The time has come the walrus said to speak of coastal things ...

Hadi Dowlatabadi: UBC
University Fellow, RFF
and CMU

hadi.d@ubc.ca

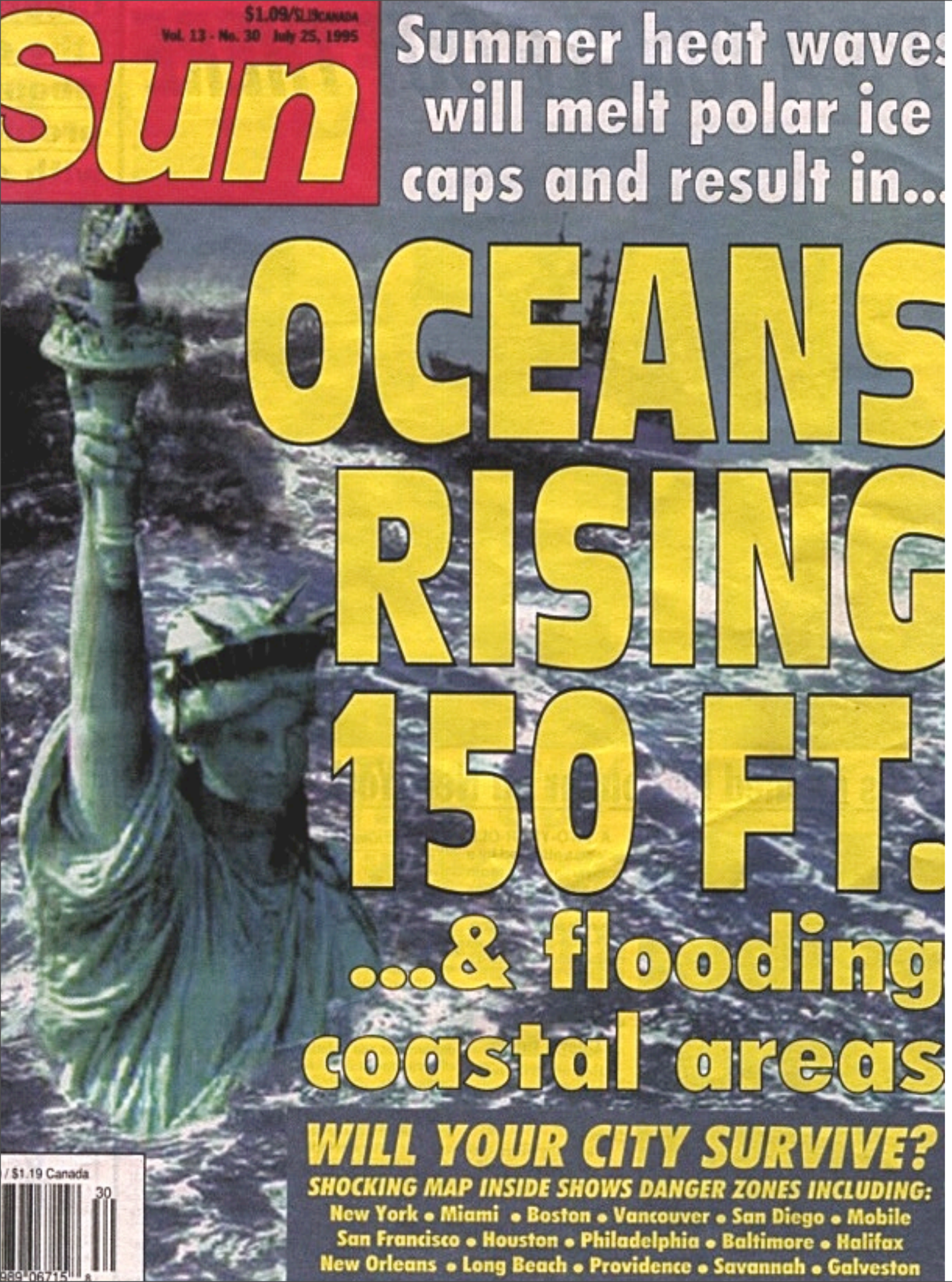
October 27th 2010
Pacific Institute for Climate Solutions

Overview

- Relative sea level rise
- Drivers of coastal zone damages
- Insurance
- Solutions

- Antigua and Barbuda
- Bahamas
- Barbados
- Belize
- Cape Verde
- Comoros
- Cook Islands
- Cuba
- Dominica
- Dominican Republic
- Fiji
- Federated States of Micronesia
- Grenada
- Guinea-Bissau
- Guyana
- Haiti
- Jamaica
- Kiribati
- Maldives
- Marshall Islands
- Mauritius
- Nauru
- Niue
- Palau
- Papua New Guinea
- Samoa
- Singapore
- Seychelles
- Sao Tome and Principe
- Solomon Islands
- St. Kitts and Nevis
- St. Lucia
- St. Vincent and the Grenadines
- Suriname
- Timor-Leste
- Tonga
- Trinidad and Tobago
- Tuvalu
- Vanuatu


(C) Shuuichi Endou



It was a hot July. There were no celebrity scandals. So the public were treated to science in the Sun.

H. Dowlatabadi October 27th 2010

First came new *science*:

Not yet!

First came new *science*:
Not yet!

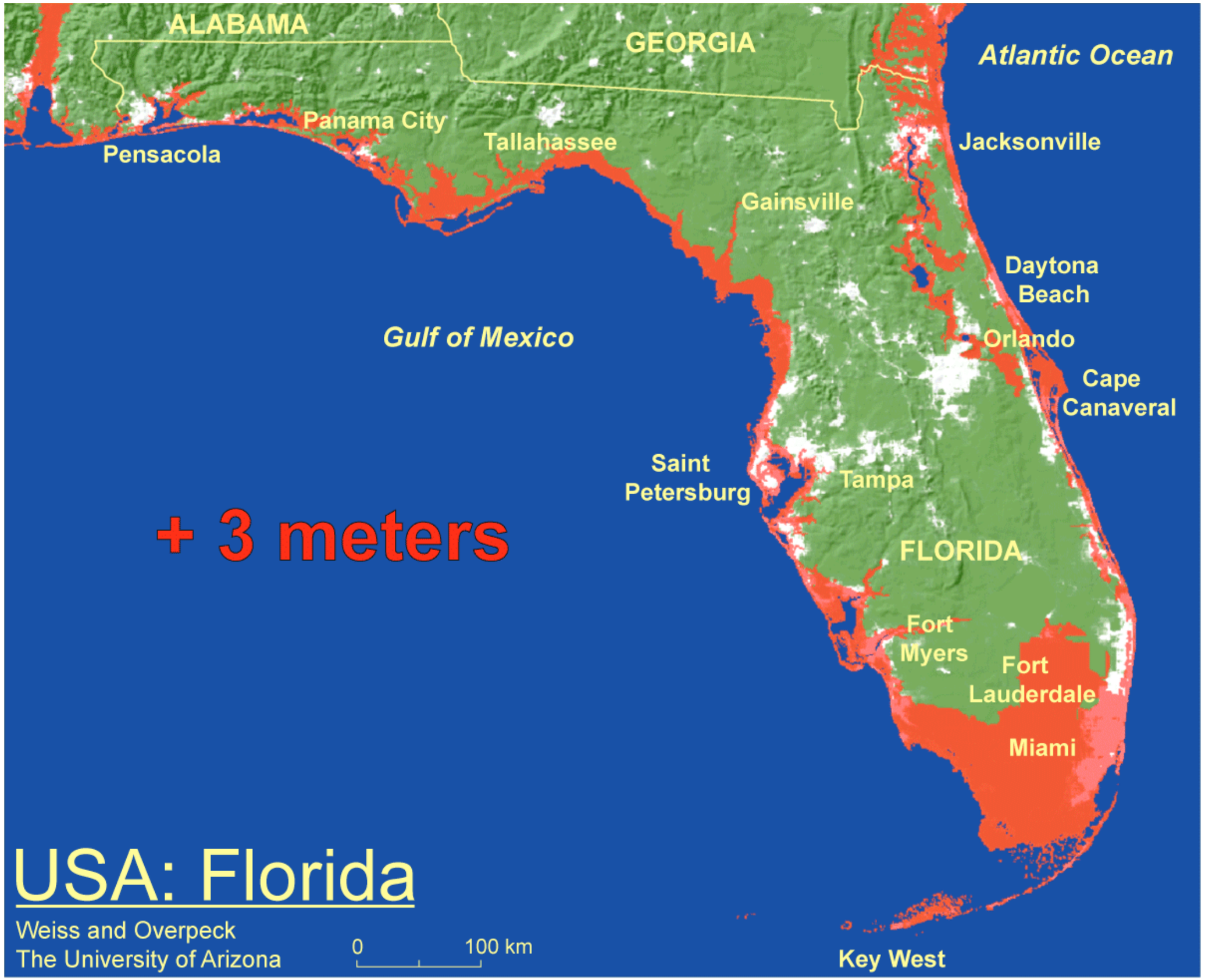
Then *engineers* made their move: Keep the seas at bay!

Then *economists* entered the fray: Just develop higher up the hill!

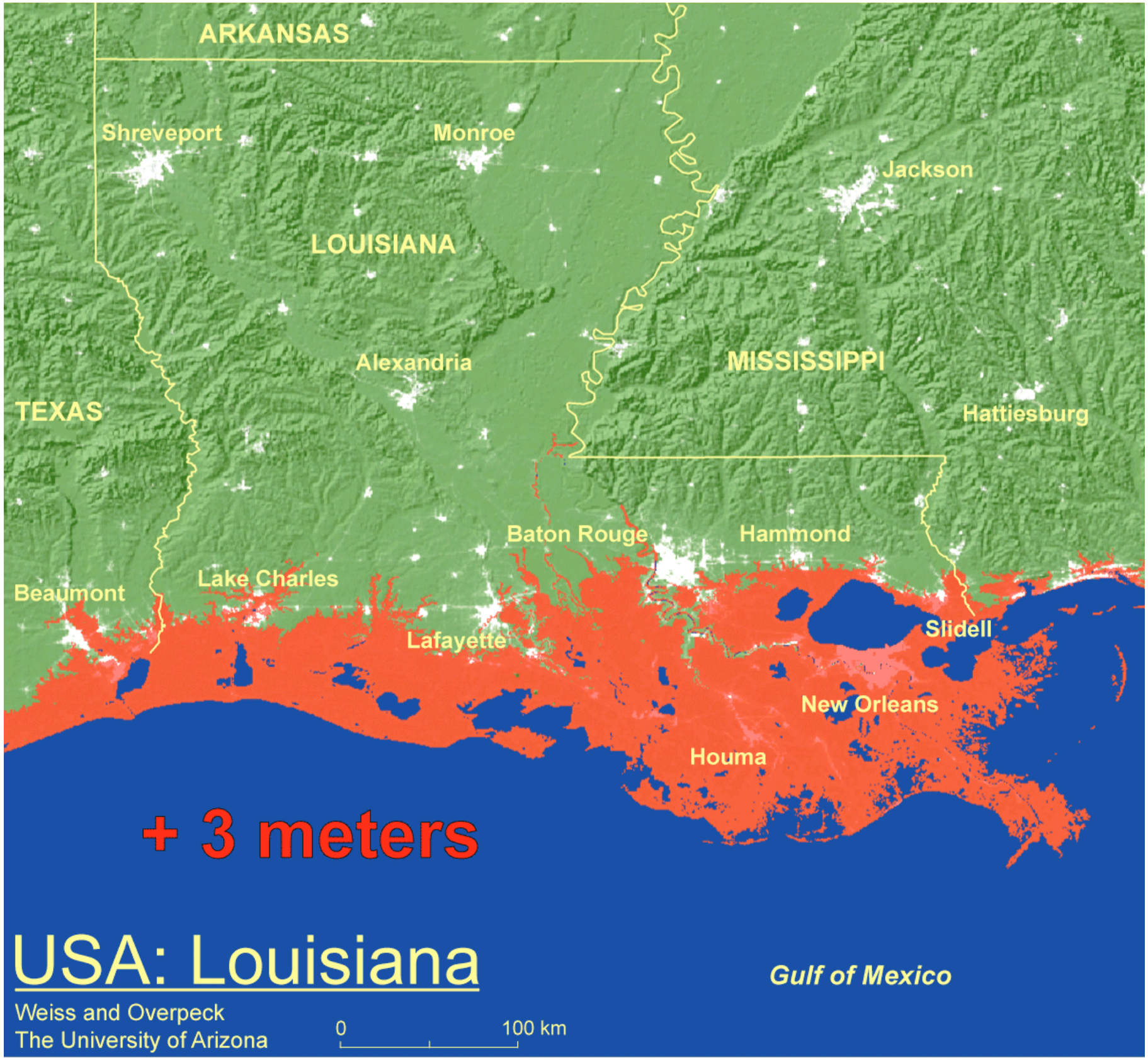
Then *economists* entered the fray: Just develop higher up the hill!

A review:
SLR & US economic impacts

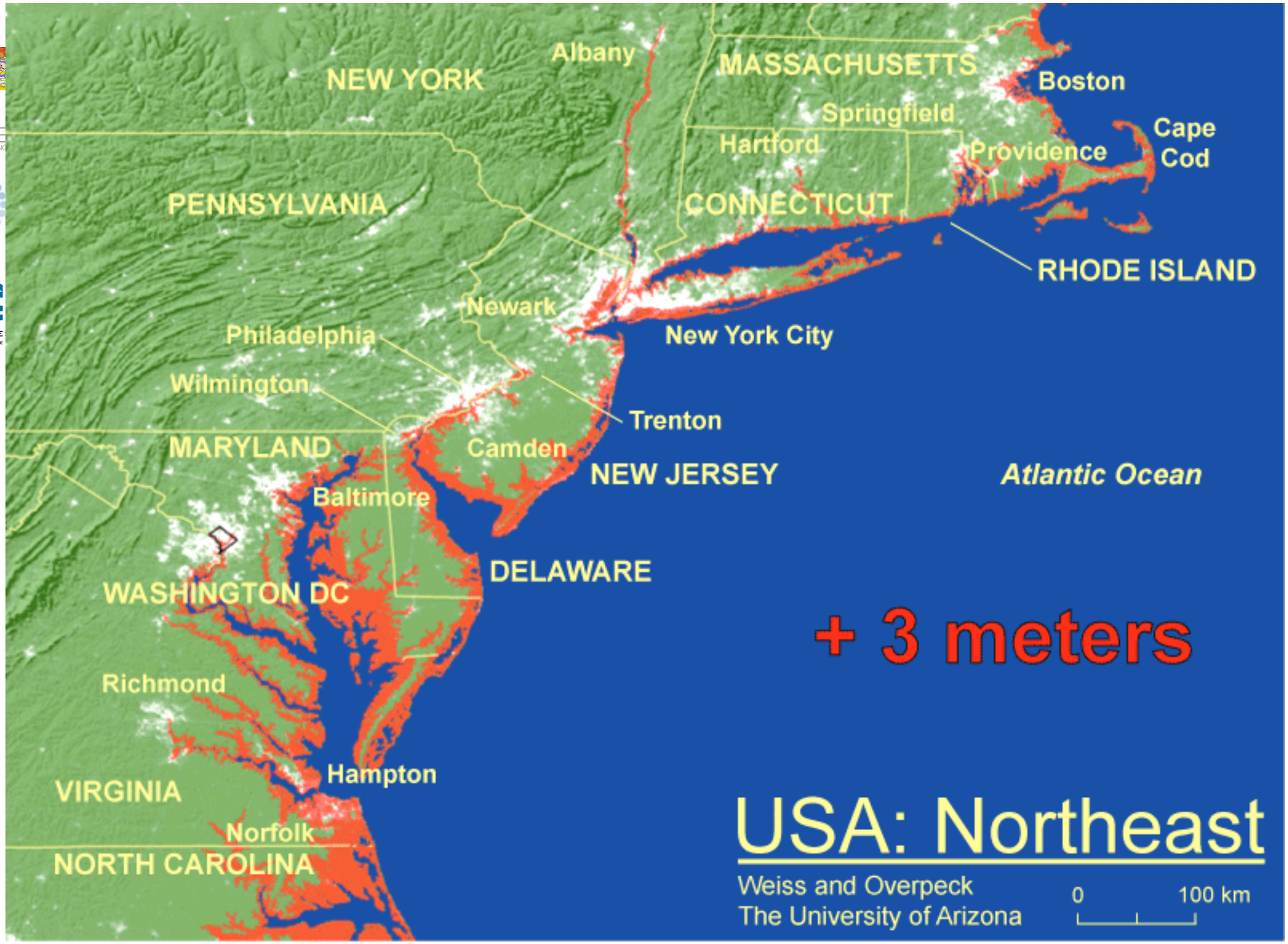
Date of study	Seal level rise (cm)	Impact in Millions of 1990 $	Intervention
1980	200	300	none
1990	50-100	138-321	Sea walls
1995	50-100	20-45	Markets



www.geo.arizona.edu/.../ slr_usafl_3meter_lg.htm



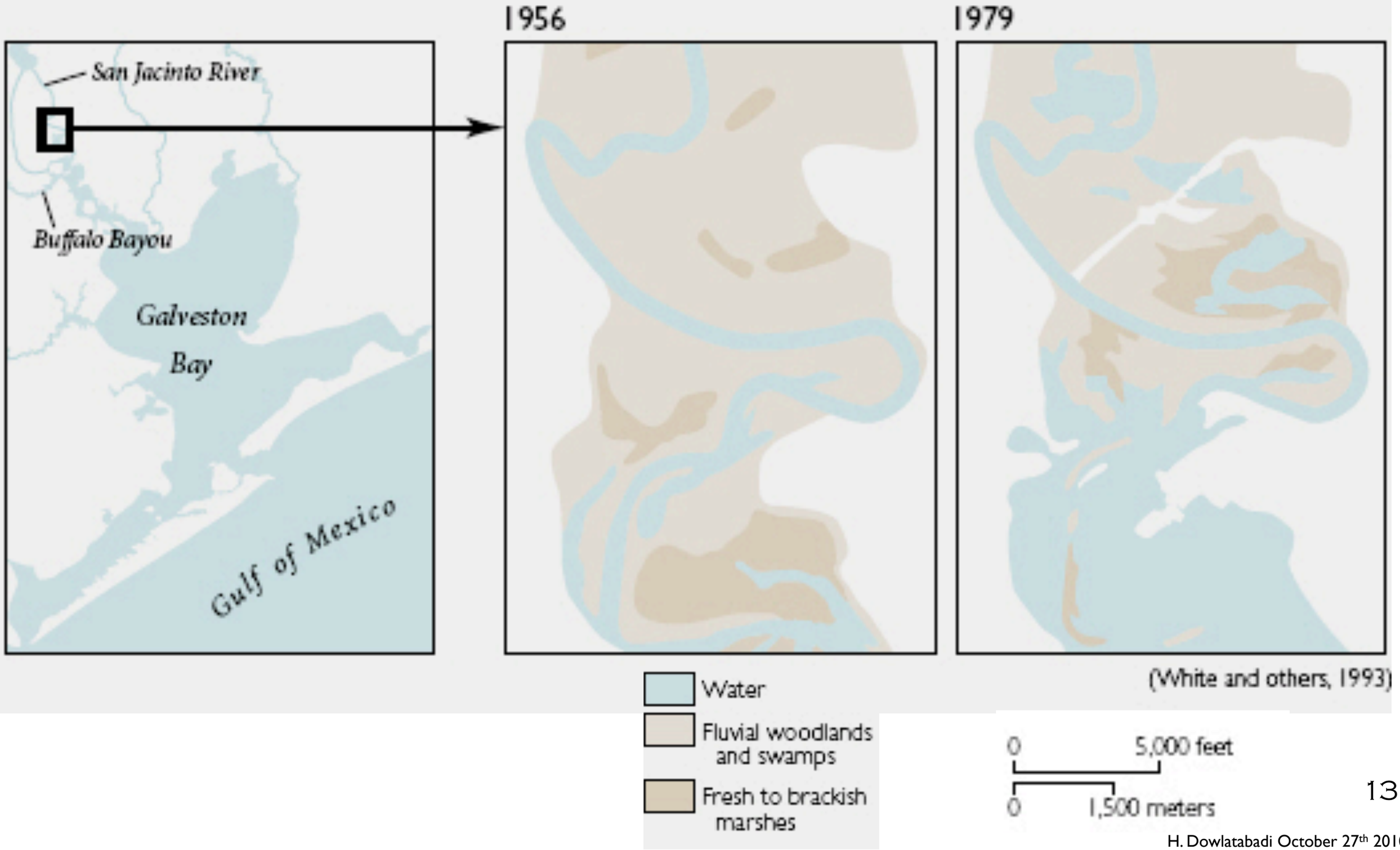
www.geo.arizona.edu/.../ slr_usafl_3meter_lg.htm



