Real Estate Values, Tax Revenues, and Climate Induced Retreat From Flood Zones

Charles Towe (PI), Zhenshan Chen, Nancy Bockstael, and Stephen Swallow

Department of Agricultural and Resource Economics

and Center for Environmental Sciences and Engineering

Funded by Connecticut Institute for Resilience and Climate Adaptation (CIRCA) and DelFavero Faculty Fellowship

CIRCA
Connecticut Institute for Resilience and Climate Adaptation

CESE
Center for Environmental Sciences and Engineering

UCONN

Quick Background

Sea level rise (SLR) is now widely recognized and active policy priority

- Pressures are mounting from the insurance and financial markets to take mitigation measures.
- There is movement of Federal insurance rates approaching actuarially fair rates in the coming decade and an appetite to diversify rates within the flood plain.

CIRCA Connecticut Institute for Resilience and Climate Adaptation

CESE Center for Environmental Sciences and Engineering

UCONN

Connecticut's exposure

- A recent study puts approximately 4,500 homes and about 10,000 residents in a chronic inundation zone by 2045.
- These homes comprise $3.4 billion in value and ~$52 million in tax revenue to towns and municipalities.
- This is no longer a distant issue as these impacts are within the term of a mortgage signed in the last year.
- And, these numbers could increase as much as 5 fold by 2100.

CIRCA
Connecticut Institute for Resilience and Climate Adaptation

CESE
Center for Environmental Sciences and Engineering

UCONN

Life and Housing in the Flood Plain

This is the crux of the study and an opportunity to define who the players are here

- Federal role
- State and Local role (non profits and land trusts)
- And most importantly, the current and future residents role

CIRCA
Connecticut Institute for Resilience and Climate Adaptation

CESE
Center for Environmental Sciences and Engineering

UCONN

The Federal Role

Through FEMA, whose responsibilities include

- Mapping flood plain zones
- Determining flood insurance rates
- Setting minimum flood plain management regulations, and requiring elevations of new construction and major renovations
- And obviously, assisting in recovery after flood events.

State and Local Role

Localities bear the burden of enforcing FEMA requirements and can impose stricter regulations.

- The state of Connecticut requires structural elevation to exceed base flood elevations (BFE) by at least one foot and some Connecticut towns have added further 'freeboard' requirements.
- Some communities have more resources than others to implement and enforce regulations.
  - Within these communities there is significant heterogeneity in policy especially with regard to the lookback period for the 50% rule.
- Community Rating System (CRS) gives insurance premium discount for local government actions such as:

CIRCA Connecticut Institute for Resilience and Climate Adaptation

CESE Center for Environmental Sciences and Engineering

UCONN

CT Coastal Towns and Its People

CT coastal zone differs from much of the US in the heterogeneity of

- Housing stock in age and quality.
- Topography

Even within the state

- Differences in ability to afford resiliency.
  - Of the 24 coastal town 5 are in the top 10% of CT localities in income but 9 are in the lower half.
- Differences in how adaptation has occurred in response to previous storm events (more elevations west than east)

CIRCA
Connecticut Institute for Resilience and Climate Adaptation

CESE
Center for Environmental Sciences and Engineering

UCONN

CT Coastal Towns and Its People

CT coastal localities are not unlike other coastal housing markets in that life in the flood plain

- has an undeniable amenity value to some residents
- but has an undeniable risk for all residents

We use the housing market, a loose aggregation of individual decisions, to measure the response to the amenity and risk signals.

CIRCA
Connecticut Institute for Resilience and Climate Adaptation

CESE
Center for Environmental Sciences and Engineering

UCONN

Overarching research objectives

First, we provide an initial analysis of the housing market in the flood plain in order to test hypotheses about the responsiveness of homeowners to market signals.

- Waterfront, near waterfront, river front, structural elevation, insurance requirements, views, and in SFHA are all of interest specifically with regard to our CT localities.

