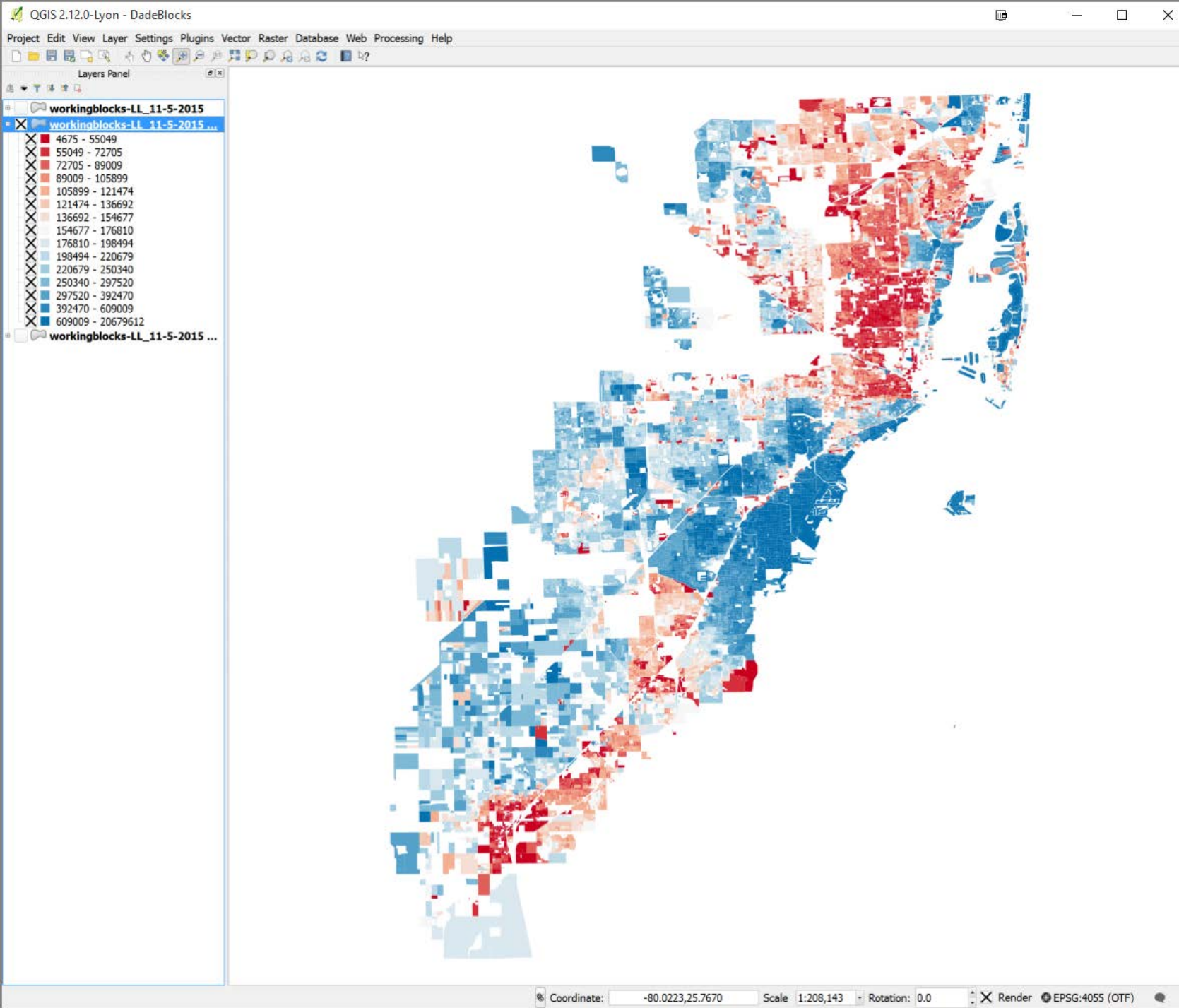
Mean of
parcel
elevations in
block

***NATURAL
ENVIRONMENT***



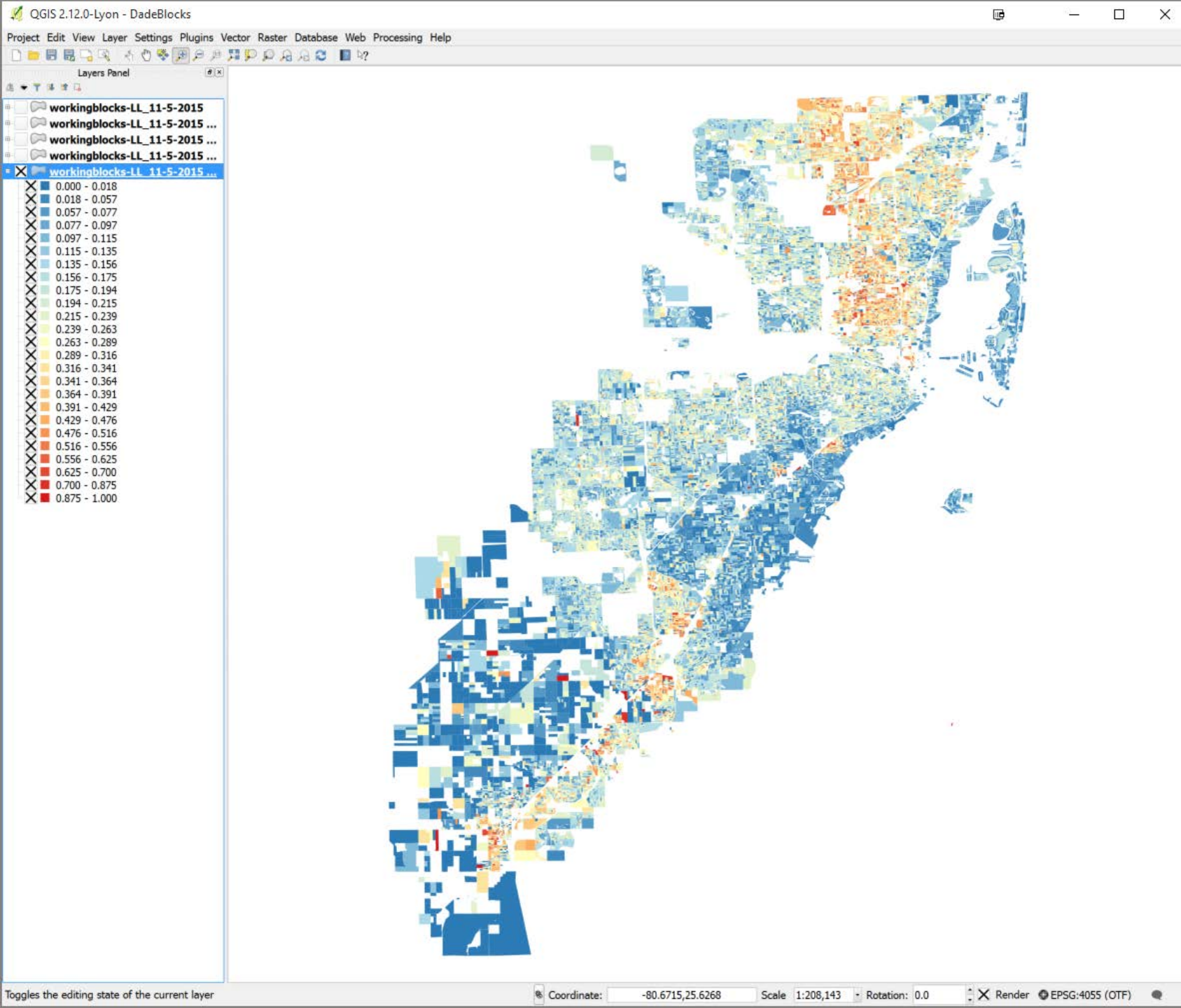
Mean year
built of
residences in
block

***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 jyperres vacrate avgyear pblack
dependent variable = fhh female householder no husband prsnt/ tot_housing_units
```

Source	SS	df	MS
Model	111.125682	5	22.2251365
Residual	285.101481	23923	.011917464
Total	396.227163	23928	.016559143

Number of obs	=	23929
F(5, 23923)	=	1864.92
Prob > F	=	0.0000
R-squared	=	0.2805
Adj R-squared	=	0.2803
Root MSE	=	.10917

fhh	Coef.	Std. Err.	t	P> t
rentrate	.0683367	.0027373	24.96	0.000
jyperres	-2.28e-08	1.53e-09	-14.90	0.000
vacrate	-.2565924	.0079804	-32.15	0.000
avgyear	.0003544	.0000396	8.94	0.000
pblack	.1899812	.0023595	80.52	0.000
_cons	-.5561625	.078207	-7.11	0.000

- proportion rentals / housing units
- avg parcel market value in block
- vacancy rate (low=high housing demand)
- age of housing stock
- proportion African-American/Black

Notice its relationship with other variables in our dataset

Yes we know about the ecological correlation issue so we are not bragging about this R²

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	
proportion college or equiv or more education	
proportion highest education 8th grade or less	
	total population of block group

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/>.