www.geo.arizona.edu/.../ slr_usafl_3meter_lg.htm

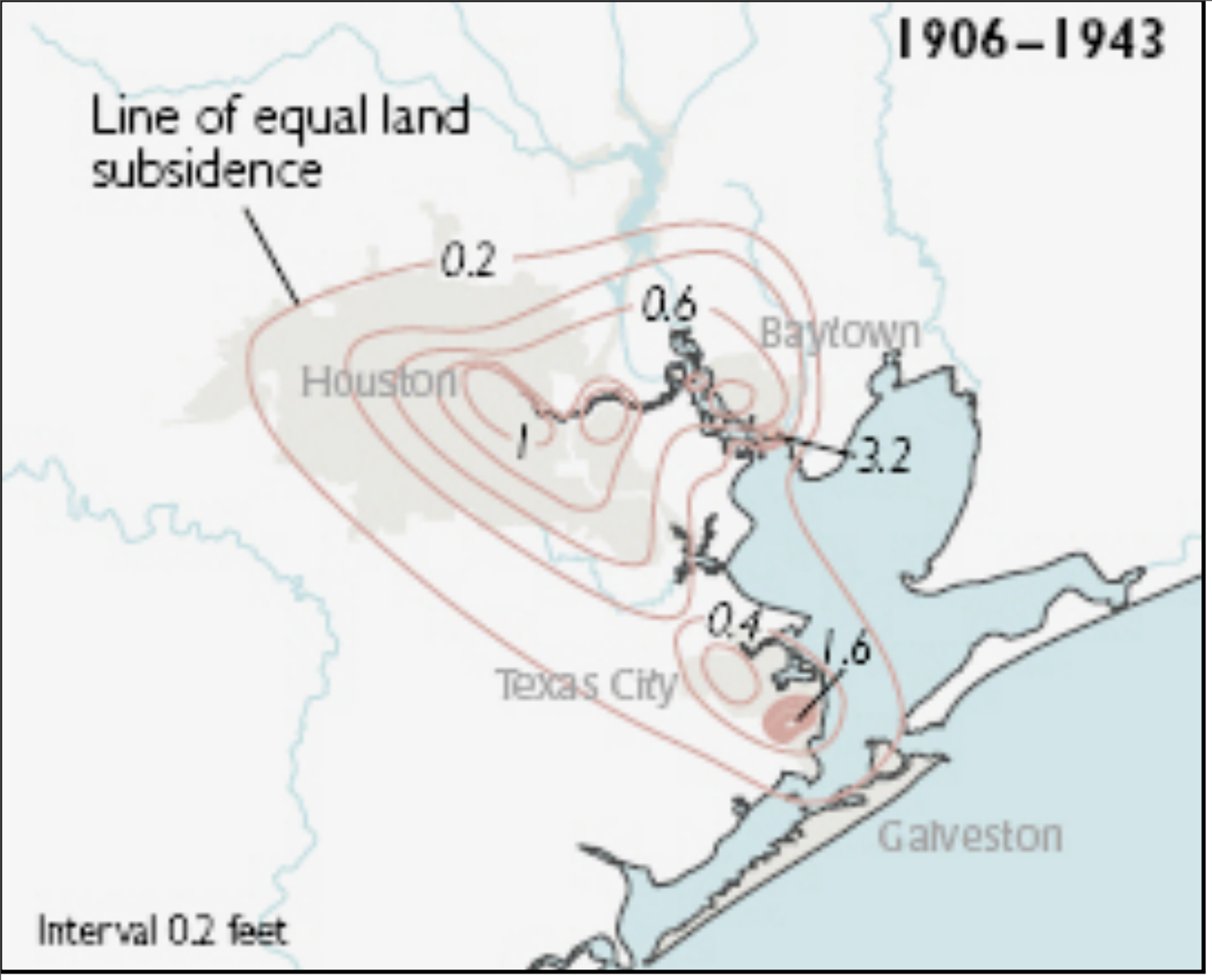
source: flmapr.org

Galveston Bay

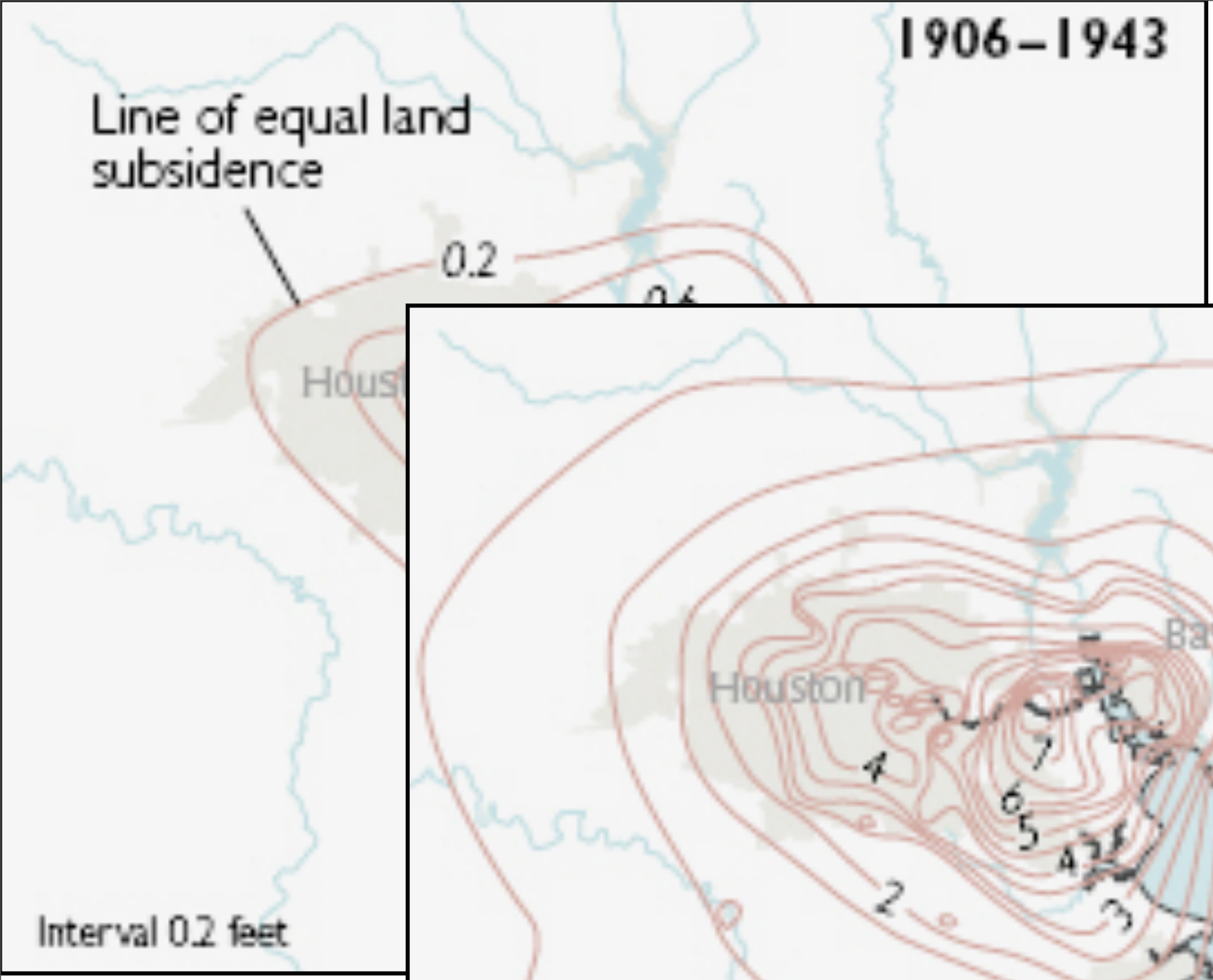


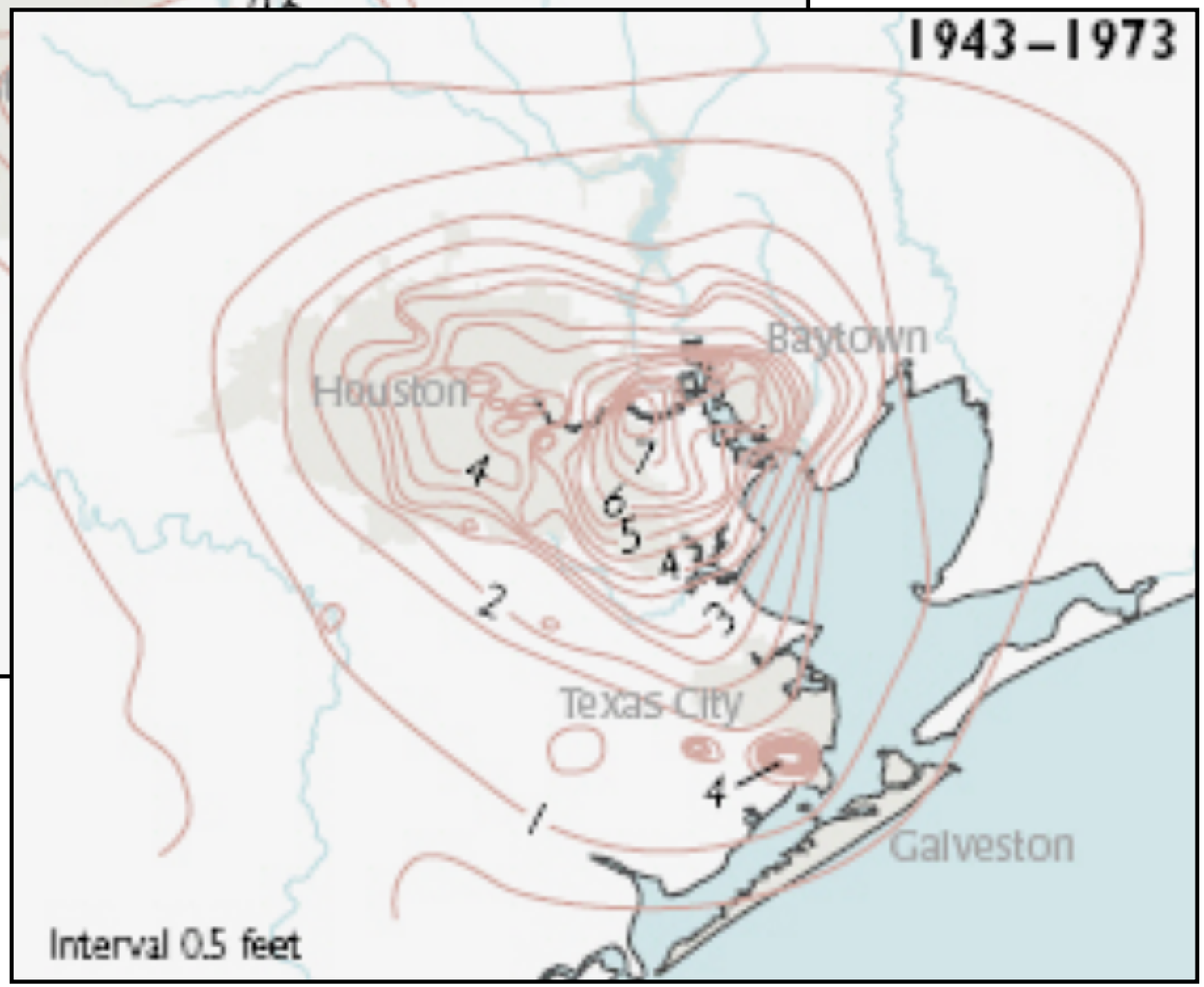
(White and others, 1993)

Houston

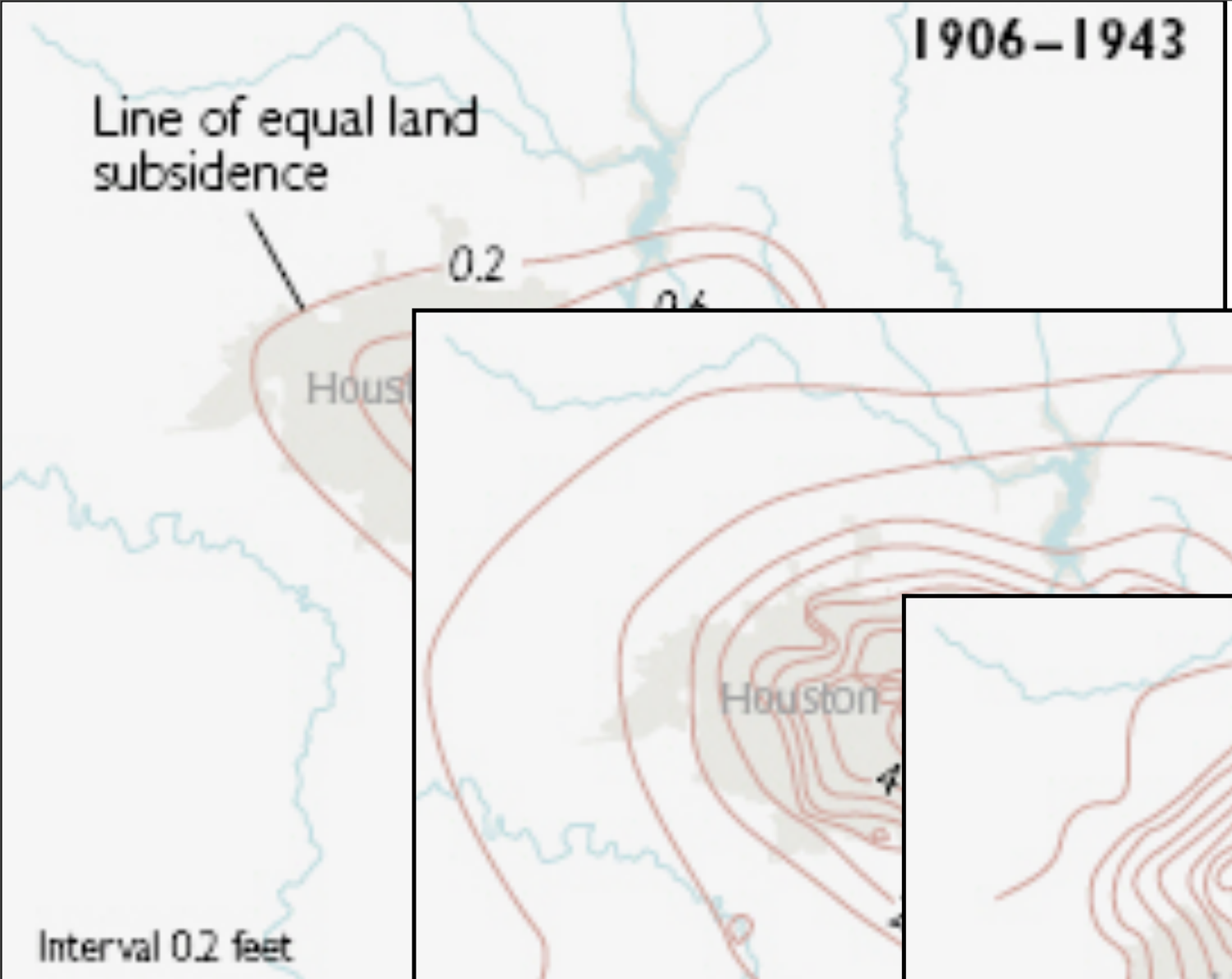

1906–1943
Line of equal land subsidence
0.2
0.6
1
3.2
0.4
1.6
Houston
Baytown
Texas City
Galveston
Interval 0.2 feet

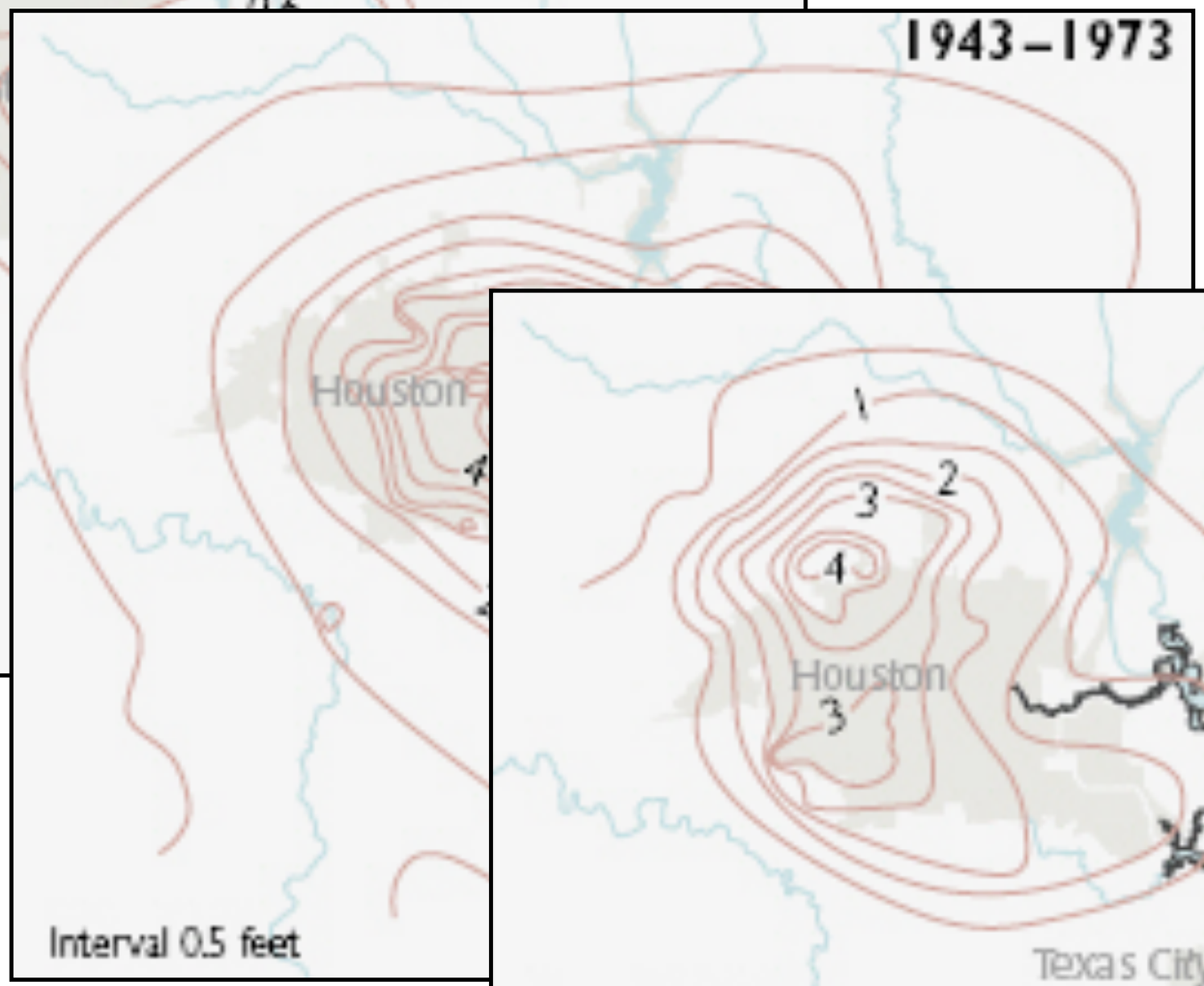
Houston


1906–1943
Line of equal land subsidence
0.2
Houst
Interval 0.2 feet


1943–1973
Houston
Baytown
Texas City
Galveston
1
2
3
4
5
6
7
Interval 0.5 feet

Houston


1906–1943
Line of equal land subsidence
0.2
Houst
Interval 0.2 feet


1943–1973
Houston
Interval 0.5 feet


1973–1995
1
2
3
4
Houston
3
Baytown
Texas City
Galveston
Interval 0.5 feet
0
30 Miles
0
30 Kilometers

source: mvwildblue.blogspot.com

source: Activerain.com

Why include storms?

- Relative sea level is the principle mode of inundation

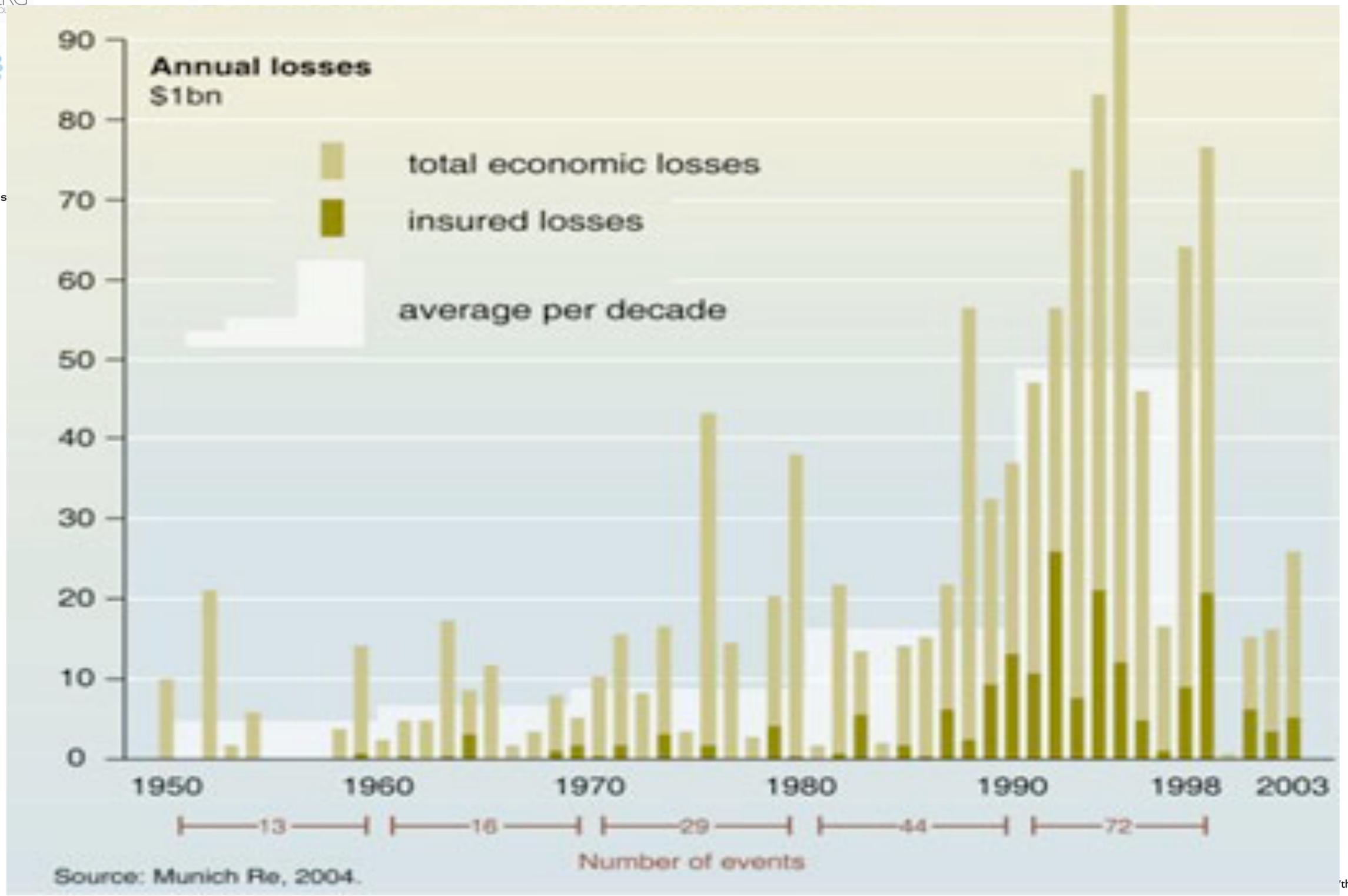
BUT

- Storms play the lead role in destroying property.

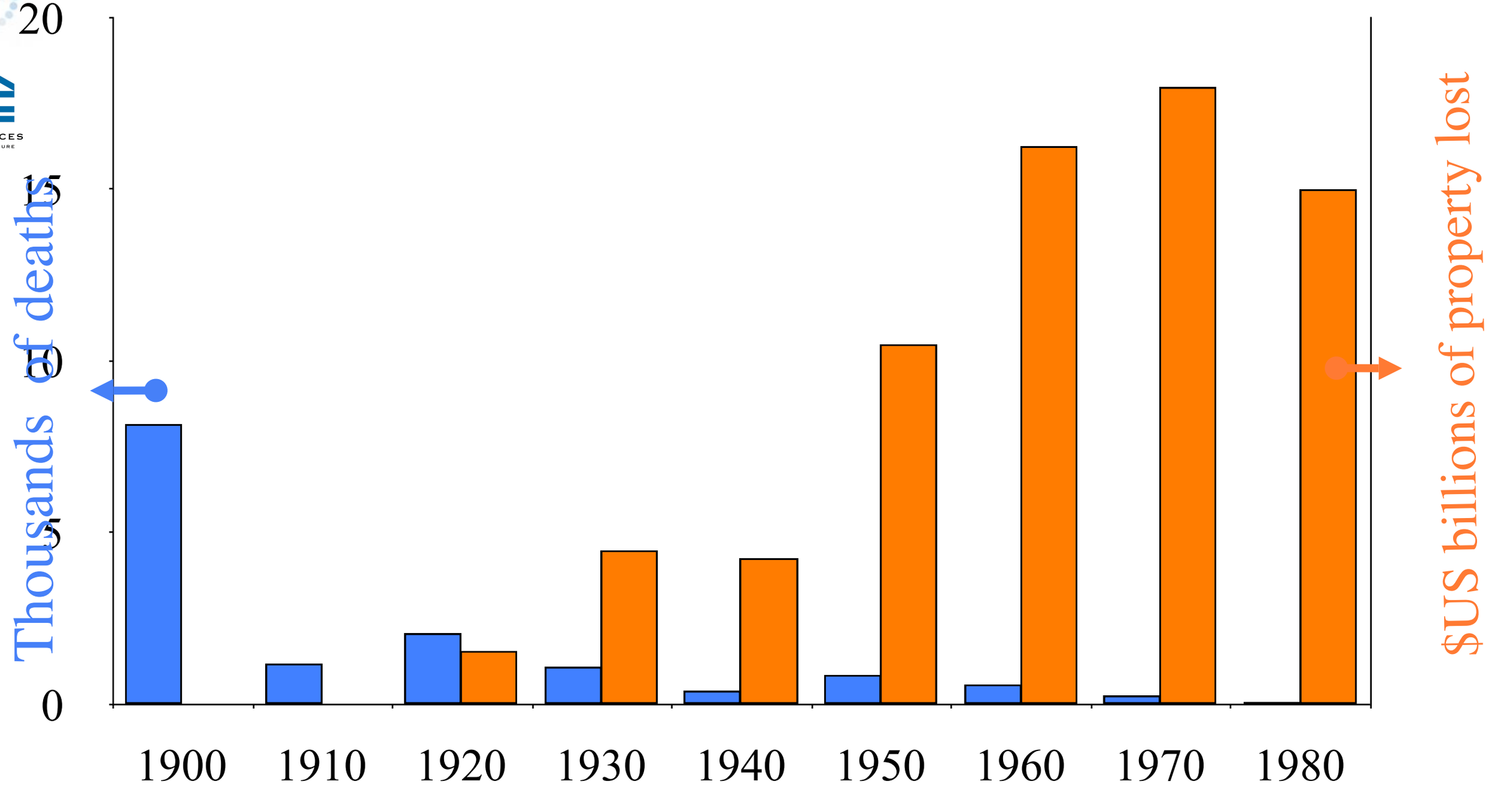
TOGETHER

- Sea level rise enhances storm potency.