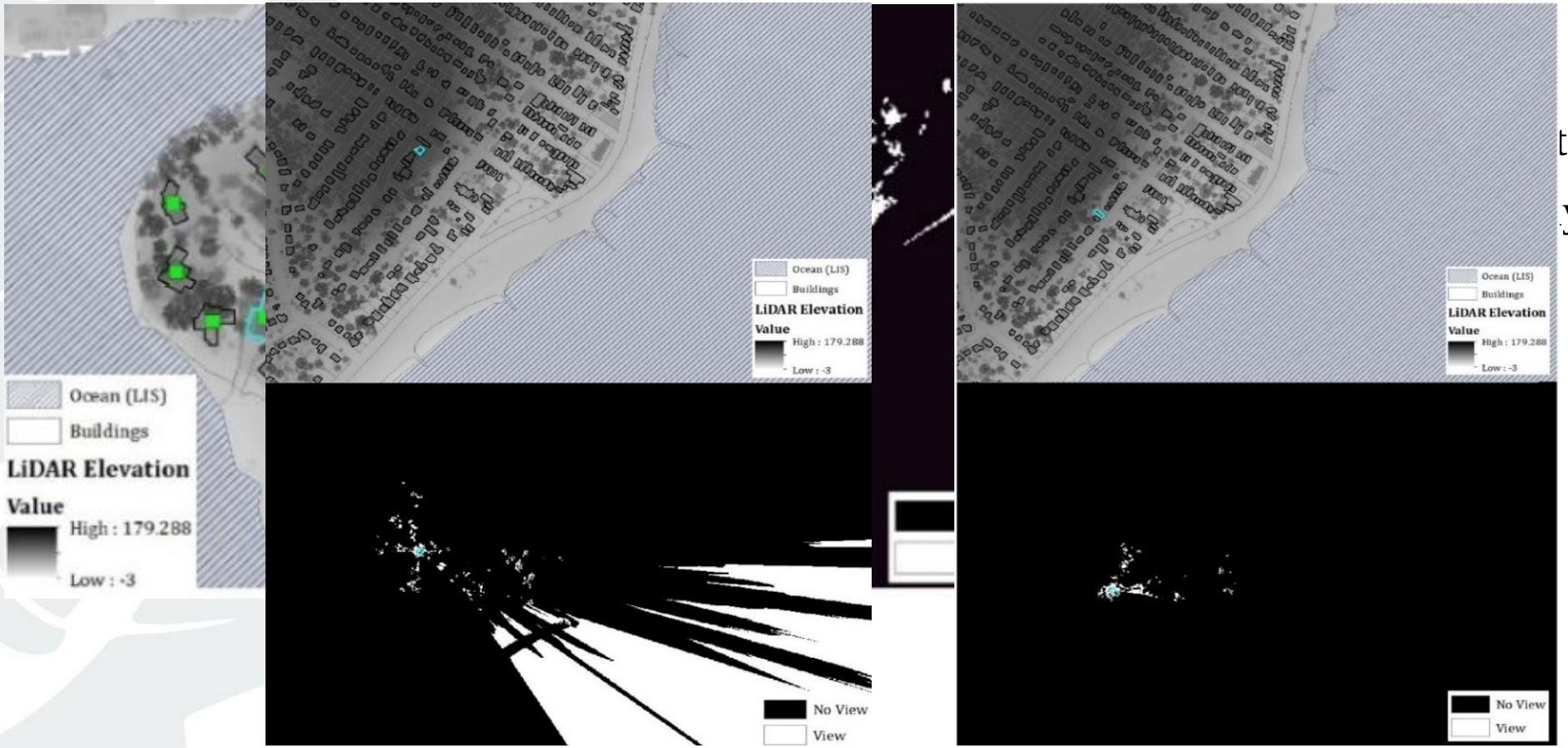
Second, we conduct a simulation to investigate retreat scenarios using our estimated parameters and some from the literature to gauge financial implications of buyout programs.

CIRCA
Connecticut Institute for Resilience and Climate Adaptation

CESE
Center for Environmental Sciences and Engineering

UCONN

A more complete viewshed analysis



t in mile

y interruptions

CIRCA
Connecticut Institute for Resilience and Climate Adaptation

CESE
Center for Environmental Sciences and Engineering

UCONN

A Simple Hedonic Model

In the simple hedonic model one would estimate a model using observed transaction prices based on the many observable characteristics of the house and property

- Lot size, structure size, house specific amenities, age, views, location (including flood plain), elevation, etc.

the neighborhood,

- Schools, CRS attributes, proximity to amenities and disamenities (again location)

and the transaction itself.