IN$URED LOSSES: (1950-2003)



RISING LOSSES, FALLING DEATHS:
Hurricanes on Continental USA



Before *inundation*

- A shorefront resident who is worried, can put it up for sale
  - If the buyer is not worried, she will get a high price
  - if the buyer is worried but not as much, she will get a discounted price.

After a *storm*

- The owner of a home that has been damaged:
  - may see this as an ill omen and sell what remains of their home and move away.
  - may use the opportunity to remodel their home.
- Insurance can pay for this ...
- ...

Assessing coastal impacts: adapting to sea level rise & storms

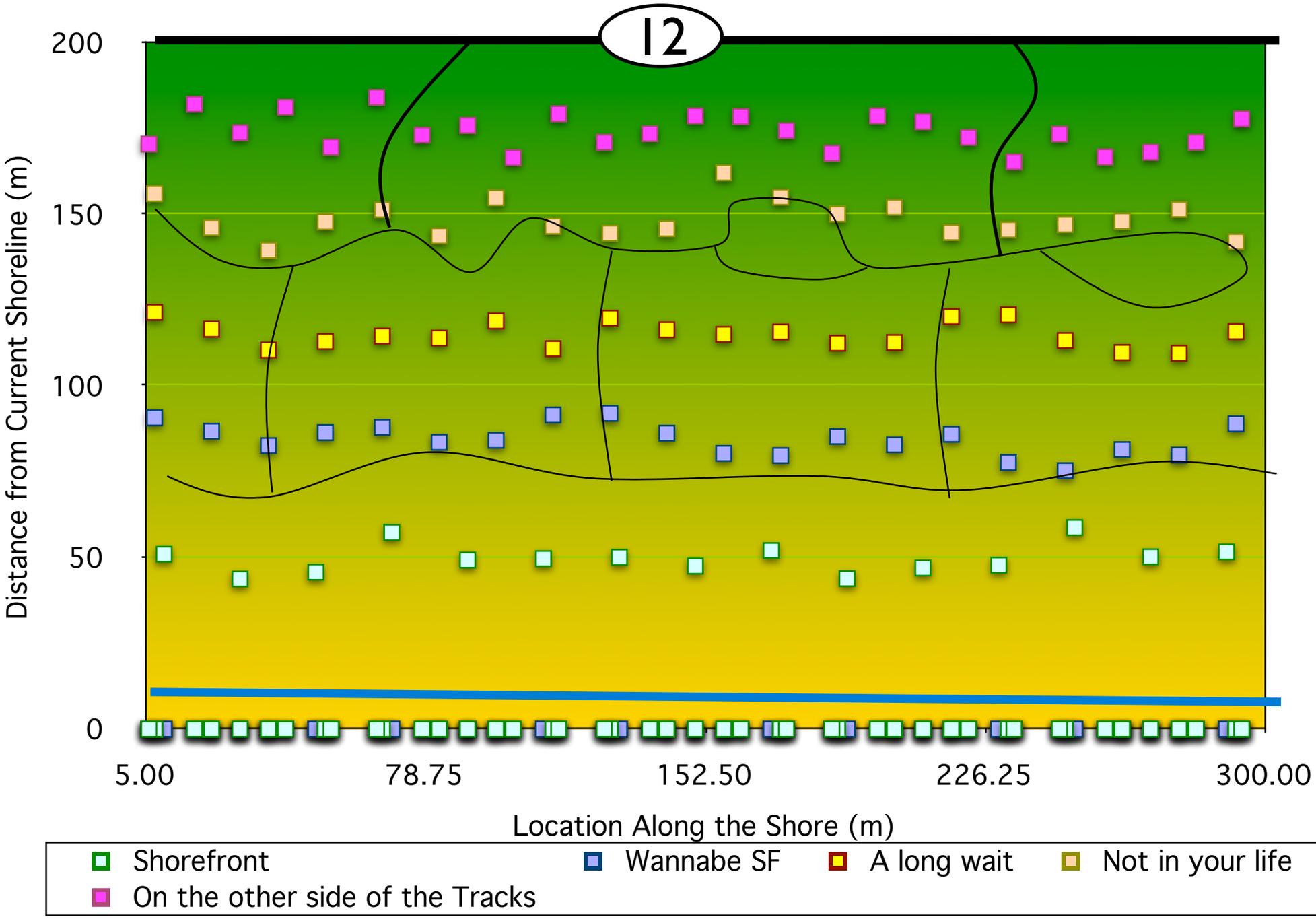
Such assessments require:

- A model of shoreline dynamics with material movement, land movement, SLR, and dunes.
- A model of storm frequency and intensity.
- A model of how individuals decide to:
  - invest in a land parcel,
  - rebuild damaged dwellings,
  - or make the decision to sell and move on...

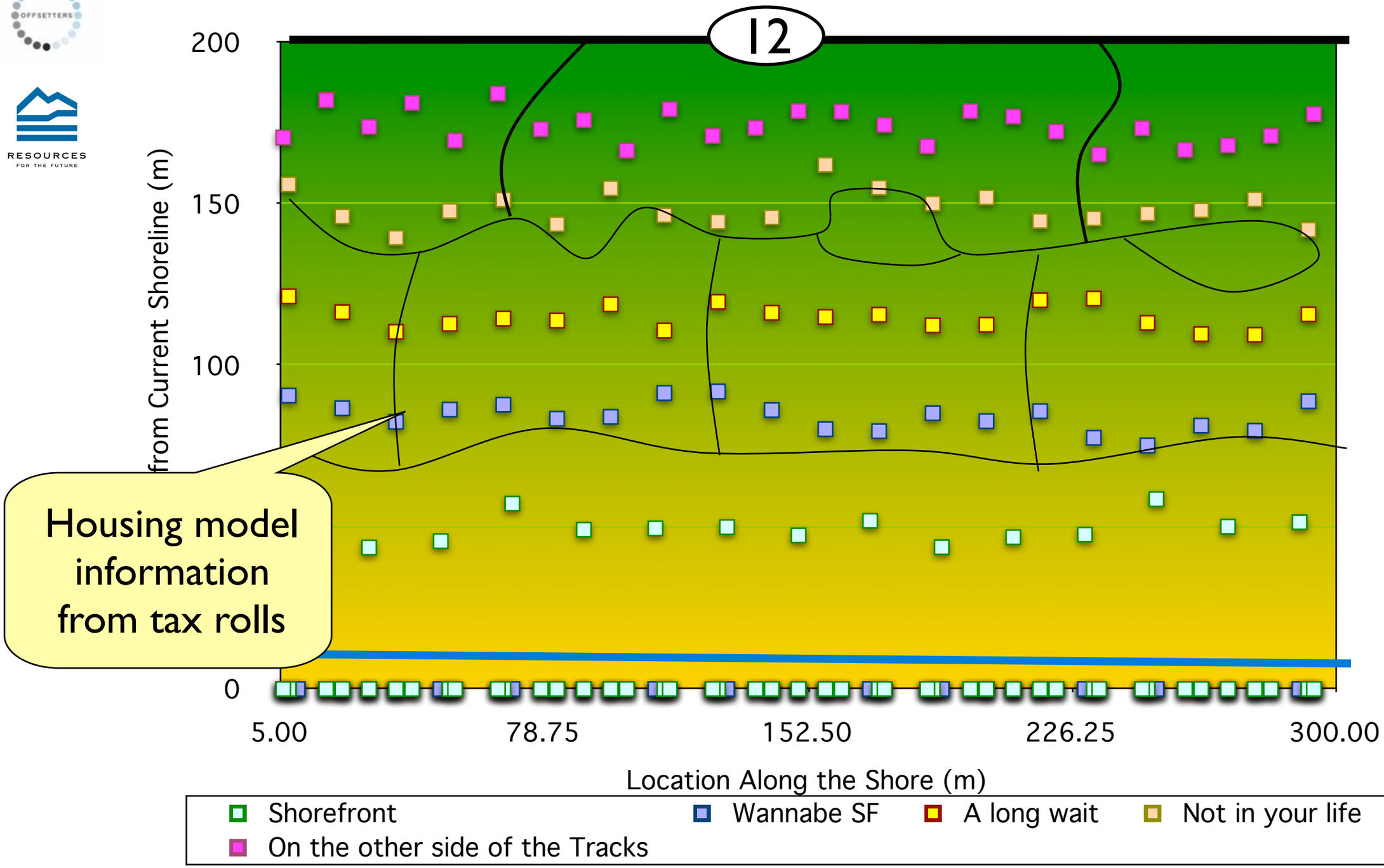
The real Duck N. Carolina

H. Dowlatabadi October 27th 2010

Our model of Duck N.C.

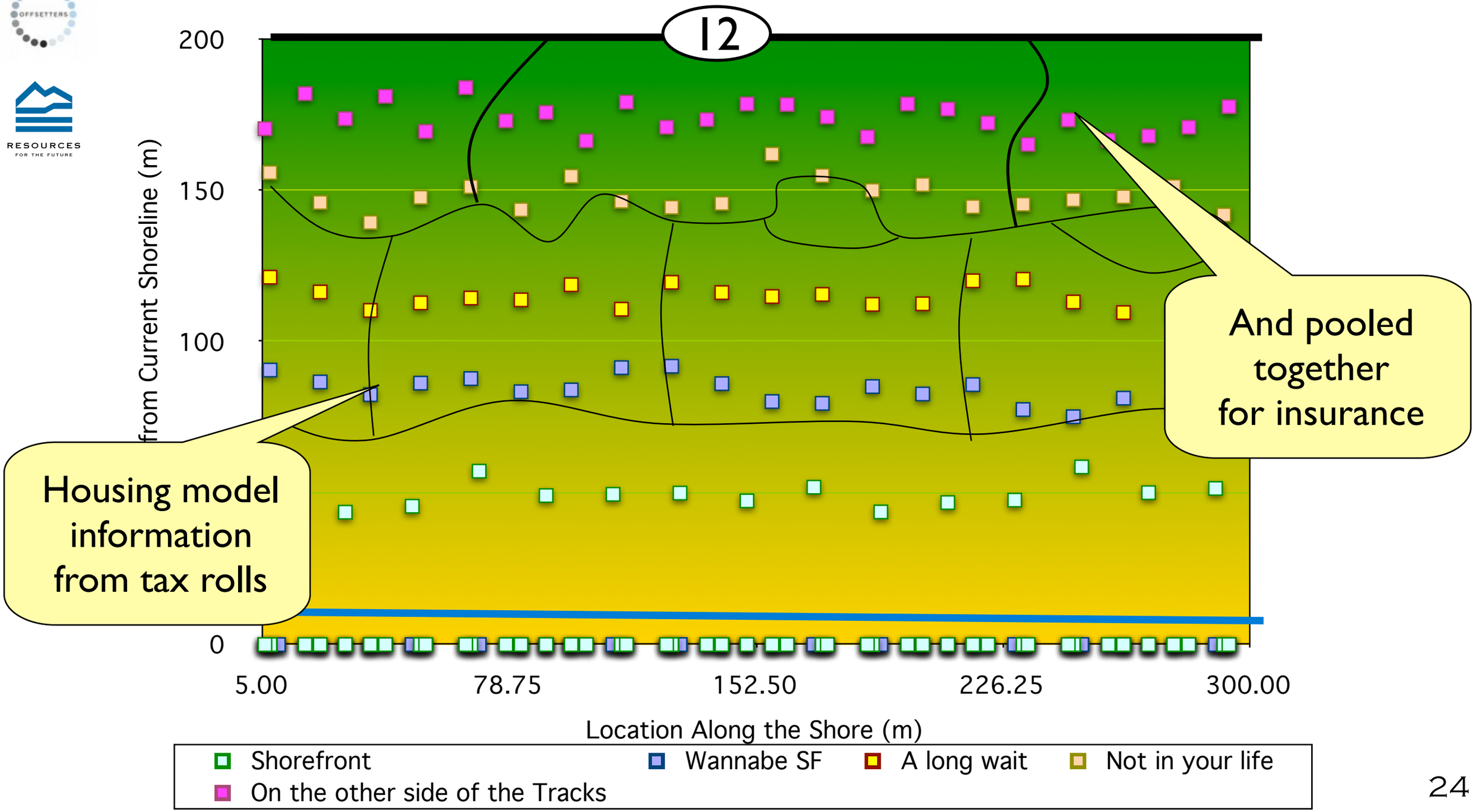


Our model of Duck N.C.



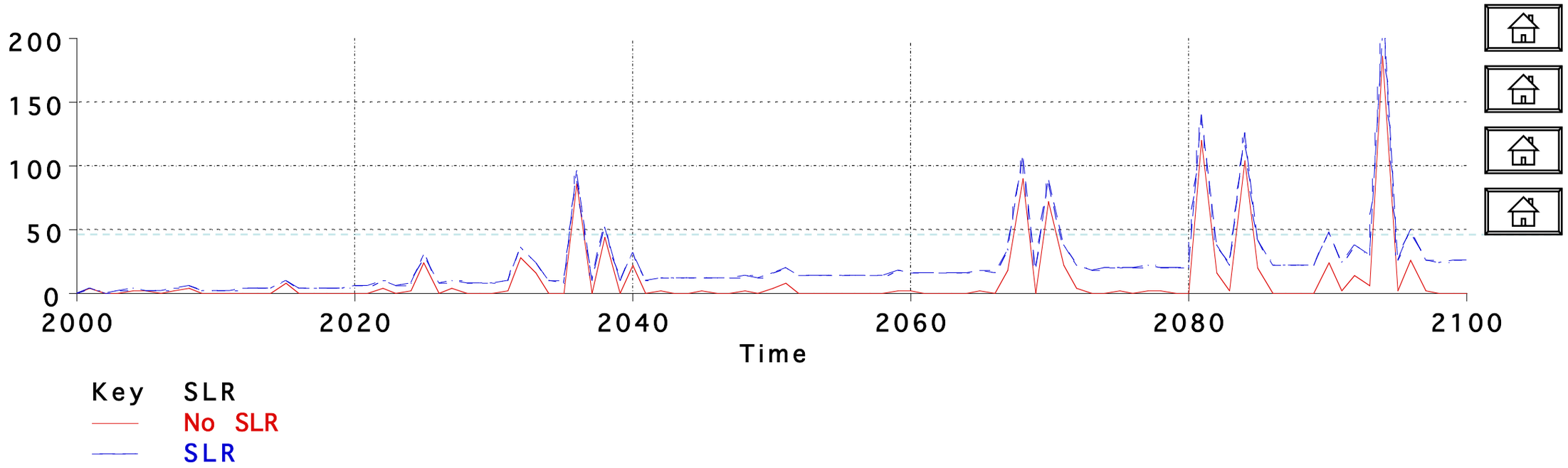
Housing model information from tax rolls

Our model of Duck N.C.



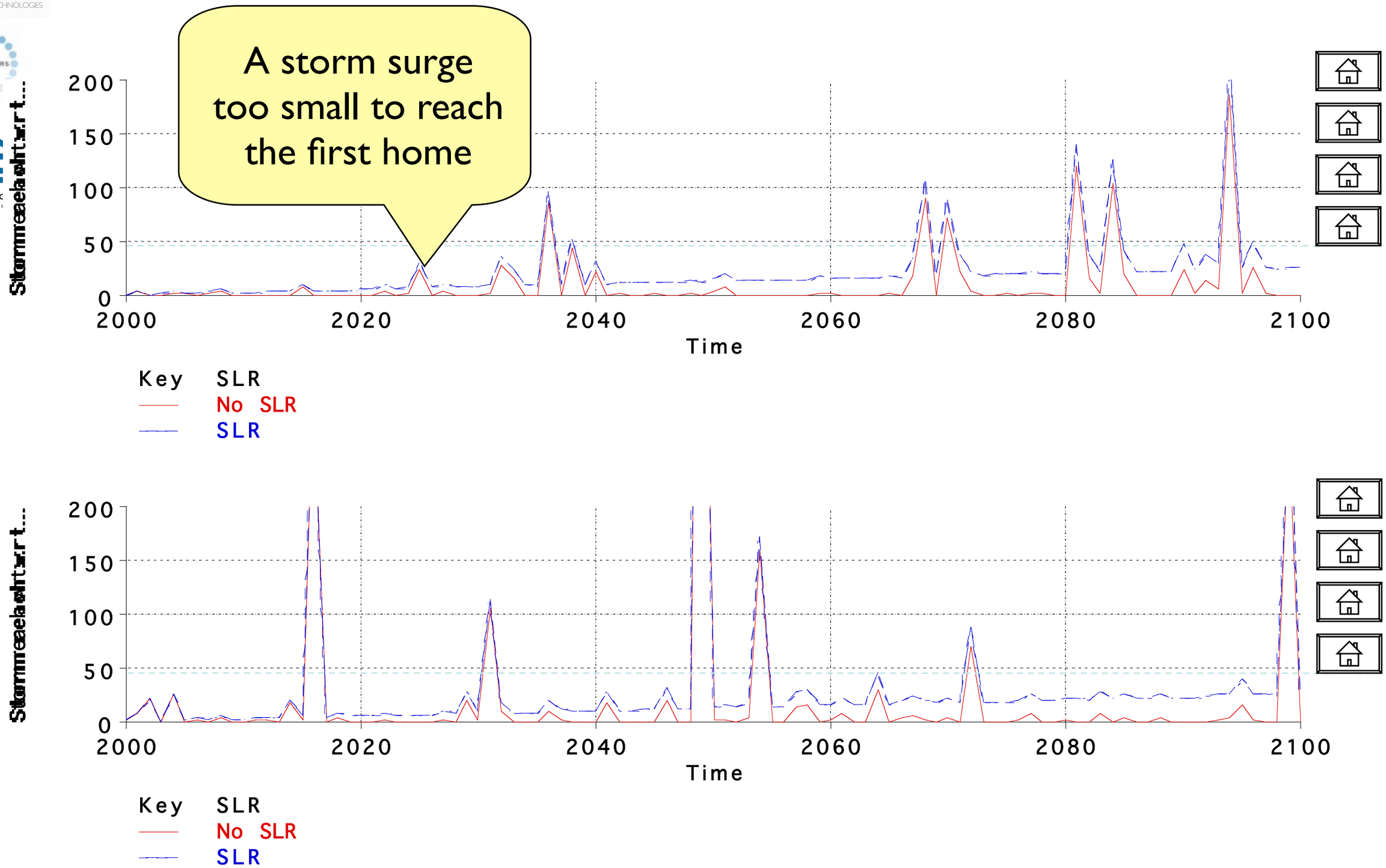
... storms & sea level are simulated

... storms & sea level are simulated



... storms & sea level are simulated

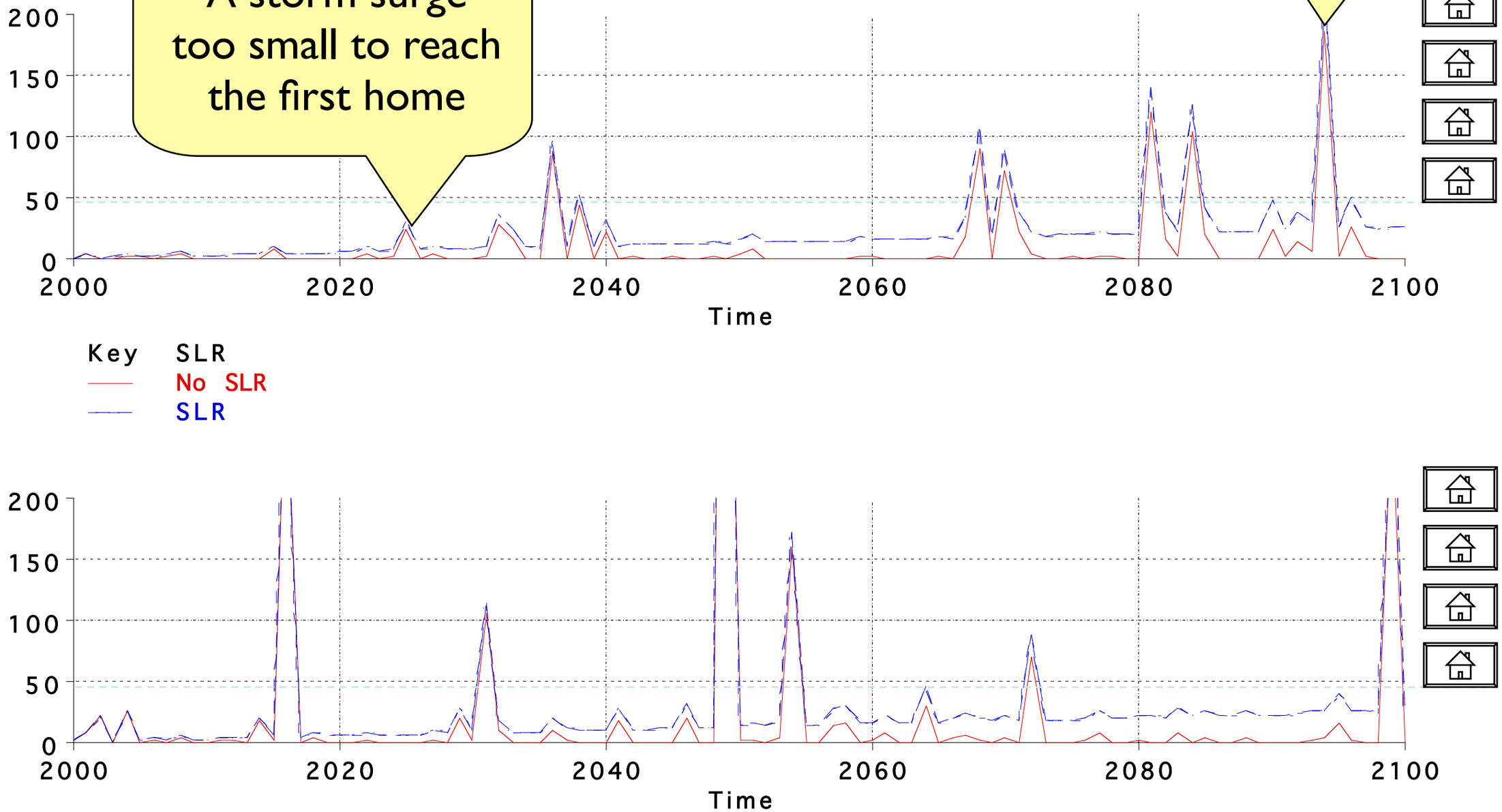
... storms & sea level are simulated



... storms & sea level are

A storm surge
too small to reach
the first home

A storm surge
that damages
4 rows of homes

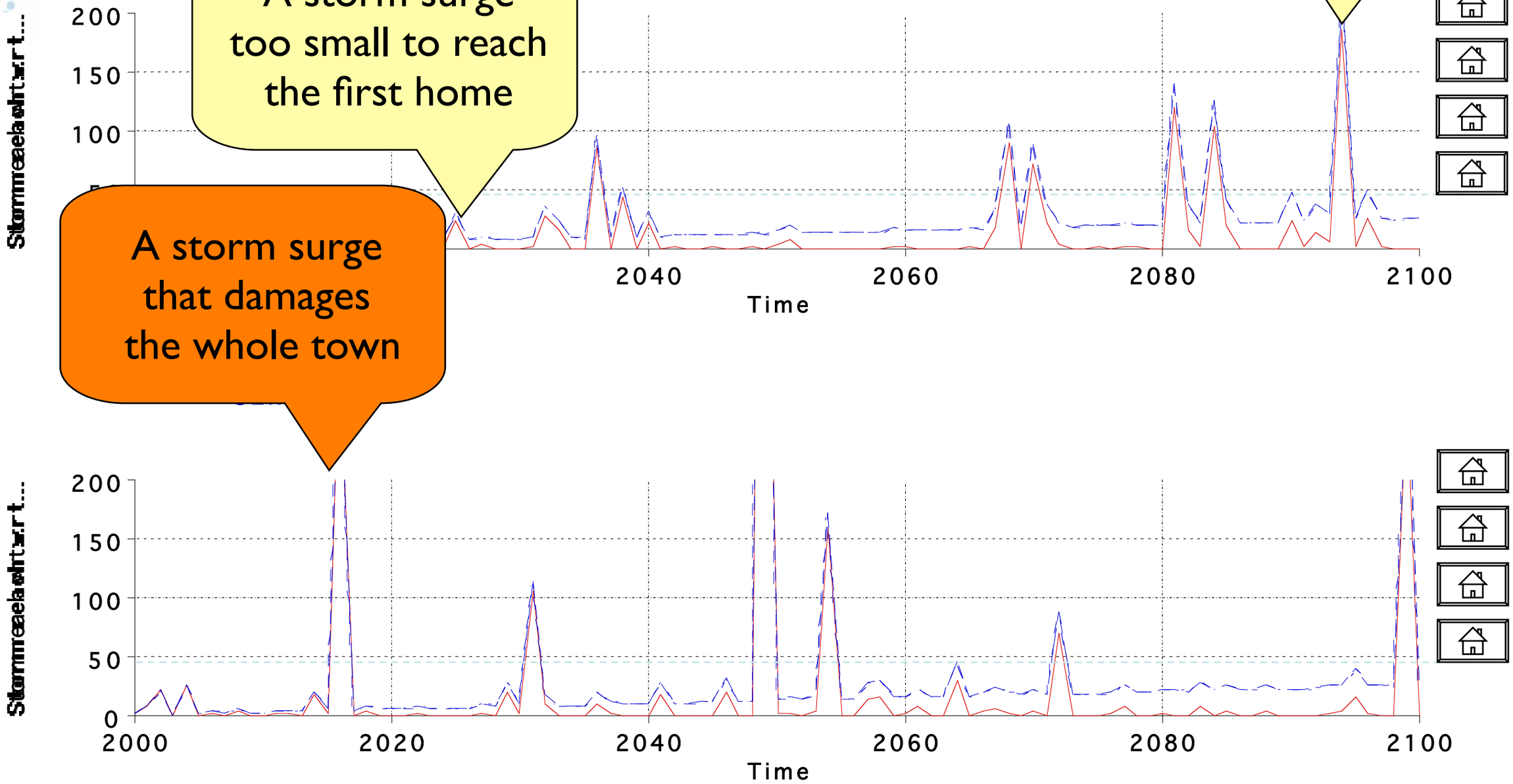


... storms & sea level are

A storm surge too small to reach the first home

A storm surge that damages 4 rows of homes

A storm surge that damages the whole town



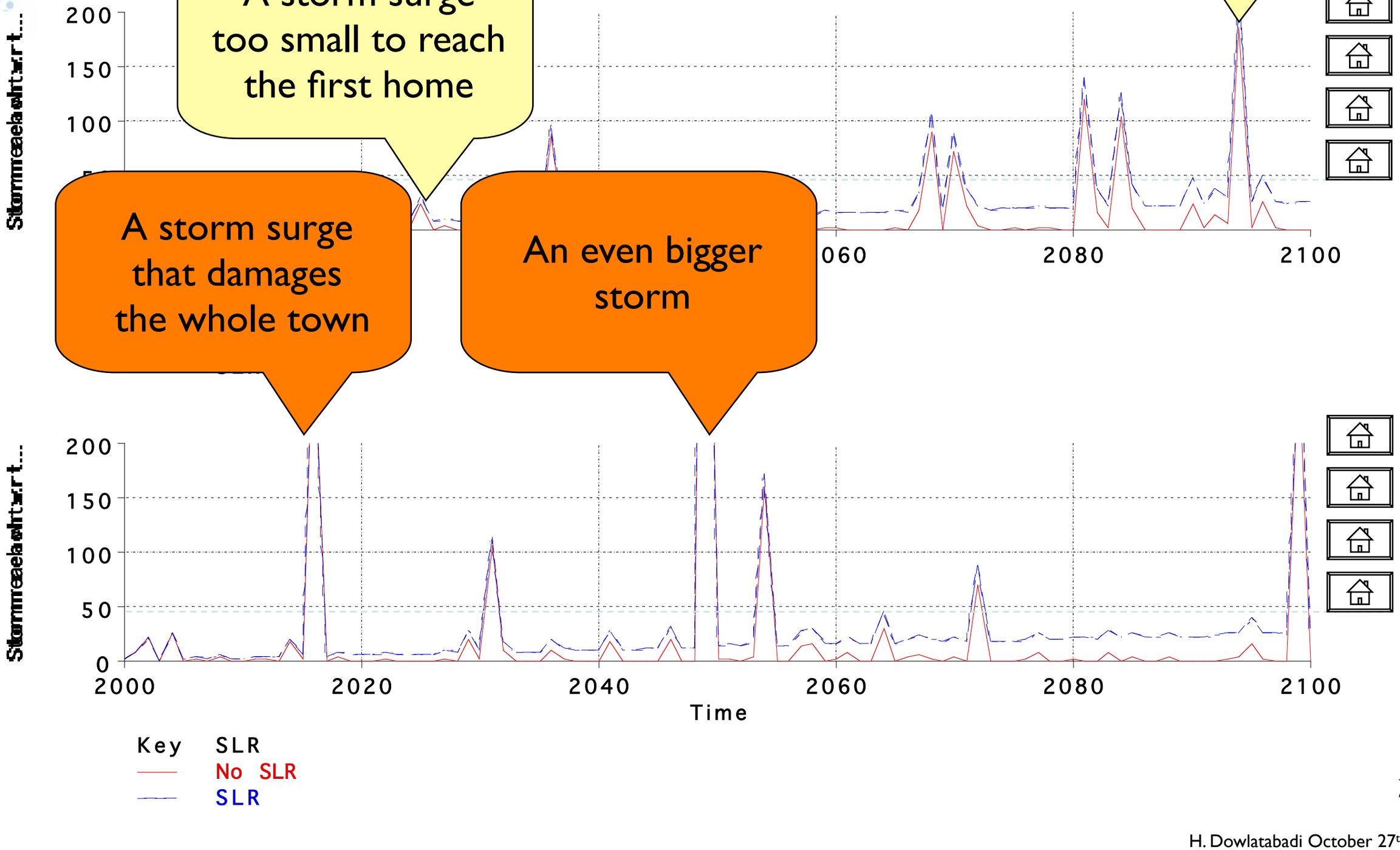
... storms & sea level are

A storm surge too small to reach the first home

A storm surge that damages 4 rows of homes

A storm surge that damages the whole town

An even bigger storm



Modeling impacts from sea level rise

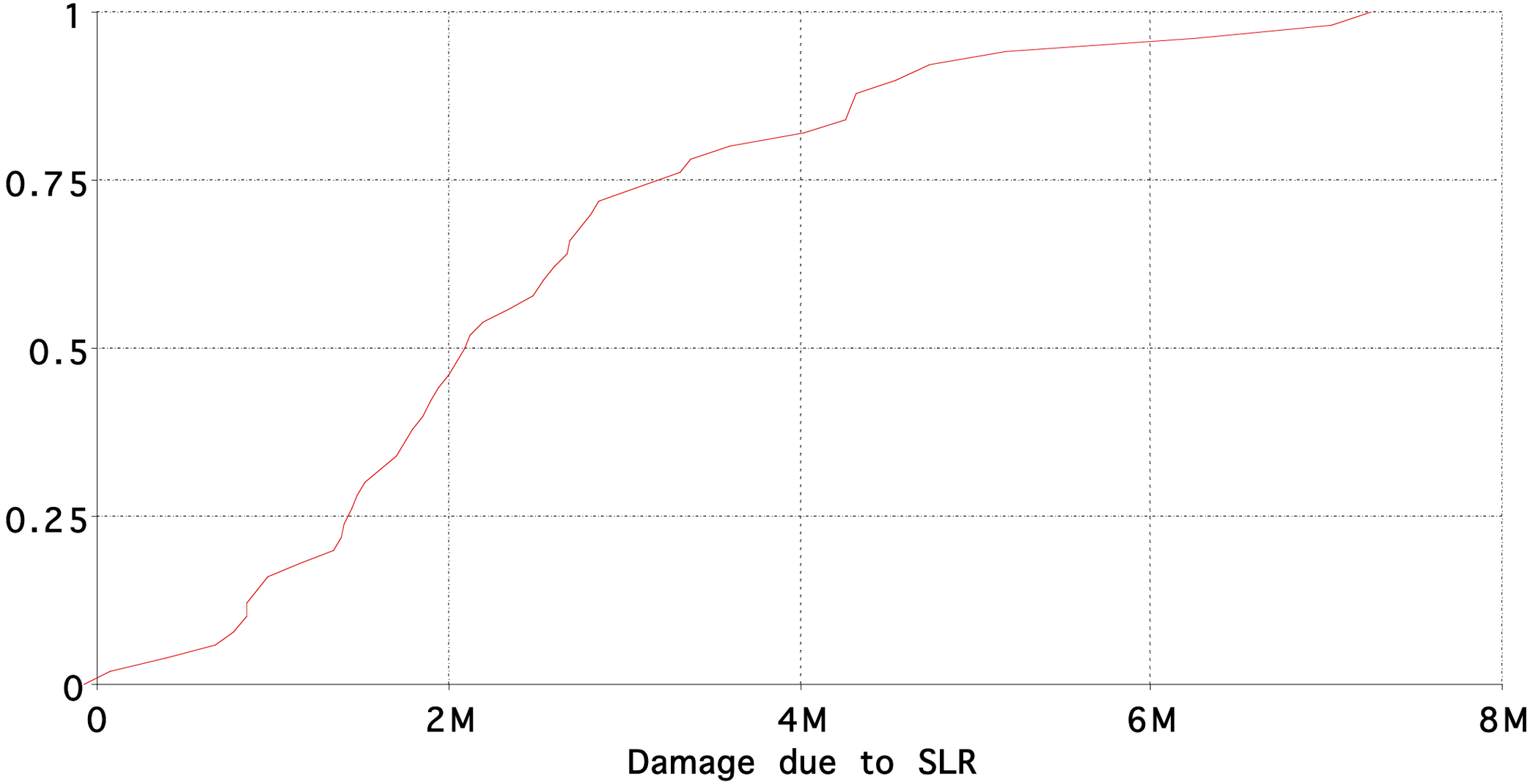
Modeling impacts from sea level rise

- We simulate how each homeowner behaves given a track of history, calculating the difference between outcomes with and without sea level rise.

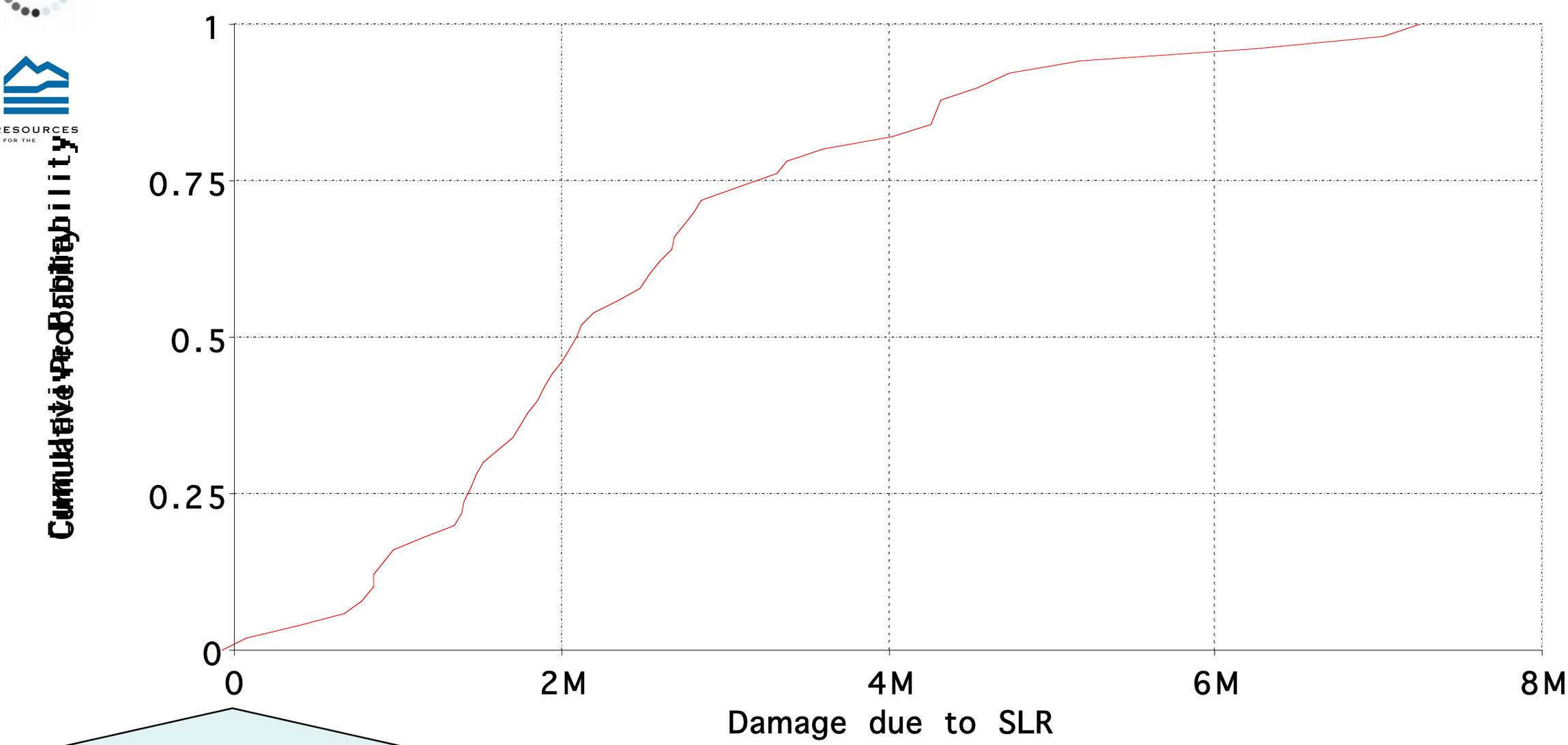
Modeling impacts from sea level rise

- We simulate how each homeowner behaves given a track of history, calculating the difference between outcomes with and without sea level rise.
- the model uses:
  - insurance claims,
  - homeowner risk aversion,
  - developer motivations, and
  - real estate market.
- Then we run the model over and again to get a sense of different patterns of storms and responses over time.