- Sales timing and financing

CIRCA Connecticut Institute for Resilience and Climate Adaptation

CESE Center for Environmental Sciences and Engineering

UCONN

Summary data – some key variables

Coastal amenities and Price differentials			
Variables	**Mean (S.D.)**		
	All	In Flood Plain	Outside Flood Plain
Housing Price	$470,432	$621,580	$451,562
	(417916)	(553222)	(393757)
Coast Front	0.012	0.078	0.004
	(0.110)	(0.268)	(0.063)
River Front	0.007	0.043	0.003
	(0.086)	(0.202)	(0.055)
Waterfront Across Street	0.004	0.020	0.002
	(0.061)	(0.139)	(0.041)
Ground Elevation	78.868	17.811	86.490
	(67.793)	(30.058)	(67.330)
N	107877	11973	95904

CIRCA Connecticut Institute for Resilience and Climate Adaptation

CESE Center for Environmental Sciences and Engineering

UCONN

Standard property characteristics
Ln Building SQFT
Ln Lot SQFT
Building Age
Building Condition
Heating Type
Pool
Garage No. of Cars
No of Stories
Total Rooms
Total Bedrooms
Total Calculated Bath Count
Air Condition
Fireplace Number

GIS Attributes
Flood Plain (SFHA DFIRM)
Sandy Surge (ft)
Base Flood Elevation (ft)
Sewer Service (dummy)
Ln (Distance nearest Highway Exit)
Ln (Distance nearest Highway)
Ln (Distance nearest Public Beach)
Ln (Distance to the Coastline)
Ln (Distance to nearest Waterbody)
Ln (Distance nearest High Density Development)
Ln (Distance nearest State Park)
Ln (Distance nearest Airport)
Ln (Distance nearest Coastal Barrier Resources System)
Ln (Distance nearest Brownfield site)
Ratio of developed land within 1 mile
Ratio of forest within 1 mile
Ratio of open space or wetland within 1 mile

CIRCA
Connecticut Institute for Resilience and Climate Adaptation

CESE
Center for Environmental Sciences and Engineering

UCONN

Regression Results - Matched Sample

Sample	Full Sample	With Loan	No Loan
Outcome	Ln(Price)	Ln(Price)	Ln(Price)
Flood Plain (SFHA DFIRM)	-0.0245+	-0.0217+	-0.0356
	(0.0133)	(0.0120)	(0.0253)
Coast Front	0.391***	0.402***	0.349***
	(0.0312)	(0.0324)	(0.0595)
River Front	0.270***	0.269***	0.250***
	(0.0372)	(0.0449)	(0.0558)
Waterfront Across Street	0.271***	0.247***	0.308***
	(0.0381)	(0.0458)	(0.0503)
Ln (LIS View Area)	0.00138	0.00203	-0.000773
	(0.00236)	(0.00256)	(0.00531)
Ln (LIS View Angle)	0.0271**	0.0264*	0.0288+
	(0.00930)	(0.0116)	(0.0158)
LIS Viewshed Slice No.	-0.00342	-0.00695*	0.000987
	(0.00210)	(0.00274)	(0.00261)
LIS Viewshed Distance (ft)	-0.00000714	-0.00000970	-0.00000675
	(0.00000586)	(0.00000656)	(0.0000120)
	19272	14423	4442
	0.830	0.866	0.828

The regression is based on matched sample (11,973 inside Flood zone, 7,430 outside). The matching is based on comprehensive property attributes, and requests exact match on transaction year.

These results show weak price discount from the flood plain status which is potentially indicative of the rather weak signal that is given to buyers along the coast in the form of disclosures.

There are heterogeneous impacts across the flood plain.

.

Note: Clustered Standard errors are in parentheses. +p<0.1,* p<0.05, ** p<0.01, *** p<0.001.

Connecticut Institute for Resilience and Climate Adaptation

UCONN

Shoreline retreat

This is a long discussed approach to adaptation, but has found limited use in practice. Why?

Obstacles –

- There are grants available but it takes time and money to get and manage them.
- Removing homes has tax revenue implications
- They require **voluntary participation** from owners

Shoreline retreat

Even so there is mounting pressure to begin this practice.