... and we calculate damages

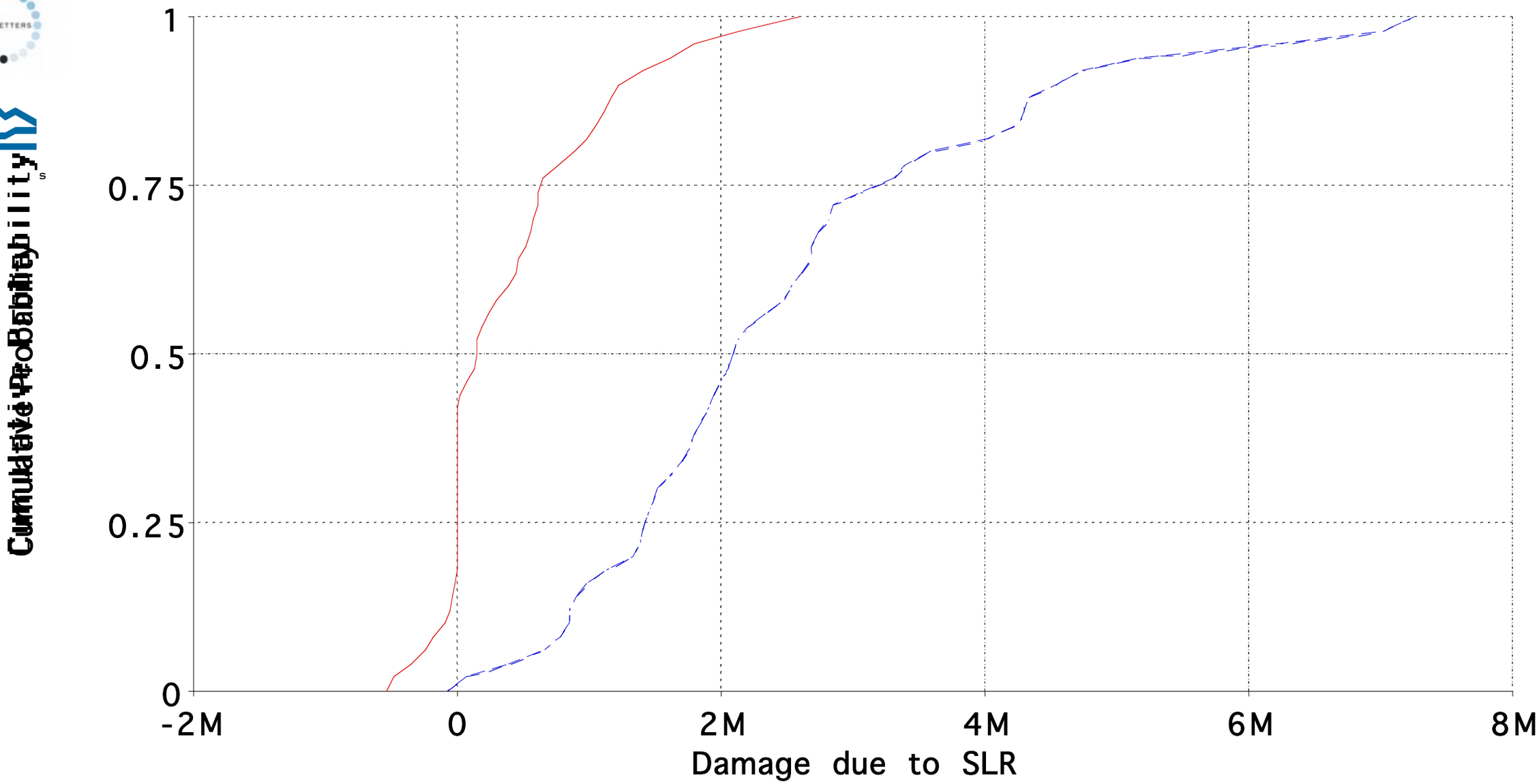


... and we calculate damages

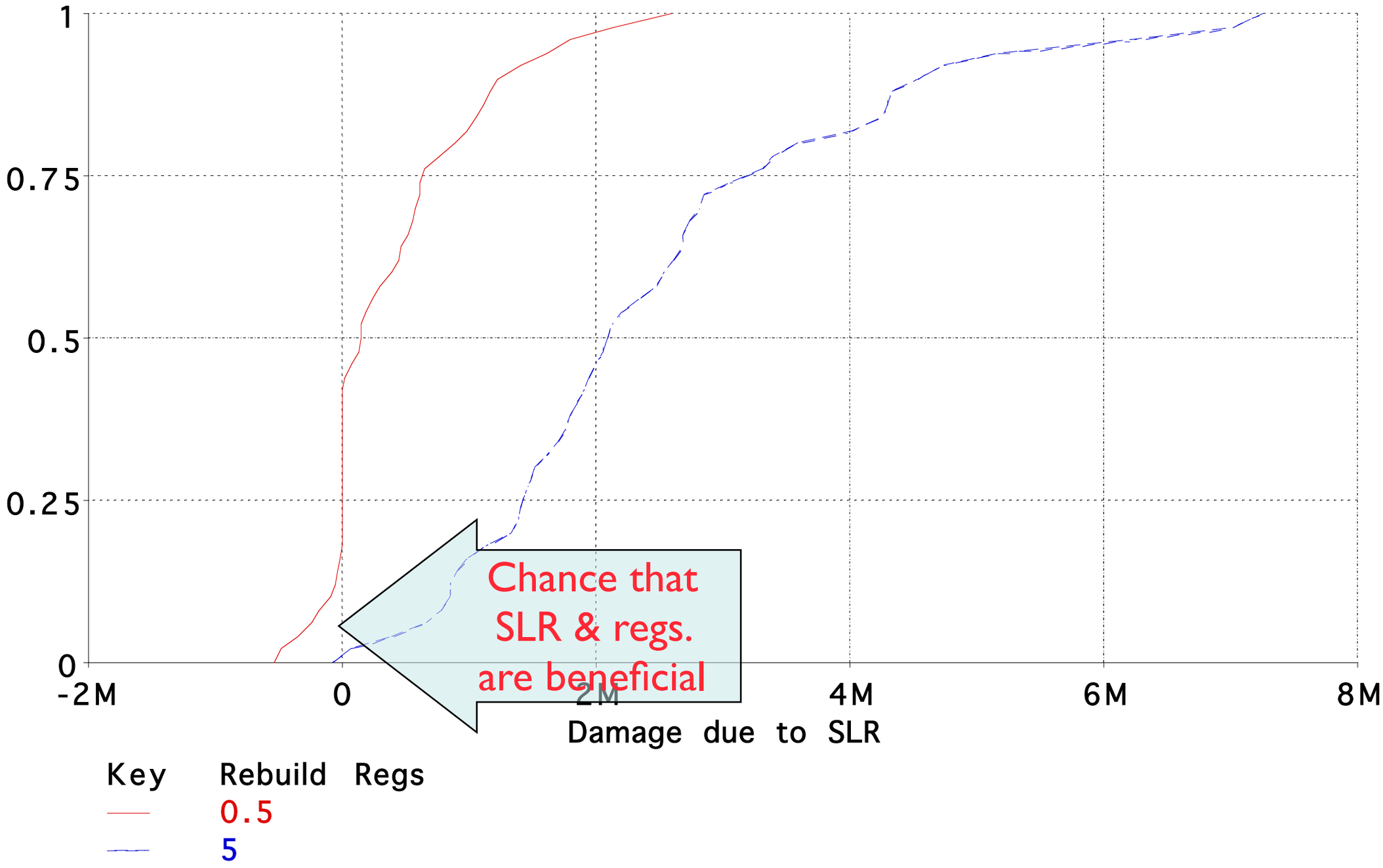


Inundation damage

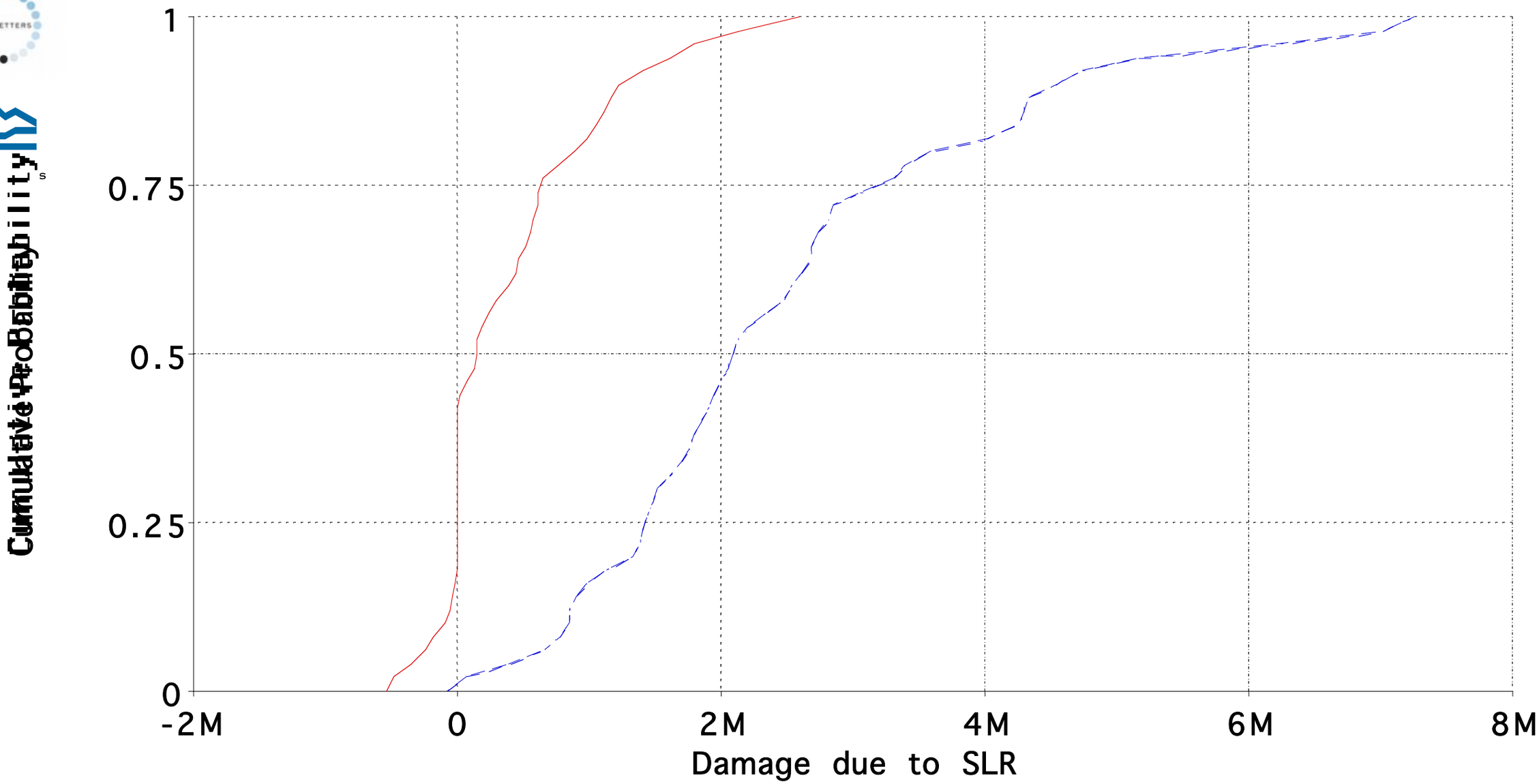
Explore the role of regulations



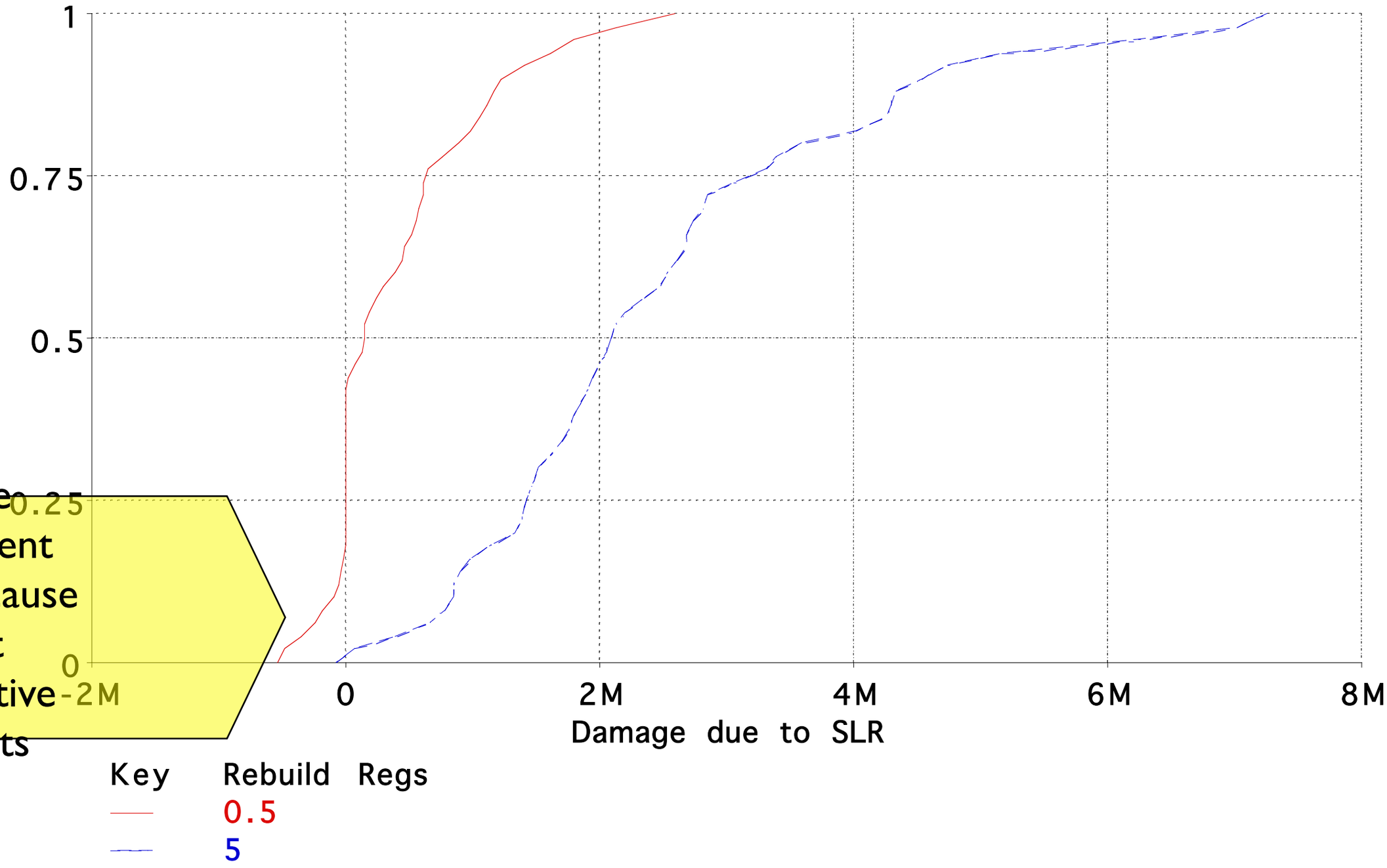
Explore the role of regulations



Explore the role of regulations

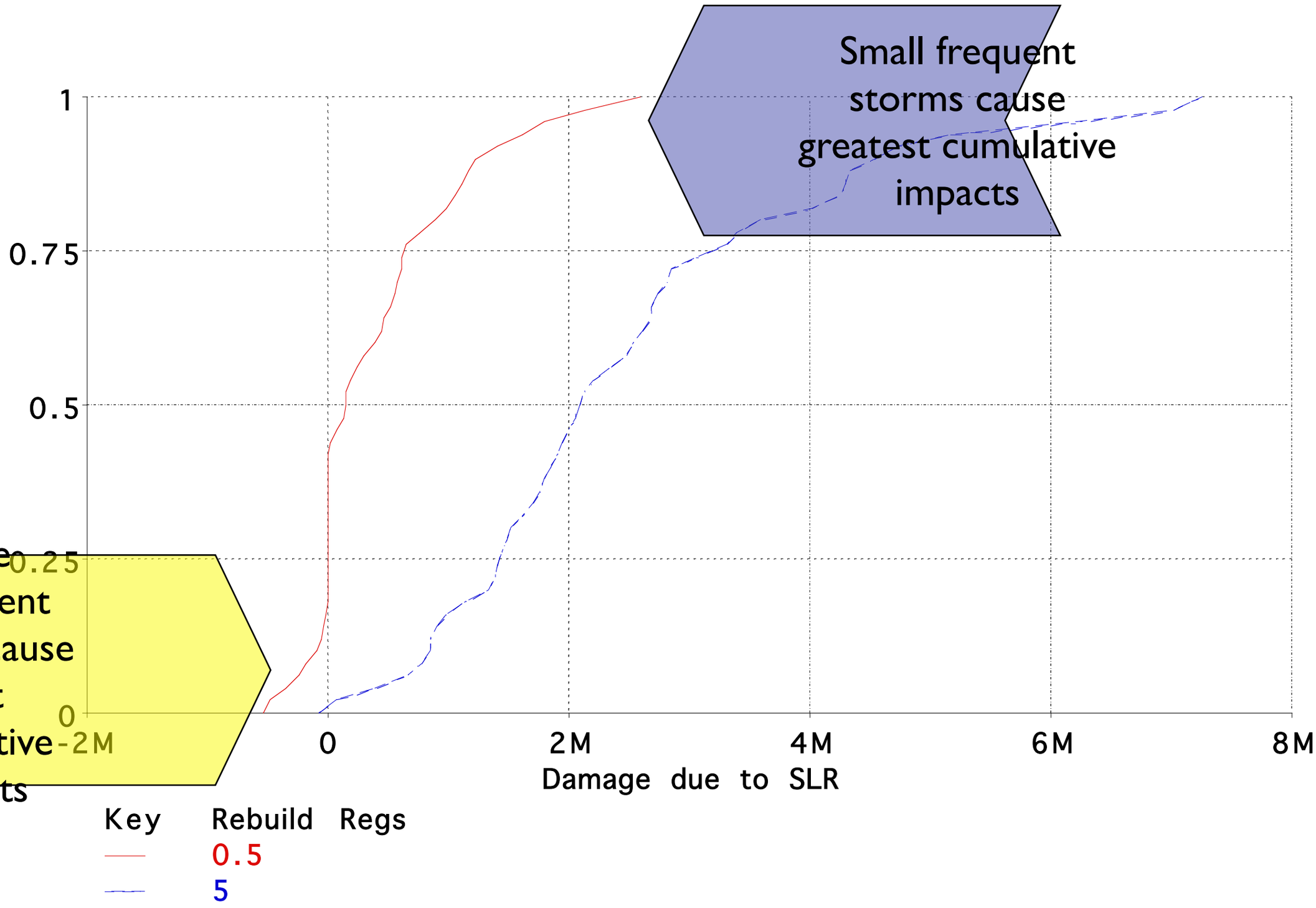


Explore the role of regulations



large infrequent storms cause least cumulative impacts

Explore the role of regulations

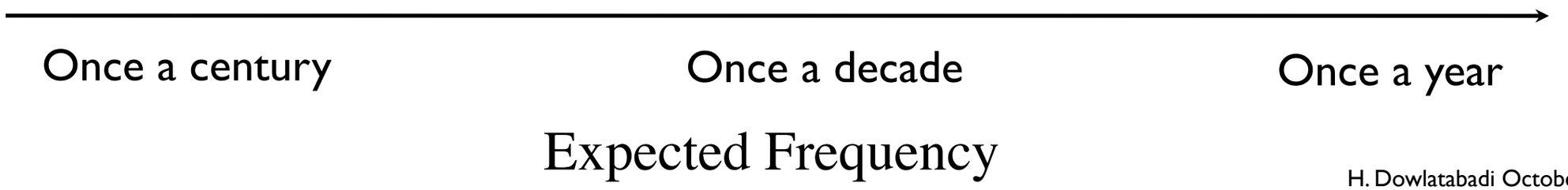


Model findings

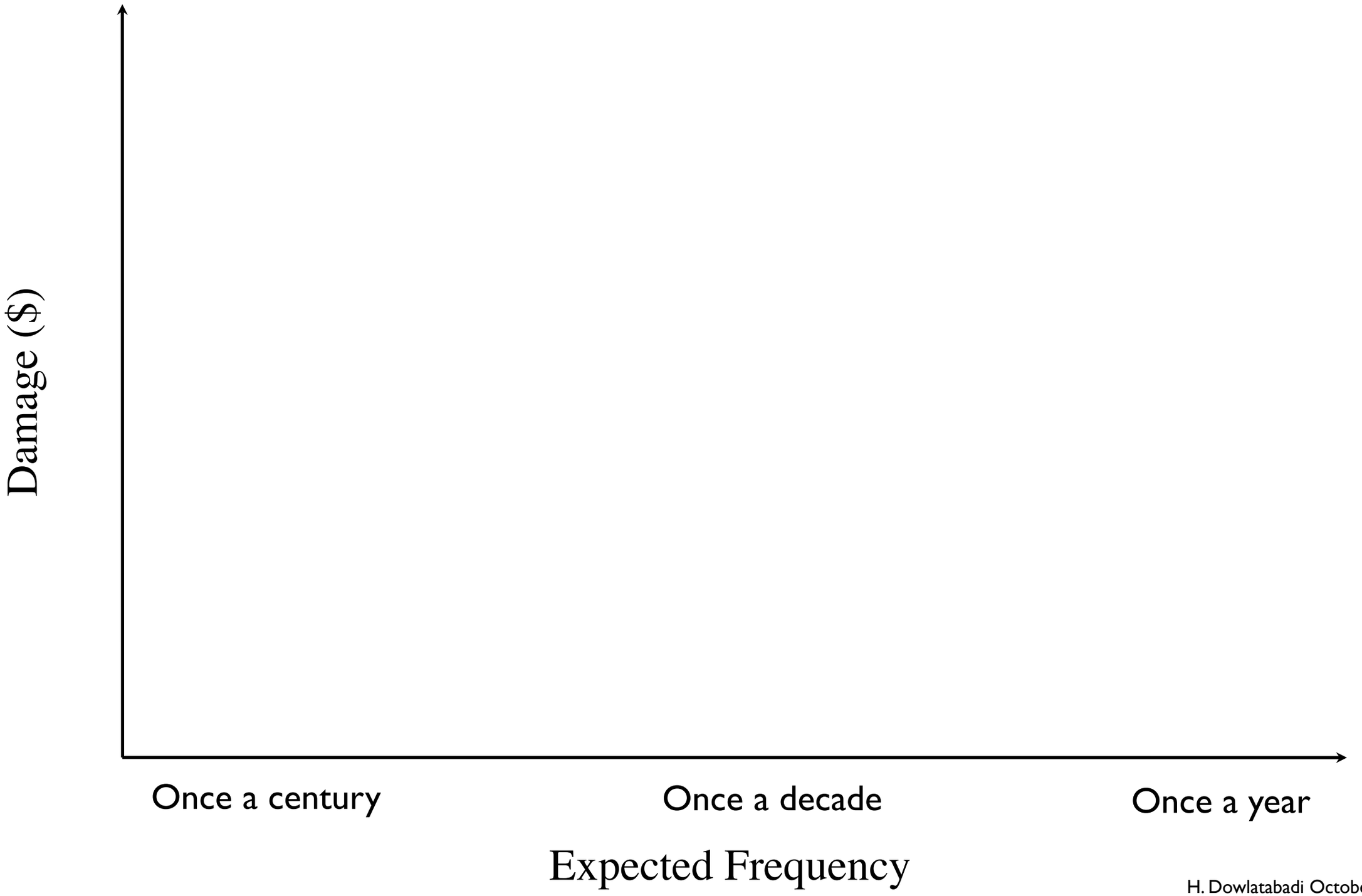
- Estimated mean damages from inundation are a TINY fraction of the range of possible outcomes.
- The range of outcomes is very sensitive to storm history.
- Market adaptations *may* help reduce impacts of inundation but are unlikely to affect storm damages.
- Regulations, if designed and implemented wisely, may help reduce impacts.

Event Frequency & Damage:

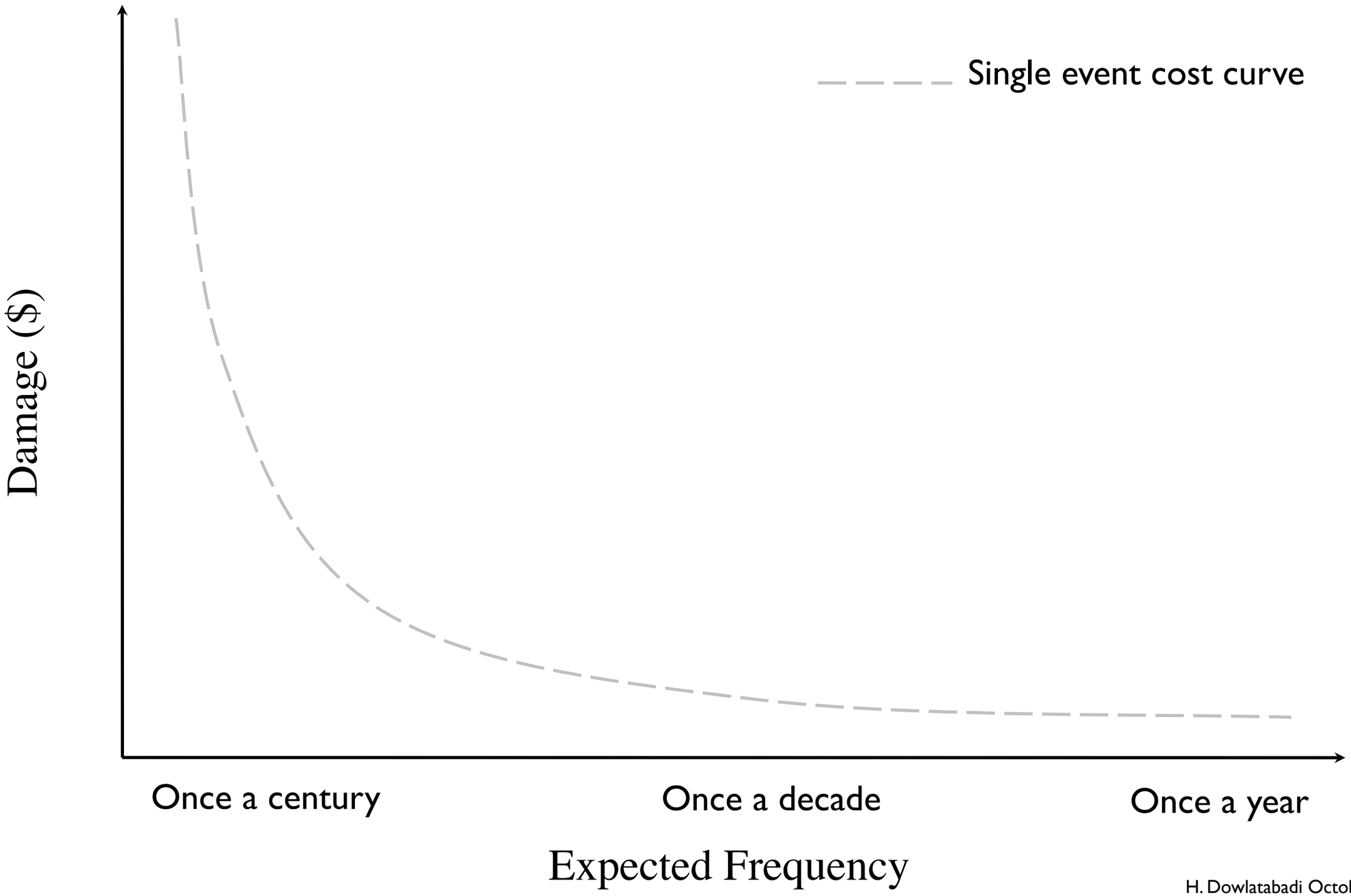
Event Frequency & Damage:



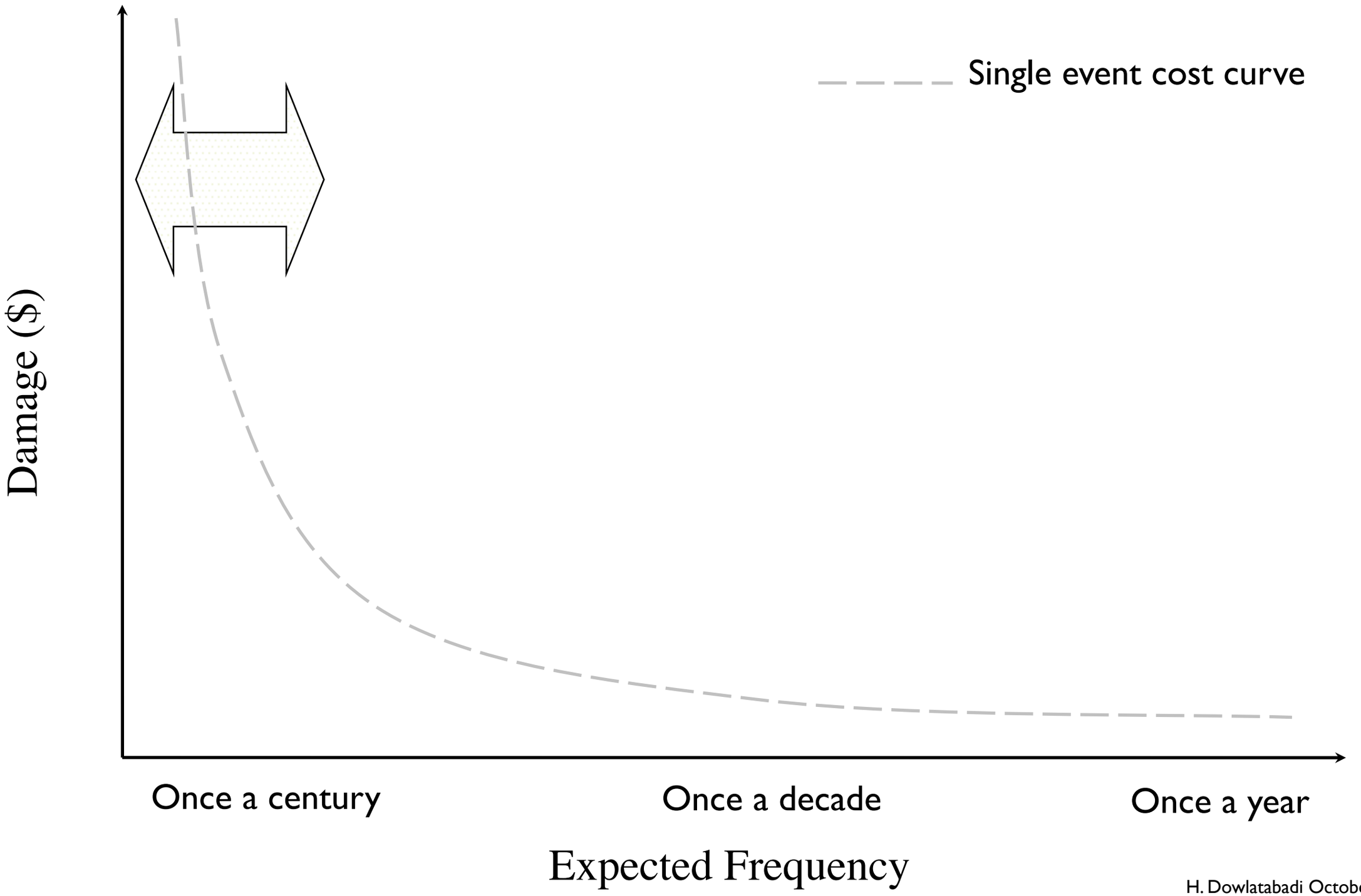
Event Frequency & Damage:



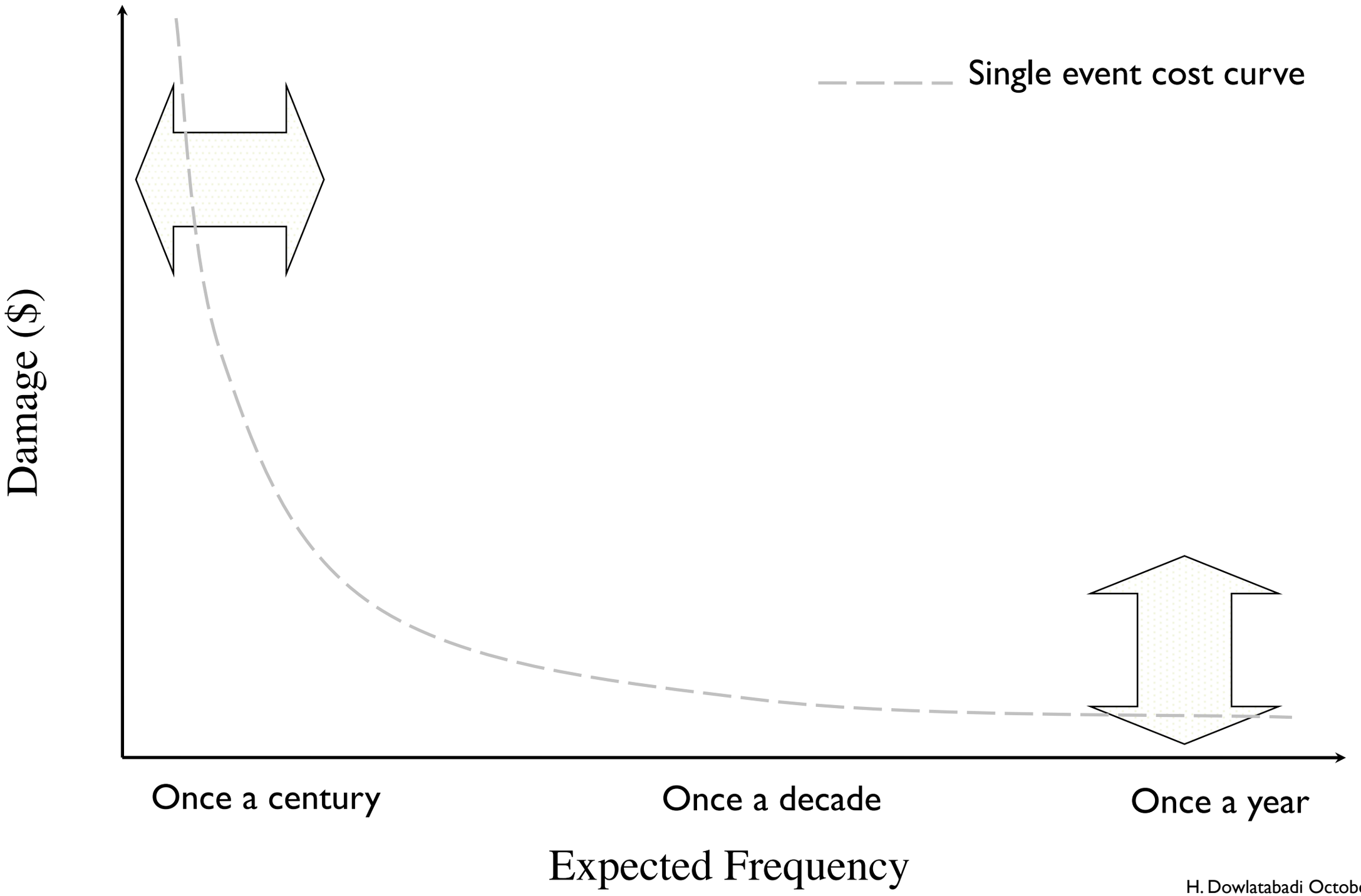
Event Frequency & Damage:



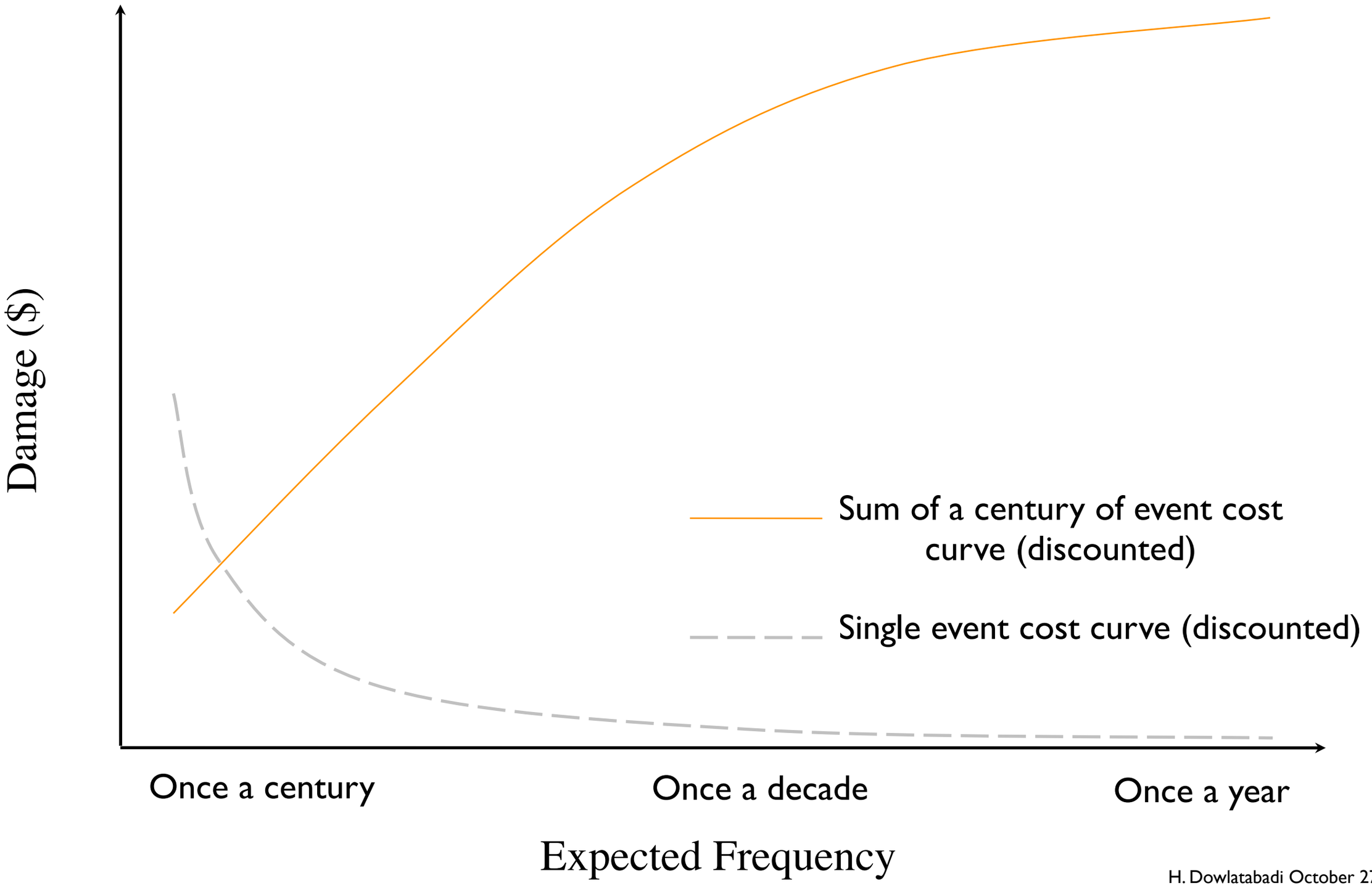
Event Frequency & Damage:



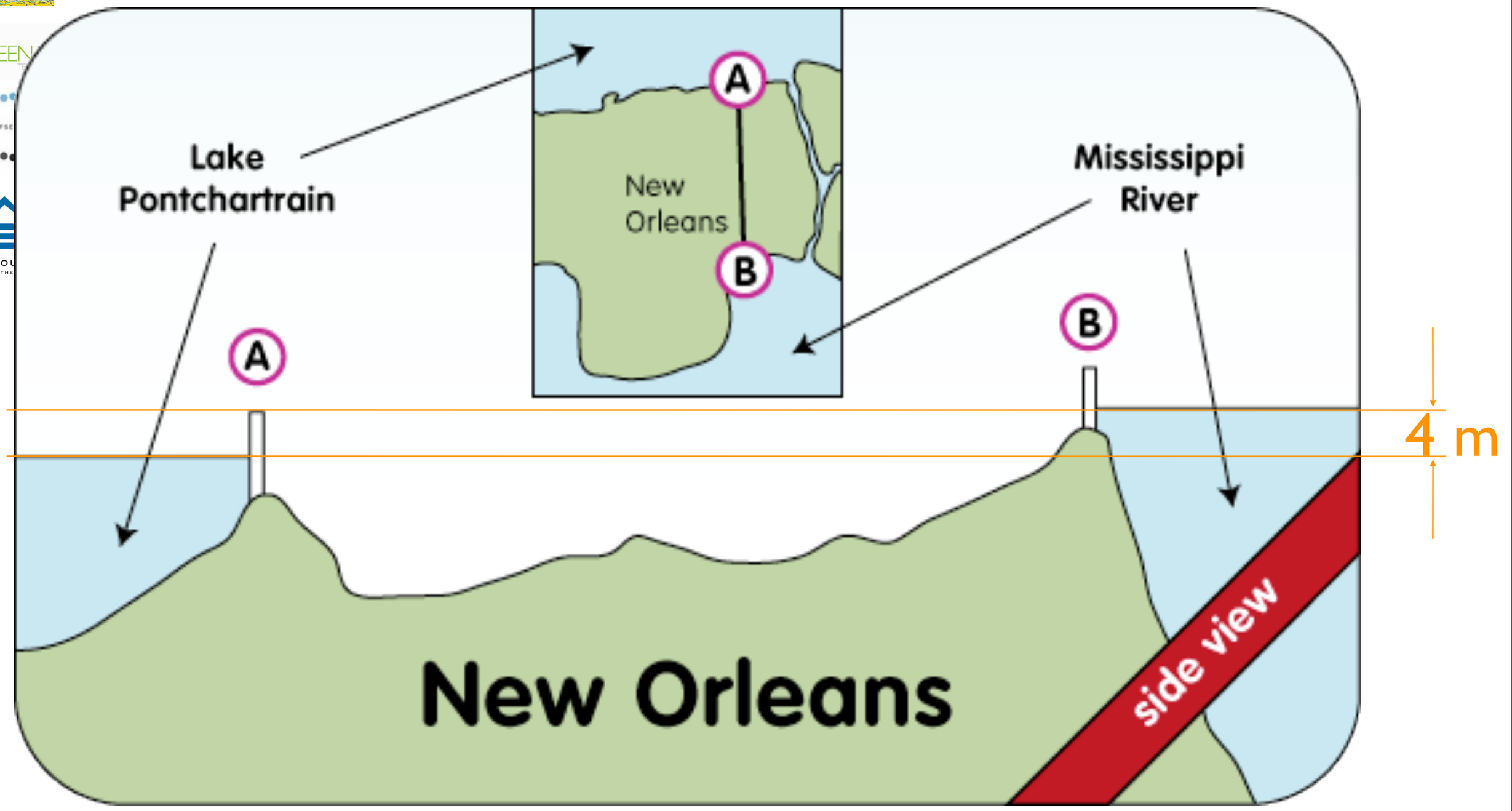
Event Frequency & Damage:



Event Frequency & Damage: After A century

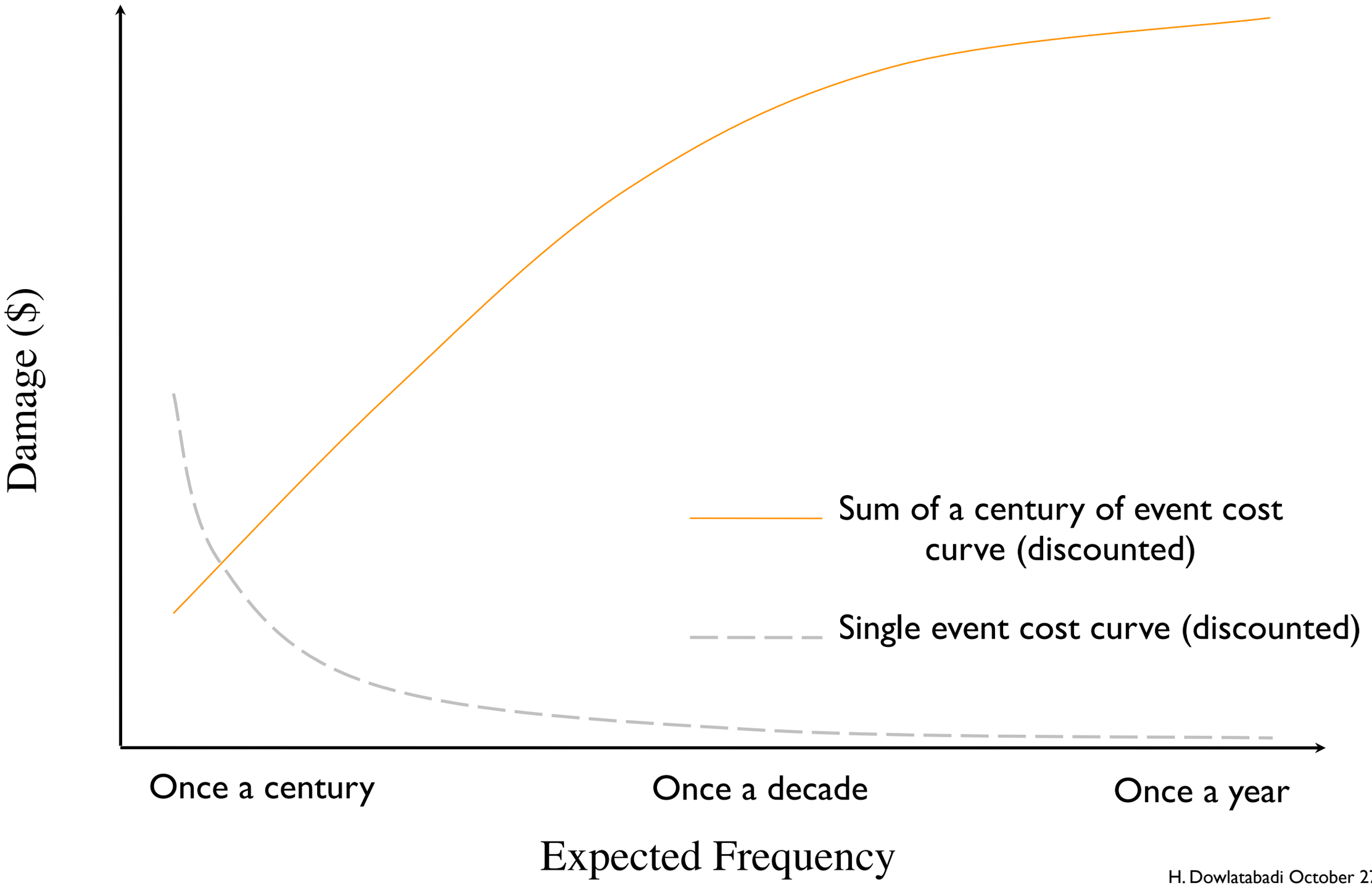


H. Dowlatabadi October 27th 2010

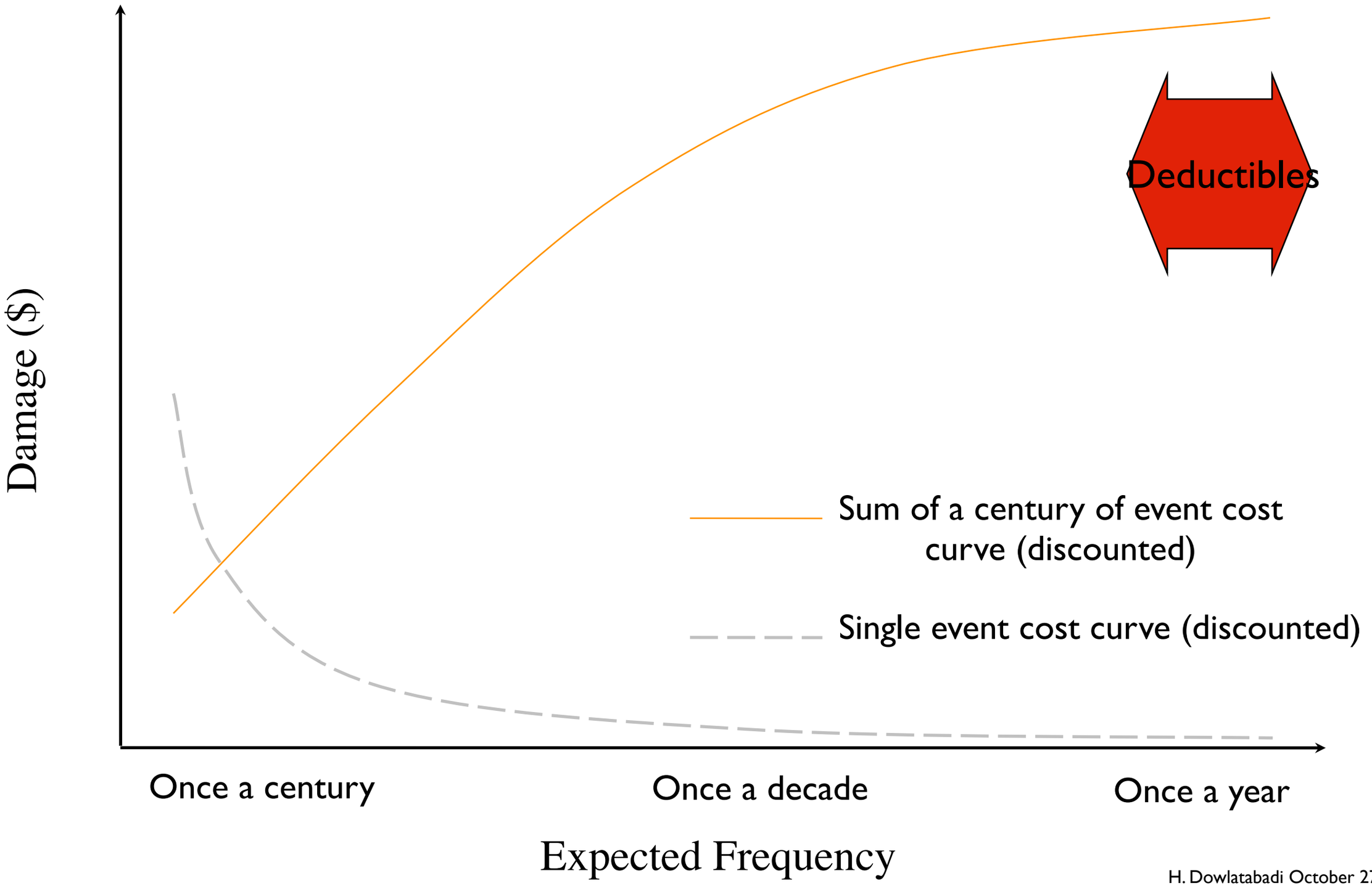


http://ltc.smm.org/buzz/media_static/hurricane_katrina/levee_system_big.gif

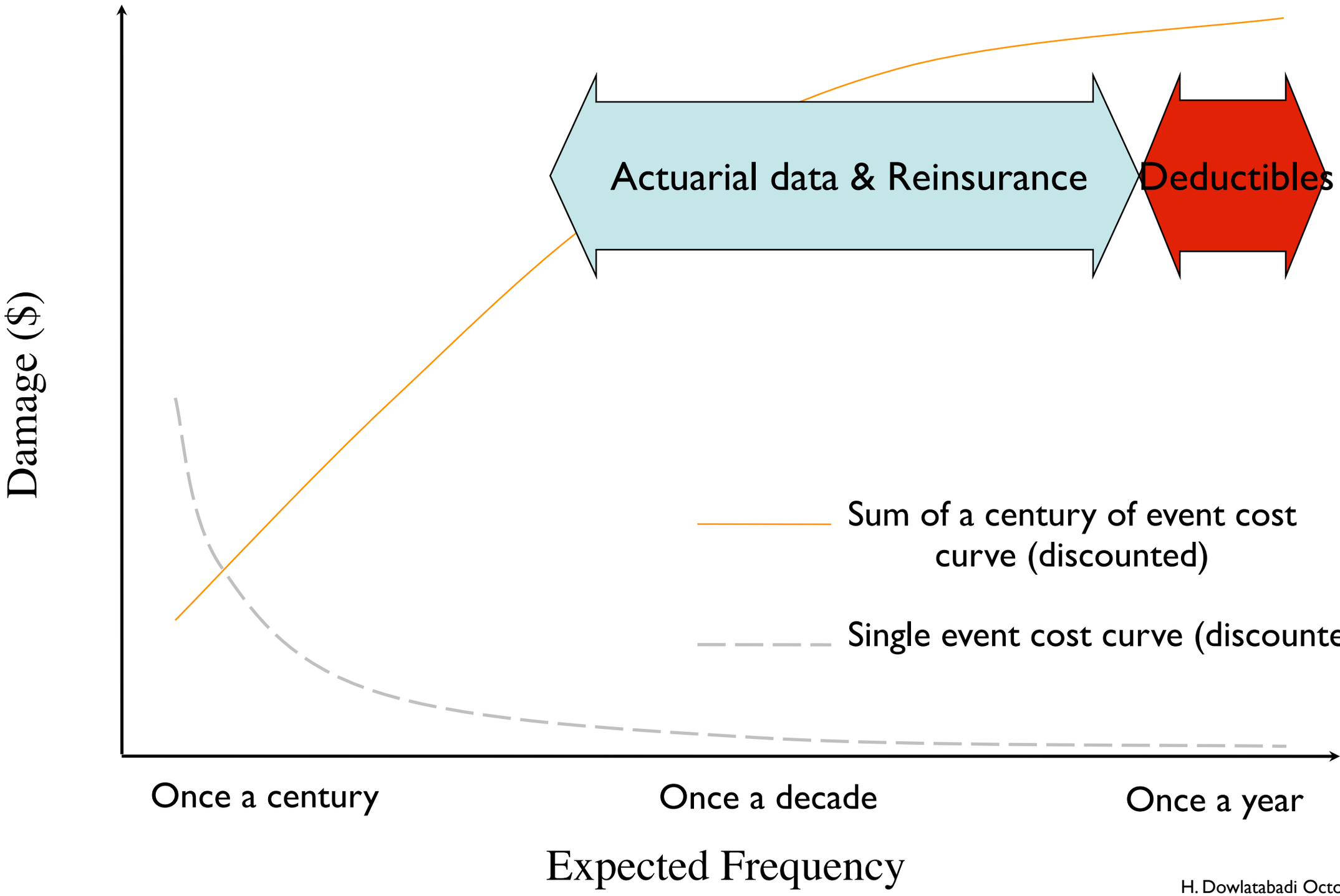
Event Frequency & Damage: After A century



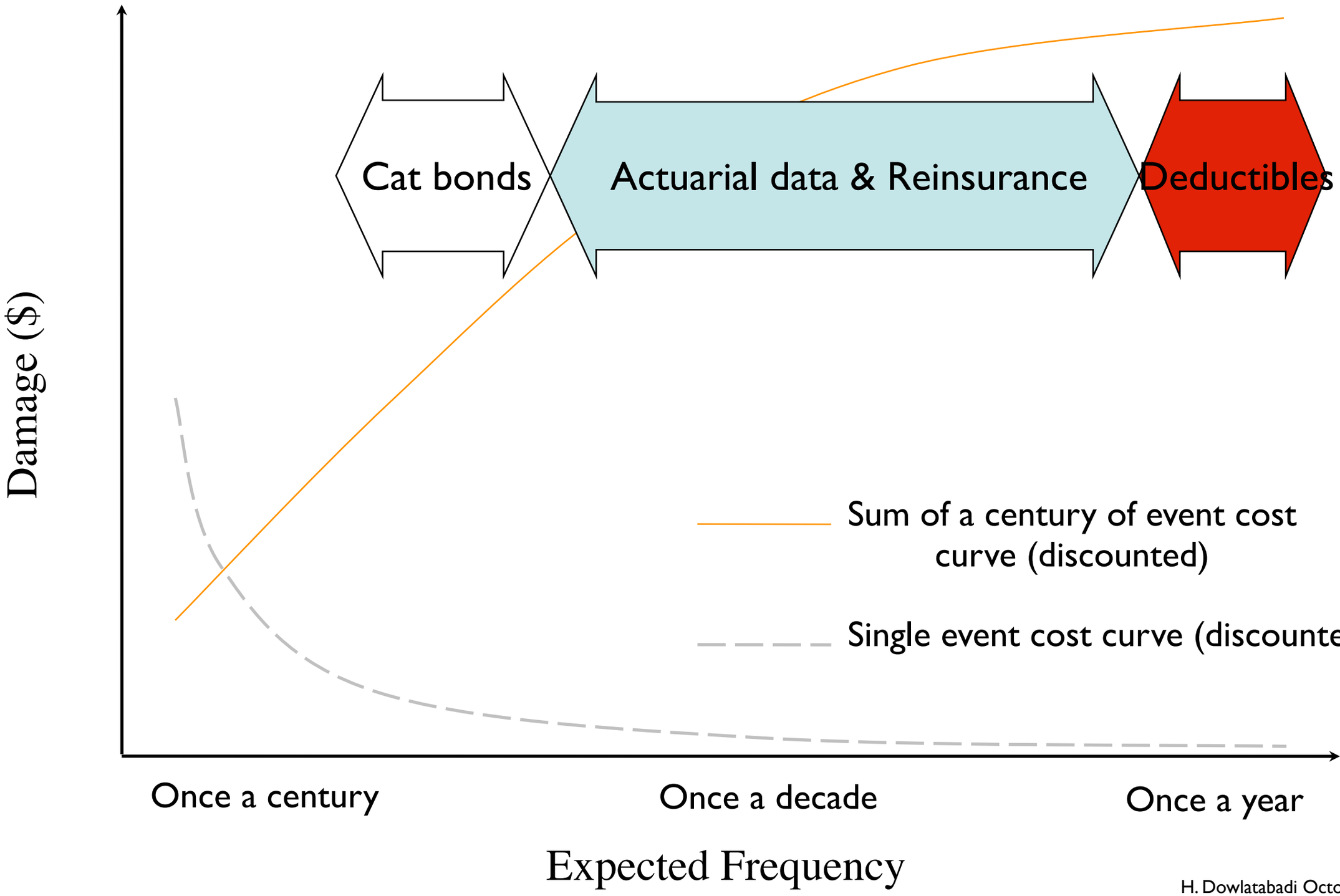
Event Frequency & Damage: After A century