- Federal pressure exists - Army Corp of Engineers, Community Rating Status
- Private sector pressure exists – mortgage restrictions and municipality bond ratings
- Non-profit conservation groups are active in this space

And willingness from homeowners

- Repetitive loss properties have owners ready and willing to retreat (see West Haven's experience, and NY's program on Staten Island and the Rockaways)

What are the benefits that may affect home values?

Using estimated parameters, we calculate change in neighboring house values due to:

- Improved views for surrounding properties
- Changing waterfront status for some surrounding properties

Using estimated parameters from the literature, we calculate change in neighboring house values due to:

- Access to new open space
- Removal of decaying, frequently flooded homes

CIRCA Connecticut Institute for Resilience and Climate Adaptation

CESE Center for Environmental Sciences and Engineering

UCONN

What are some of the other benefits to home values?

- Reduced demand on emergency services
- Savings on infrastructure repair and maintenance
- Flood plain and groundwater protection for remaining homes (FEMA promotes including this benefit)
- CRS status changes providing discounts on homeowners flood insurance premiums
- Equilibrium and reinvestment effects - as communities change, prices change, and homeowners respond.

Many more these are just a few

CIRCA
Connecticut Institute for Resilience and Climate Adaptation

CESE
Center for Environmental Sciences and Engineering

UCONN

Defining retreat scenarios

- A logical place to start would be with the Severe Repetitive Loss properties, houses that have 4 or more flood claims of more than $5000 over past 10 years. Most vulnerable but information not available.
- An alternative is to use future projections of SLR and flood frequency for the coming decades. This is where we started.

Scenario 1 – The SLR retreat

All single family detached residential houses in our study area that are :

- Located within the area predicted to suffer at least 20 inches of sea level rise (relative to Mean Higher High Water/MHHW) by 2050.
- Located on a non-conforming lot (<10,000 square foot lot size) so that redevelopment is non-profitable.

Approximately 500 properties with a mean assessed value of $233,000.

Scenario 2 – The SFHA retreat

All single family detached residential houses in our study area that are :

- Located within the within the 100 year flood zone (SFHA) predictions by 2050.
- Located on non-conforming lots (<10,000 square foot lot size)

Results in approximately 9,000 properties with a mean assessed value of $330,000.

We know it is unrealistic but is a measure of the full scope of retreat.

Including Assessed Property Values

Scenarios 3 and 4 applies further criteria to those in Scenario 2.

- Restricts range of property value
- Defines as retreat projects with reasonable size and contiguity requirements.

These scenarios focus on the value of the property rather than the income of the household. Added advantage of being more practical, as lower-valued houses cost local governments less to buy out, making more buyouts possible.

Scenario 3 – The SFHA & Assessed value

Same geographic focus of Scenario 2 of the SFHA with assessed value less than $250,000 (with contiguity considerations)

- Approximately 2,040 properties, mean assessed value $159,000.

Scenario 4 – The SFHA & Improvement value

Same geographic focus of Scenario 2 of the SFHA with an improved value less than $60,000 (with contiguity considerations)

- Approximately 1,200 properties, mean assessed value $169,000, improvement value $64,000.

CIRCA Connecticut Institute for Resilience and Climate Adaptation

CESE Center for Environmental Sciences and Engineering

UCONN

Net Present Value stream of revenues (to 2050)

Scenarios ($ in millions)	Statistic	Total Tax Base Loss / Revenue stream loss	Gain via View	Gain via Waterfront	Gain via Public Open Space	Gain via Spillover	Aggregated Gain
Net Present Value of Revenue							
1. 2050 SLR	Value ($)	124.7	2.1	0.67	-	3.1	5.4
	Gain/Loss	42.6	0.049	0.015	-	0.073	**0.127**
2. 2050 flood zone	Value ($)	2,742	12.7	16.8	-	26	44.9
	Gain/Loss	997	0.012	0.017	-	0.026	0.045
3. 2050 flood zone - assessed $250k	Value ($)	316	2.3	5.2	3.3	7.5	12
	Gain/Loss	129	0.018	0.04	0.026		0.093
4. 2050 flood zone - improved $60k	Value ($)	181	2.3	4.4	2.1	3.4	9.8
	Gain/Loss	67	0.034	0.066	0.03	0.051	**0.146**

Note: Calculated to 2050 5% discount rate, denominator is the lost revenue stream number for percentages.