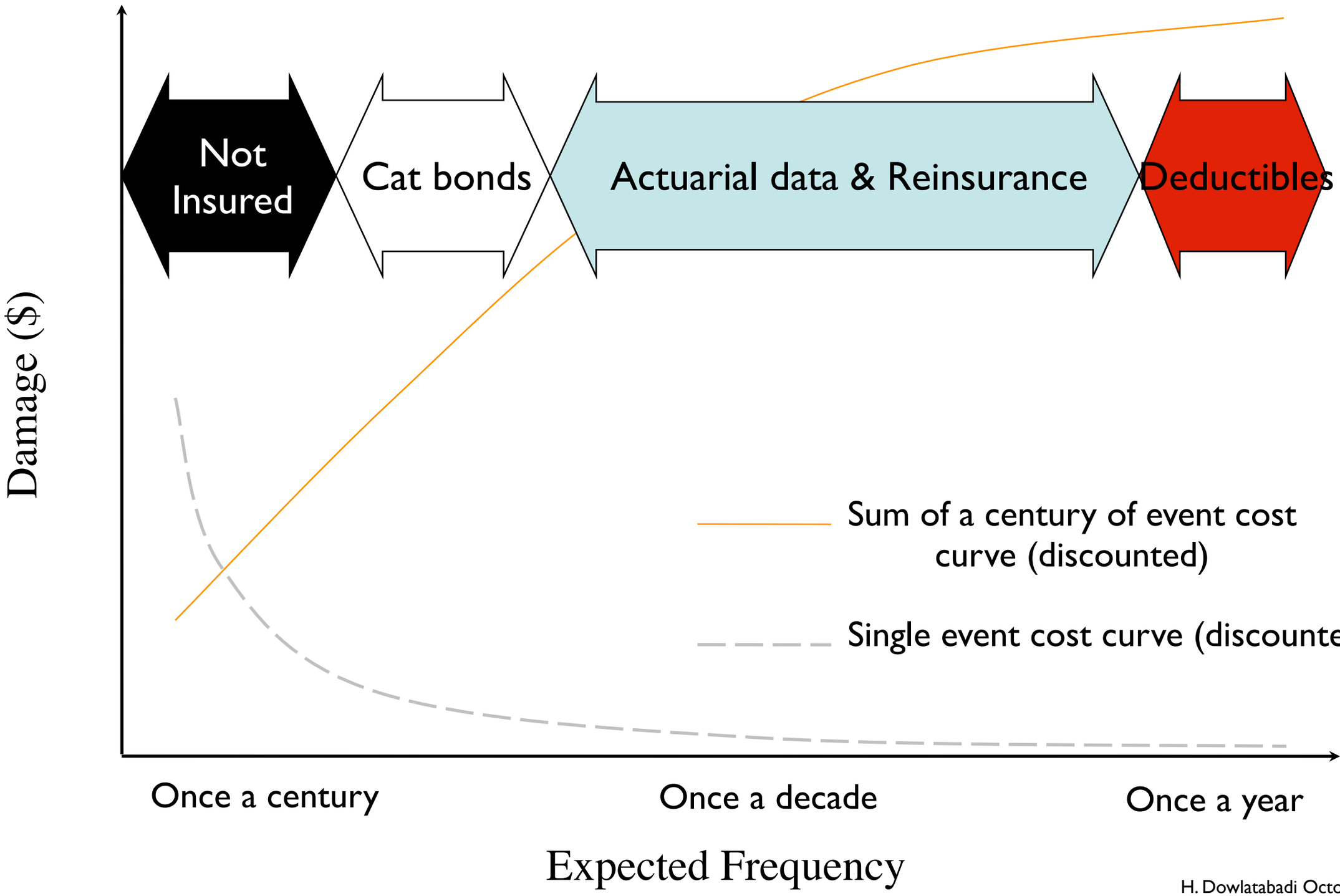
Event Frequency & Damage: After A century



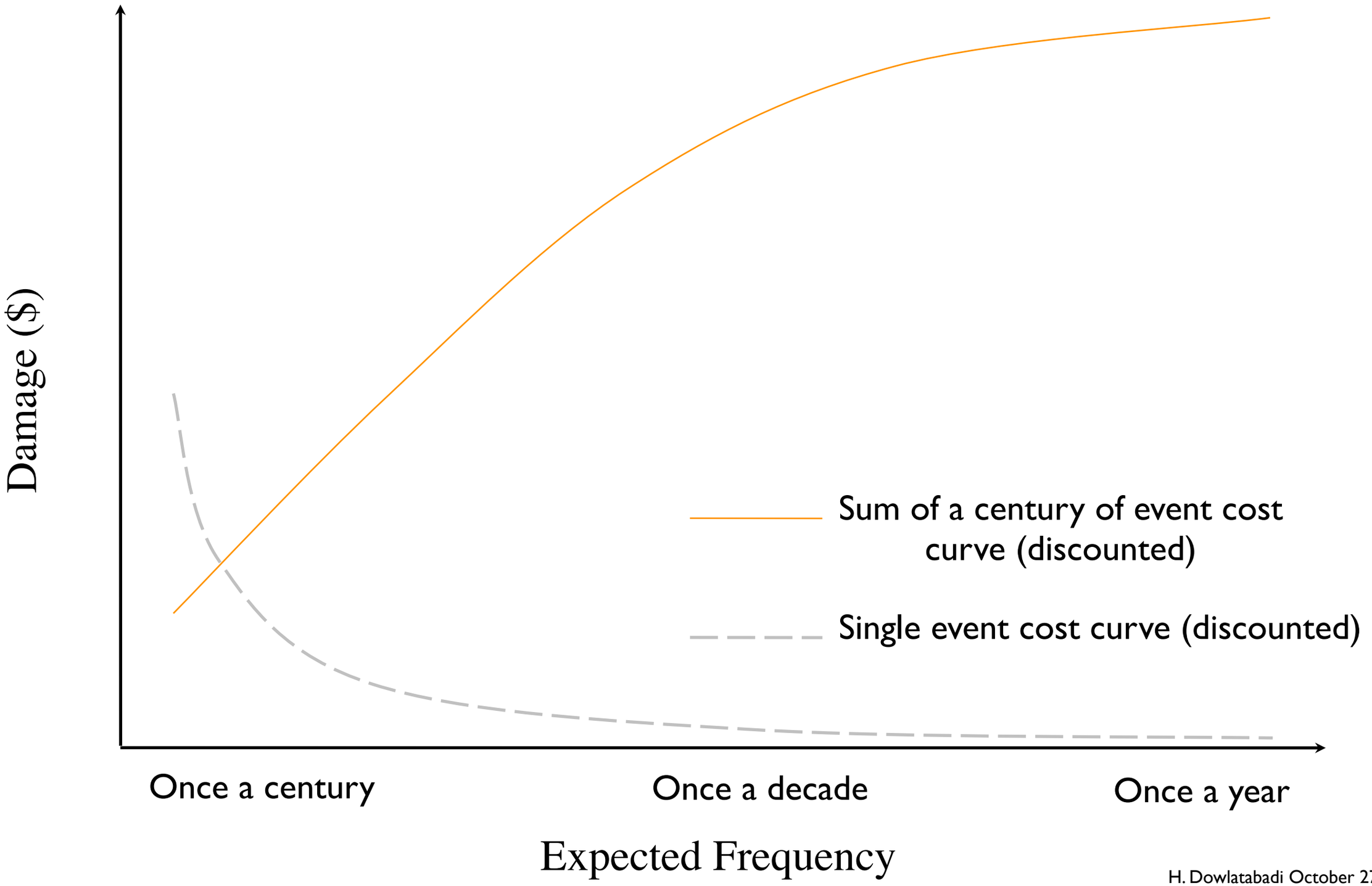
Event Frequency & Damage: After A century



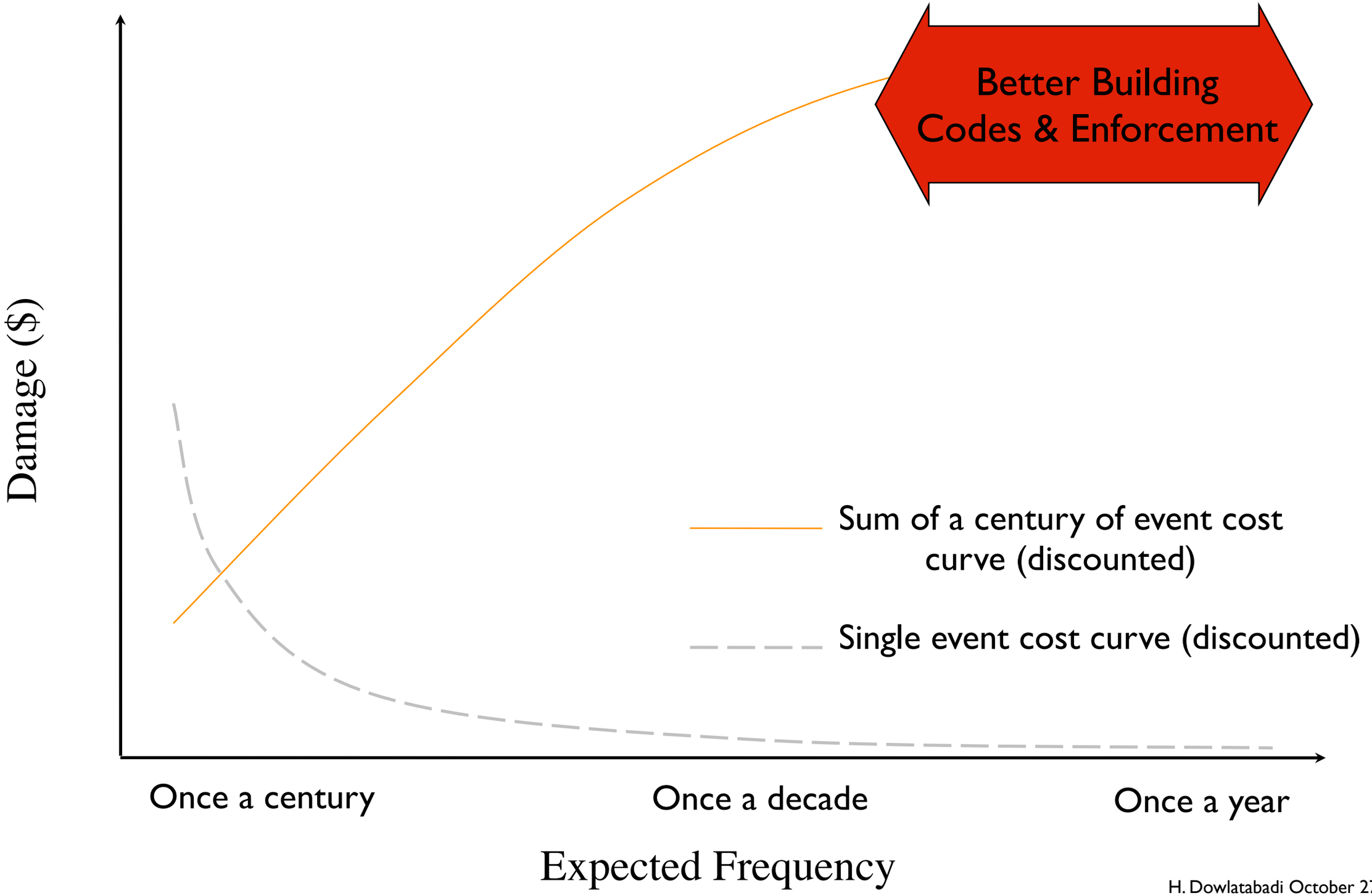
Event Frequency & Damage: After A century



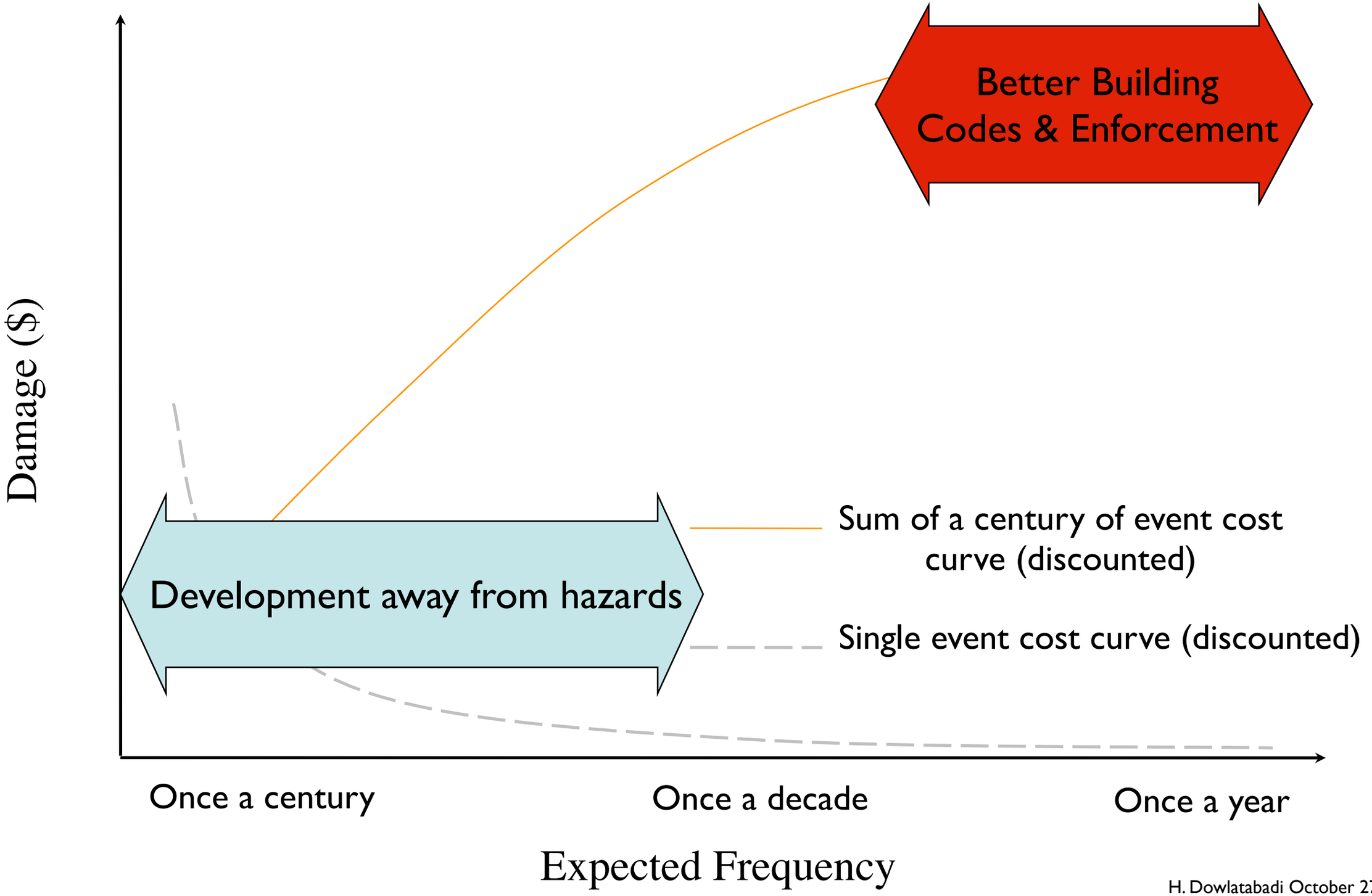
Cooperation



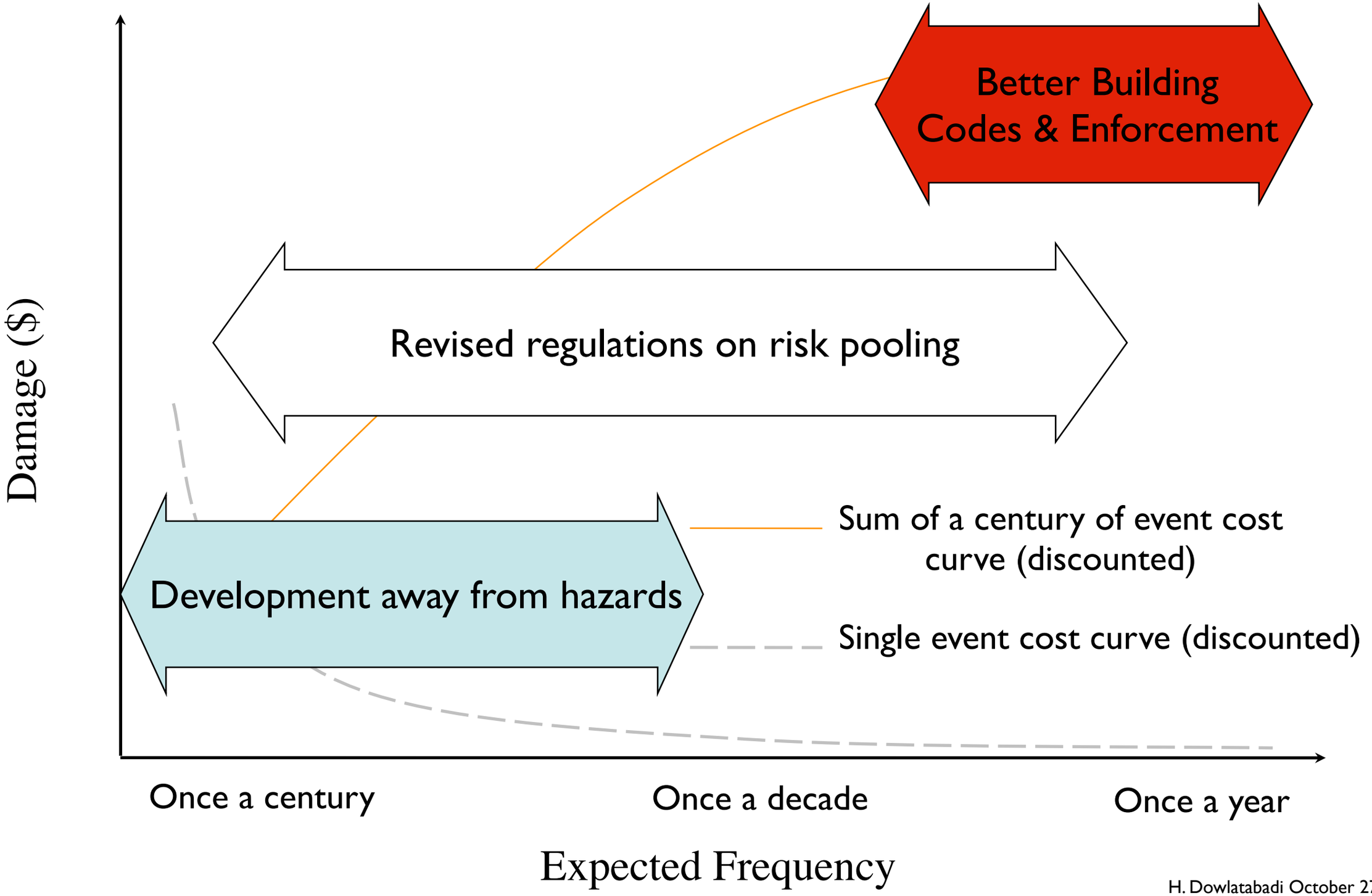
Cooperation



Cooperation



Cooperation



Solutions

- Improve building codes
- Revisit where we can build
- Change regulations regarding mortgage availability.
- Revise insurance regulations and premia

Epilogue

- Only a fraction of the impacted can afford insurance.
- A smaller faction still have chosen to carry insurance coverage.
- Insurance will flee once the storms intensify.
- Coastal defenses only create higher future vulnerability.

The Walrus and The Carpenter
Lewis Carroll
(from *Through the Looking-Glass and What Alice Found There*, 1872)

"The time has come," the Walrus said,
"To talk of many things:
Of shoes--and ships--and sealing-wax--
Of cabbages--and kings--
And why the sea is boiling hot--
And whether pigs have wings."

"But wait a bit," the Oysters cried,
"Before we have our chat;
For some of us are out of breath,
And all of us are fat!"
"No hurry!" said the Carpenter.
They thanked him much for that.

"A loaf of bread," the Walrus said,
"Is what we chiefly need:
Pepper and vinegar besides
Are very good indeed--
Now if you're ready, Oysters dear,
We can begin to feed."

"But not on us!" the Oysters cried,
Turning a little blue.
"After such kindness, that would be
A dismal thing to do!"

"It was so kind of you to come!
And you are very nice!"
The Carpenter said nothing but
"Cut us another slice:
I wish you were not quite so deaf--
I've had to ask you twice!"

"It seems a shame," the Walrus said,
"To play them such a trick,
After we've brought them out so far,
And made them trot so quick!"
The Carpenter said nothing but
"The butter's spread too thick!"

"I weep for you," the Walrus said:
"I deeply sympathize."
With sobs and tears he sorted out
Those of the largest size,
Holding his pocket-handkerchief
Before his streaming eyes.

"O Oysters," said the Carpenter,
"You've had a pleasant run!
Shall we be trotting home again?'
But answer came there none--
And this was scarcely odd, because
They'd eaten every one.

Additional Slides

Have we missed the boat?

Have we missed the boat?

- Inundation is due to the combined effect of sea level rise and *storm surge*.

Have we missed the boat?

- Inundation is due to the combined effect of sea level rise and *storm surge*.
- When sites are inundated the problem is attribution of the event to nature or man:
  - It never used to be like this. This is due to climate change we should get out while we can.
  - This is a normal occurrence of an infrequent storm event. There is no substantial sea level rise and the statistics of storms are also unchanged. We should stay put and make repairs
- Adaptation in stochastic environments is difficult.

The cognitive challenge

The cognitive challenge

Storms are infrequent.

The cognitive challenge

Storms are infrequent.

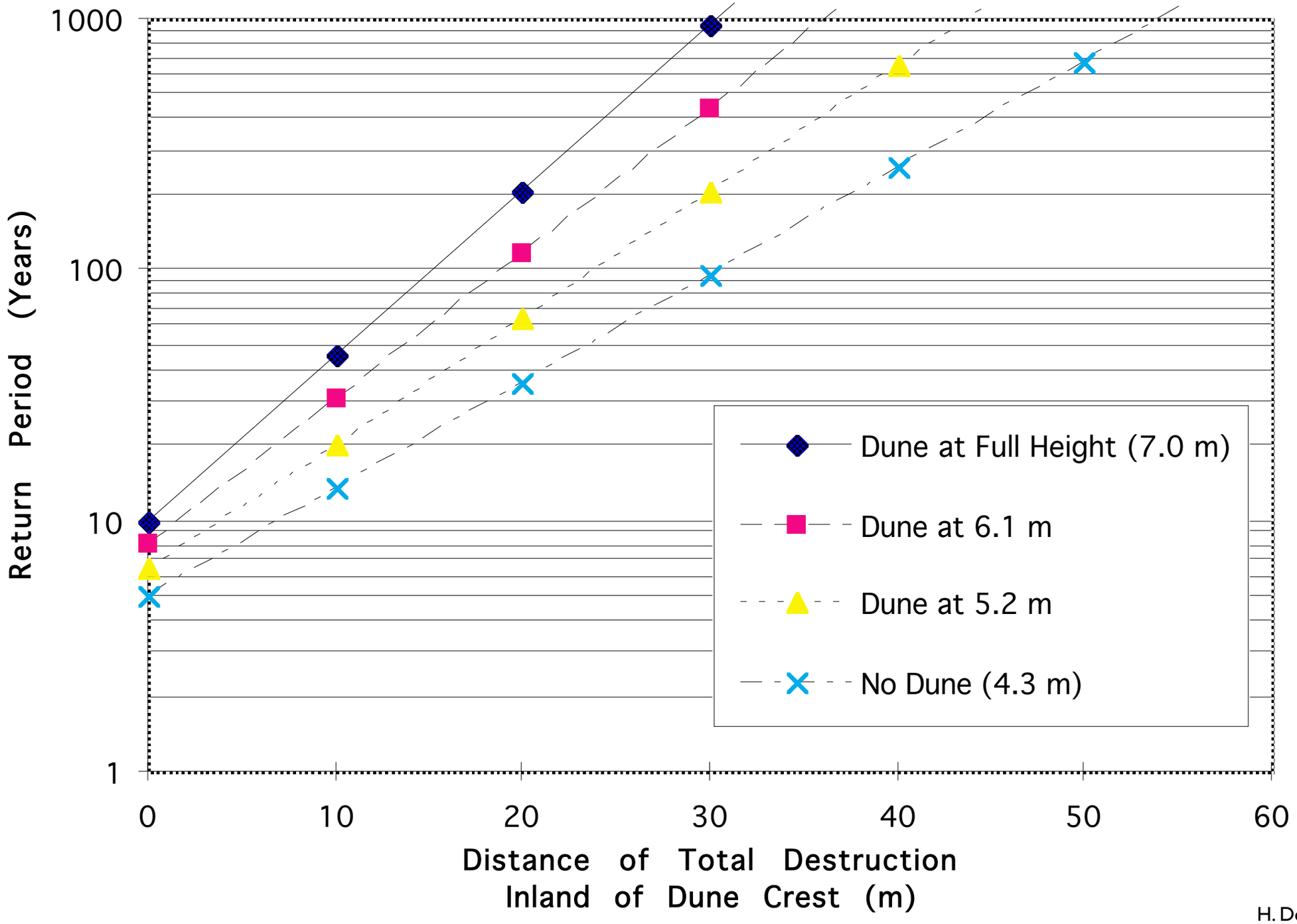
- Storms in quick succession, even where there is little or no sea level rise, can be misinterpreted as evidence of climate change. This could lead to inappropriately abandoned property.