CIRCA Connecticut Institute for Resilience and Climate Adaptation

CESE Center for Environmental Sciences and Engineering

UCONN

Simulation summary

- These scenarios are removing many homes – a true retreat.
- The costs of buying the property is not included.
- The benefits that we can estimate are a fraction of the tax losses, but our benefit measures are far from comprehensive.
- Because Scenario 1 retreats more close to coast property it does convey more value from views for less purchases. (~12% recovery of revenue loss)
- Scenarios 3 and 4 buyout many homes but few with additional view amenities because the retreats are from non-coast front properties. (also ~14%)

CIRCA
Connecticut Institute for Resilience and Climate Adaptation

CESE
Center for Environmental Sciences and Engineering

UCONN

Future Simulations

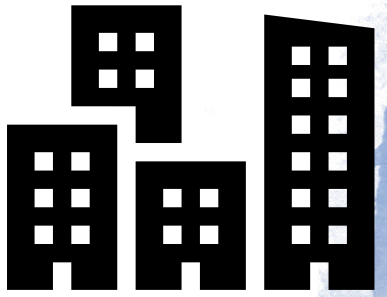
A more targeted simulation might attempt to optimize a particular objective, such as:

- Conservation objective: maximum acreage in contiguous parcels (or maximum area/edge ratio) or
- Municipal budget objective: maximum acreage bought out for given total change in projected real estate tax revenues.
- Infrastructure objective

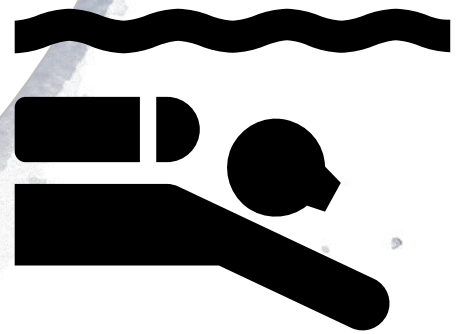
CIRCA Connecticut Institute for Resilience and Climate Adaptation

CESE Center for Environmental Sciences and Engineering

UCONN



Thank you!



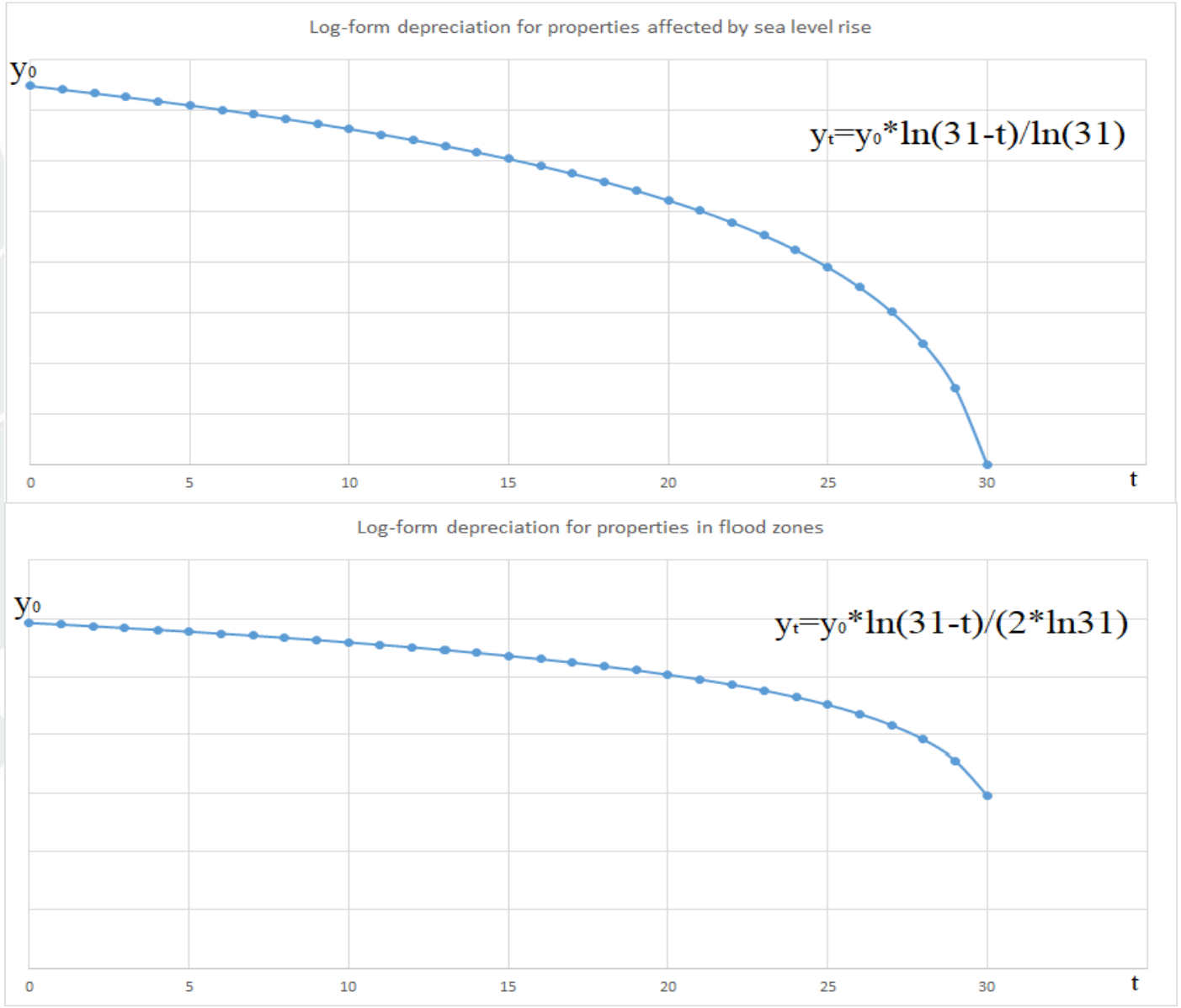
Heterogeneous effects

We also investigated the heterogenous effects across different coastal proxy bands, socio-economic conditions, and time periods.

- We find the average flood zone discount is highest in the coastal proxy band of .55-.85 miles,
- is higher for low socio-economic groups (both in income and relative residence value), and
- is higher in years after Hurricane Sandy and Biggert-waters act (though the discount drops when the Homeowner Affordability Act of 2014 kicks in).

Go back

Figure 1. Assumed depreciation in assessed value for properties to be removed



Go back

UCONN

Example removal structures

A ‘stranded asset’ problem

Go back

Small, low valued structures:

any renovation triggers elevation requirement

Often non-conforming lots –

can’t accommodate elevated building

UCONN

Go back

“ This **FEMA compliant** beachside location ….” Zillow.com

UCONN

Modeling, a matching approach

- The traditional hedonic model uses ordinary statistical regression analysis to correlate home prices with all attributes of a home
  - A significant lift, especially since specifying the mathematical functional form can create undesired bias in estimating ”value” for being in the flood plain
- Rather, we use a “matching approach” to attempt to eliminate or, at least, control for sources of bias that are difficult to identify with measurable variables
  - A quasi-experimental approach to mitigate or eliminate many potential sources of bias
- The matching approach narrows the sample to comparable homes:
  - Homes in one set are in the flood plain (treated)
  - Homes in the matched set are comparable in attributes, but not in the flood plain (control)
- All data involve actual sales of homes and their transactions price

Modeling, a matching approach

Using the matched sample we run the regression

School district and sales time effects

$$Y_i = \alpha + \tau \cdot SFHA + \beta C_i + \sum_k S_i^k + m + t + s + st + \varepsilon_i$$

τ – average flood zone price effect and the vector of parameters in β that collect other amenity impacts of interest for the retreat simulation.

How to aggregate changes?

For each house to be bought out, we calculate the discounted present value of lost taxes as:

1. Straight tax base loss, or
2. Predicted decline in assessed value over time due to inundation, i.e. decline, in lieu of retreat
   - Thus the discounted stream of revenues is lower for these parcels.

Future Work

- Work on the dynamic sorting model. Conduct the formal policy simulations, which could apply to many potential policies. Also, the retreating simulation could be improved by incorporating aggregated demand change.
- Collect more elevation data and perform a more rigorous analysis on elevation/modification.
- Collect and process permit data to build a measure of investment response to policy levers.

CIRCA
Connecticut Institute for Resilience and Climate Adaptation

CESE
Center for Environmental Sciences and Engineering

UCONN