The cognitive challenge

Storms are infrequent.

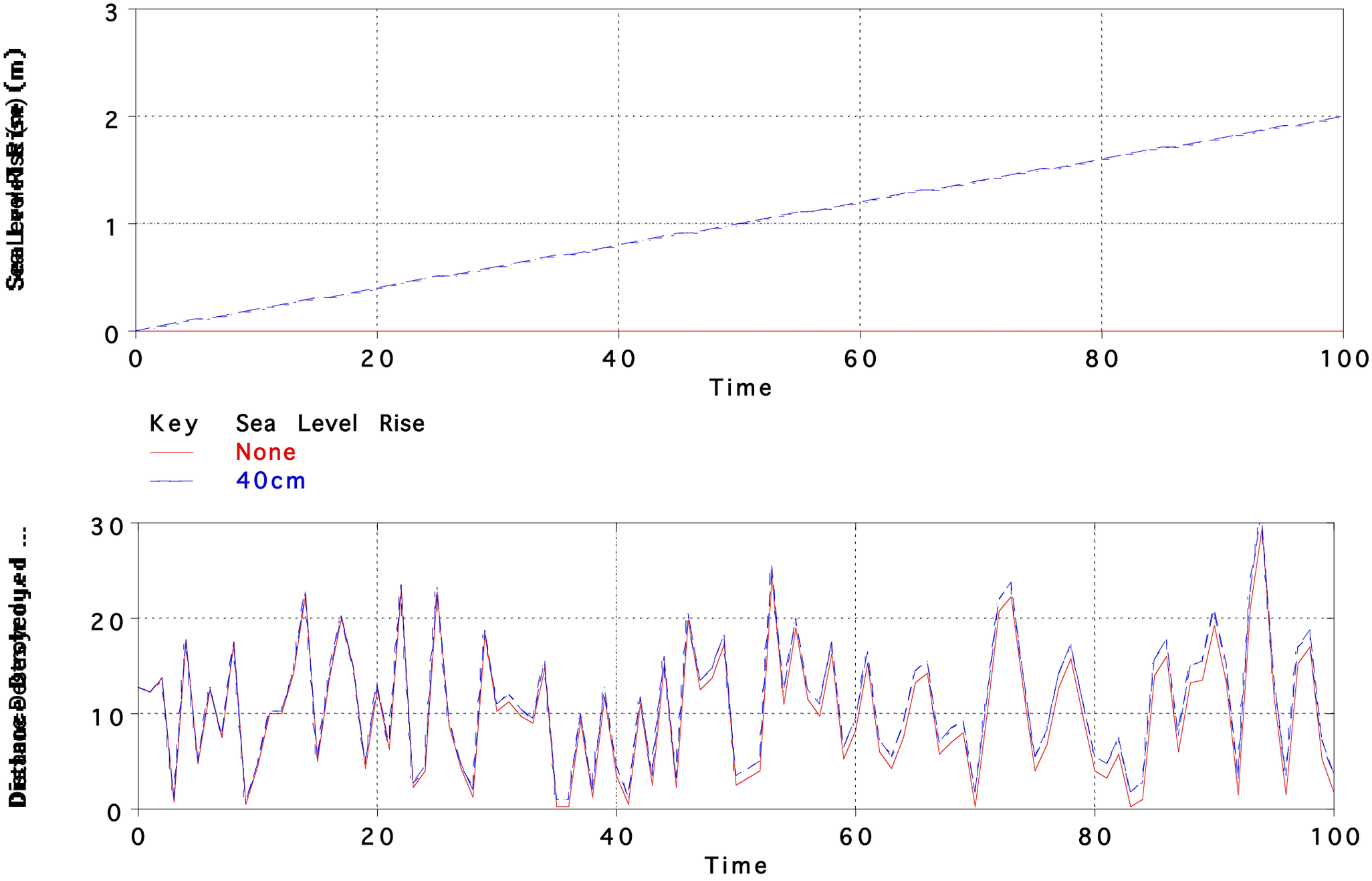
- Storms in quick succession, even where there is little or no sea level rise, can be misinterpreted as evidence of climate change. This could lead to inappropriately abandoned property.
- A period of calm, even while sea level is rising, may be misinterpreted as evidence of immunity from SLR impacts. Thus, there can be significant investment in inherently vulnerable locations.

Model of storm impact & return period



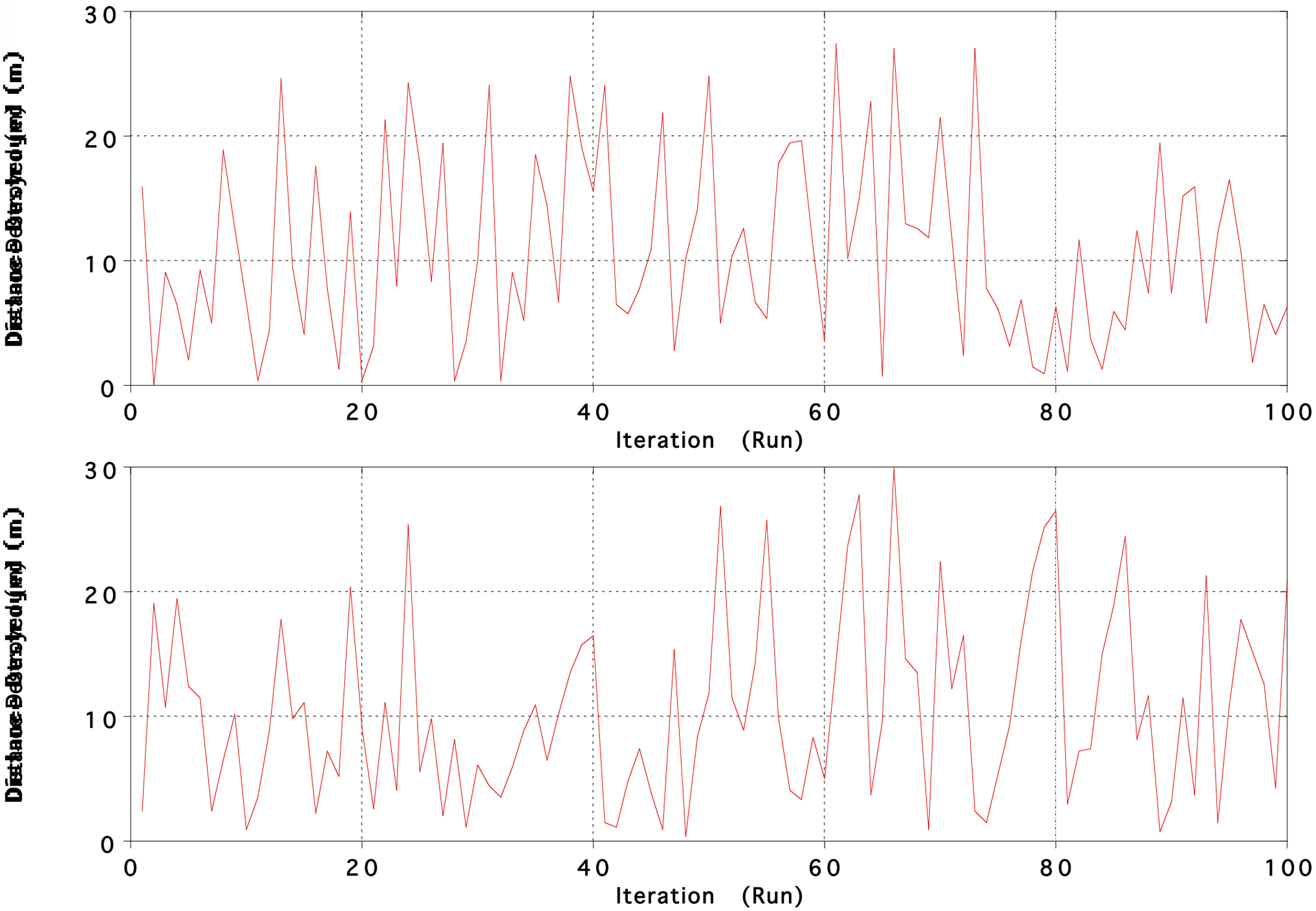
H. Dowlatabadi October 27th 2010

Secular Sea Level Rise Plus Storms



H. Dowlatabadi October 27th 2010

Two storms histories compared



Some aspects of valuation

Some aspects of valuation

- Structures continue to provide service long after their assumed economic life of 30 years. We assume their *value* is related to their physical life ≈ 65 years.

Some aspects of valuation

- Structures continue to provide service long after their assumed economic life of 30 years. We assume their *value* is related to their physical life ≈ 65 years.
- Contents of structures
  - land-ward of dune crest — 30% of the property value.
  - sea-ward of dune crest are assumed negligible.
- Damages are often limited to how property is damaged or lost. We look at utility losses which are based on lost utility due to SLR.

Particulars of this Case Study

Particulars of this Case Study

- Actual value estimates for each lot at Duck North Carolina are used in the analysis.

Particulars of this Case Study

- Actual value estimates for each lot at Duck North Carolina are used in the analysis.
- Duck is a barrier island, we have ignored the sound side impacts of SLR.

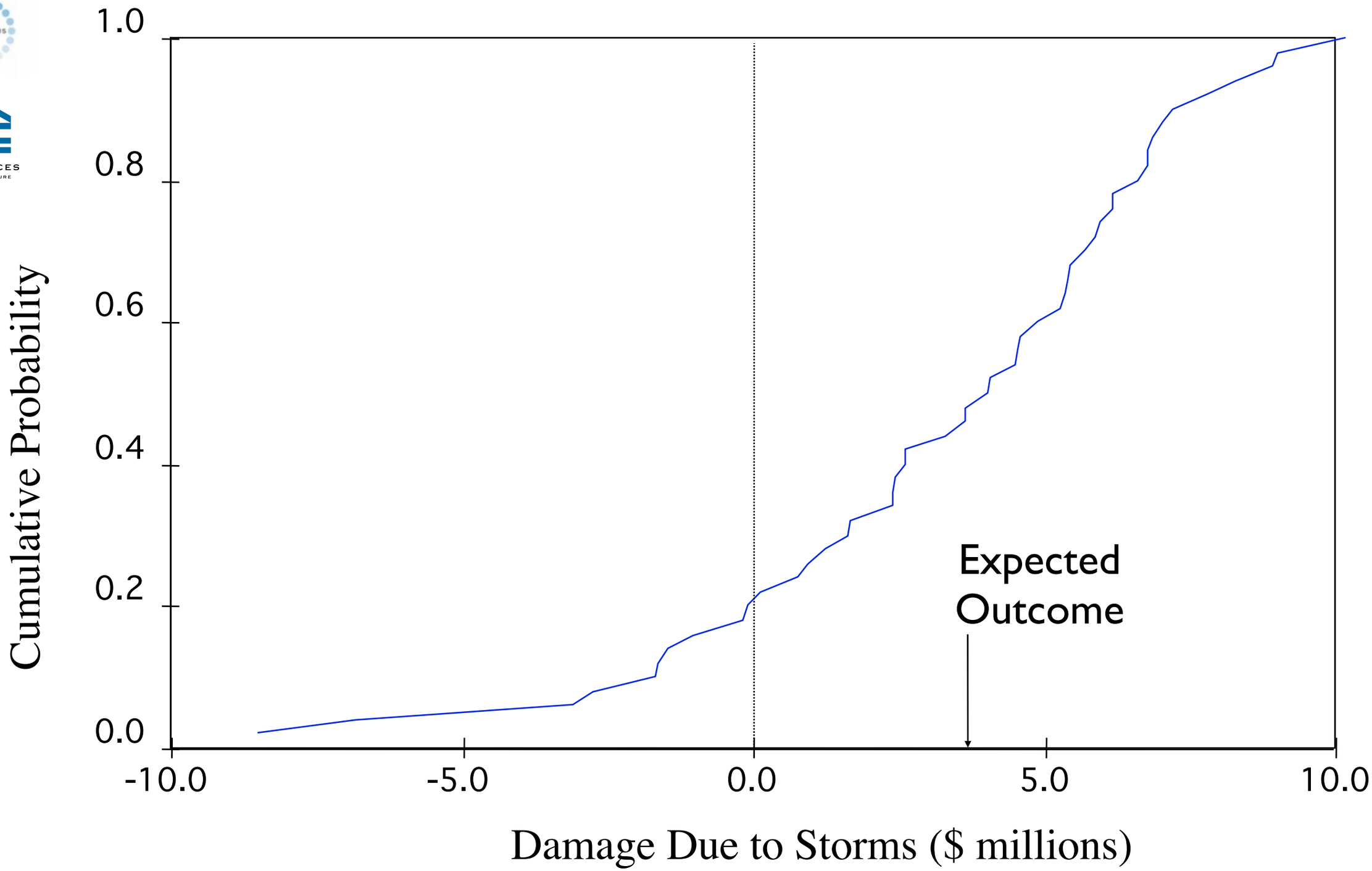
Particulars of this Case Study

- Actual value estimates for each lot at Duck North Carolina are used in the analysis.
- Duck is a barrier island, we have ignored the sound side impacts of SLR.
- Duck enjoys an accreting shoreline, we imposed shoreline erosion in order to have an SLR effect and simulate average conditions on the US Atlantic coast.

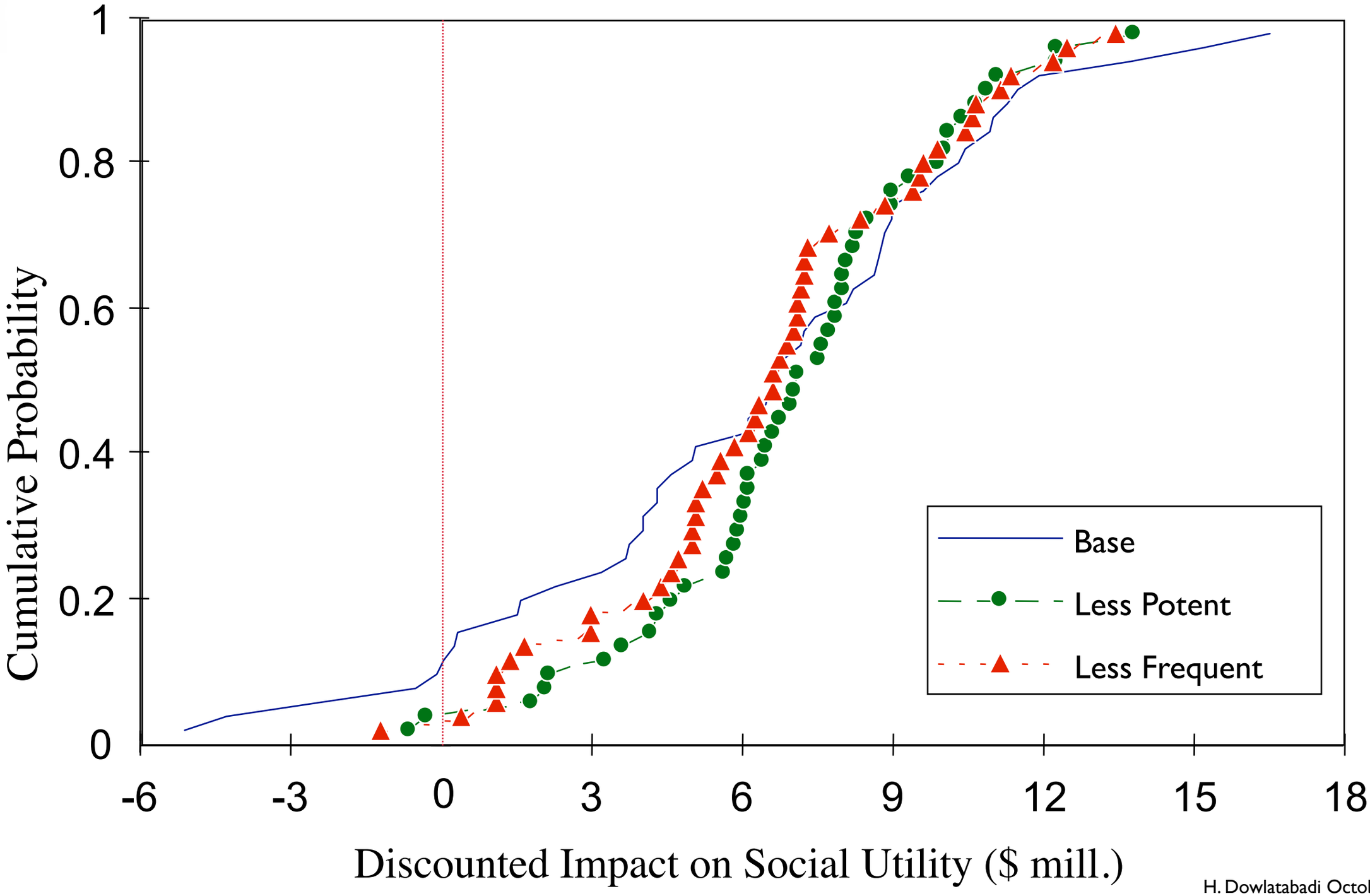
Particulars of this Case Study

- Actual value estimates for each lot at Duck North Carolina are used in the analysis.
- Duck is a barrier island, we have ignored the sound side impacts of SLR.
- Duck enjoys an accreting shoreline, we imposed shoreline erosion in order to have an SLR effect and simulate average conditions on the US Atlantic coast.
- In this study neither sea-walls, nor beach replenishment is considered as a means of impact amelioration.

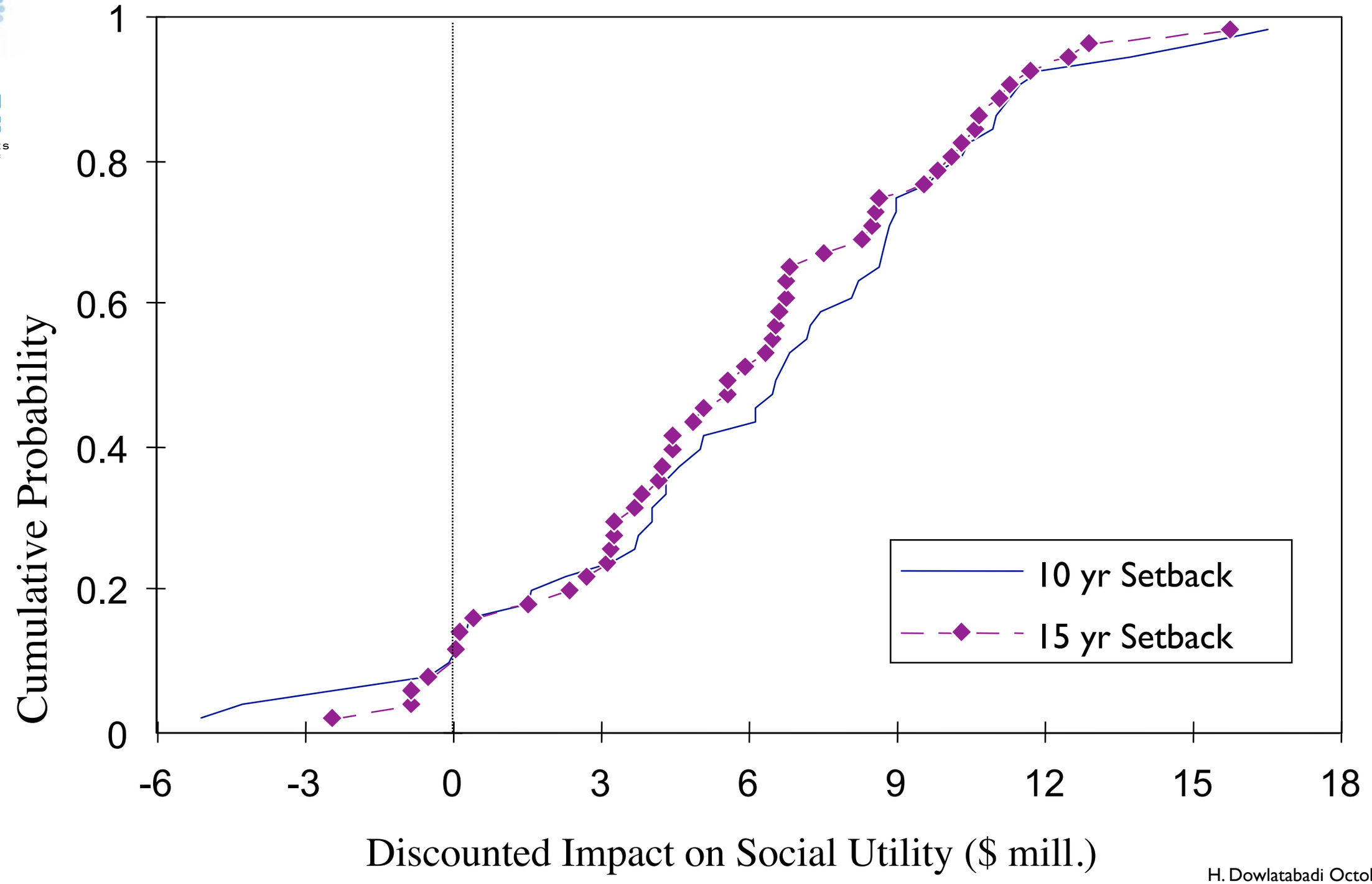
Range of damages



Comparison of outcomes with different storm regimes



Assessing a possible regulation



How can coastal impacts be lowered?

How can coastal impacts be lowered?

- The pattern of coastal development can be restricted to take advantage of protection offered by accreting shores.

How can coastal impacts be lowered?

- The pattern of coastal development can be restricted to take advantage of protection offered by accreting shores.
- Clearer signals about risks of coastal dwelling, the role of governments in disaster relief, and scope of insurance markets.

How can coastal impacts be lowered?

- The pattern of coastal development can be restricted to take advantage of protection offered by accreting shores.
- Clearer signals about risks of coastal dwelling, the role of governments in disaster relief, and scope of insurance markets.
- Through integrated assessment it is possible to develop set-back and redevelopment rules which are designed to maximize utility as we learn more about SLR and changing storm regimes.

Climate, Impact & Insurance Events: differ in definition

- A climate event can be defined in terms of physical thresholds, e.g. wind speed in a hurricane.
- An impacts event can be defined in terms of a threshold in the magnitude of assets at risk.
- An insurance event can be defined in terms of a threshold in the damaged incurred to insured assets.