

# So You'd Like to Stop Shore Erosion along the Calvert Cliffs. You'd better think before you act.

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# The Conclusion First:

There are two processes acting on eroding sea cliffs.

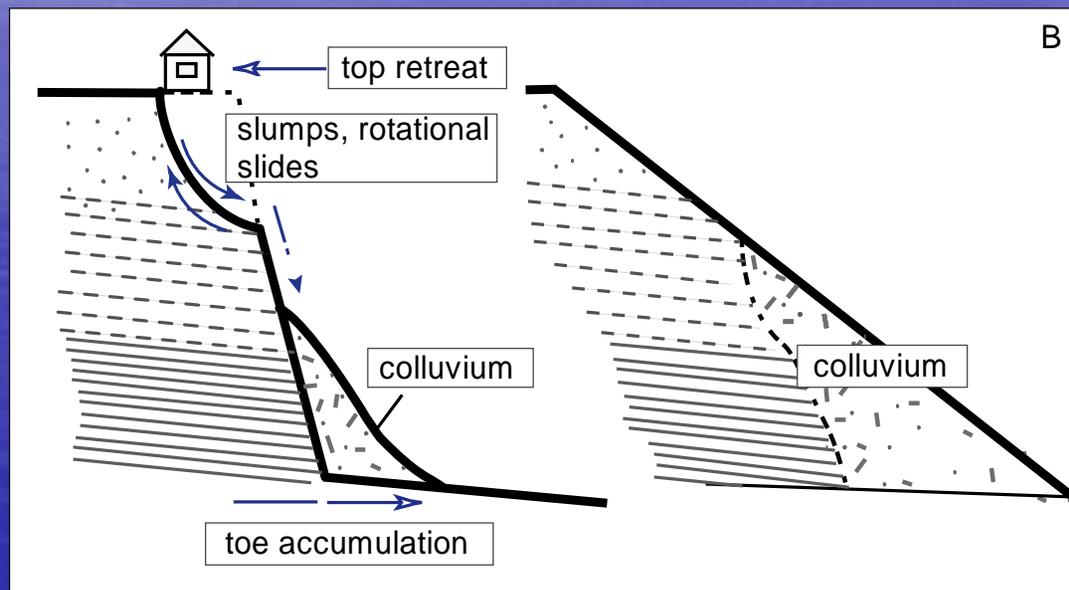
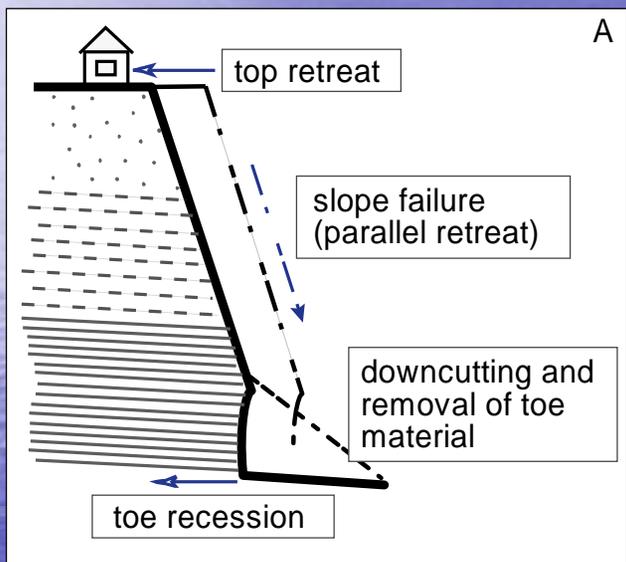
The most obvious process is bluff retreat.

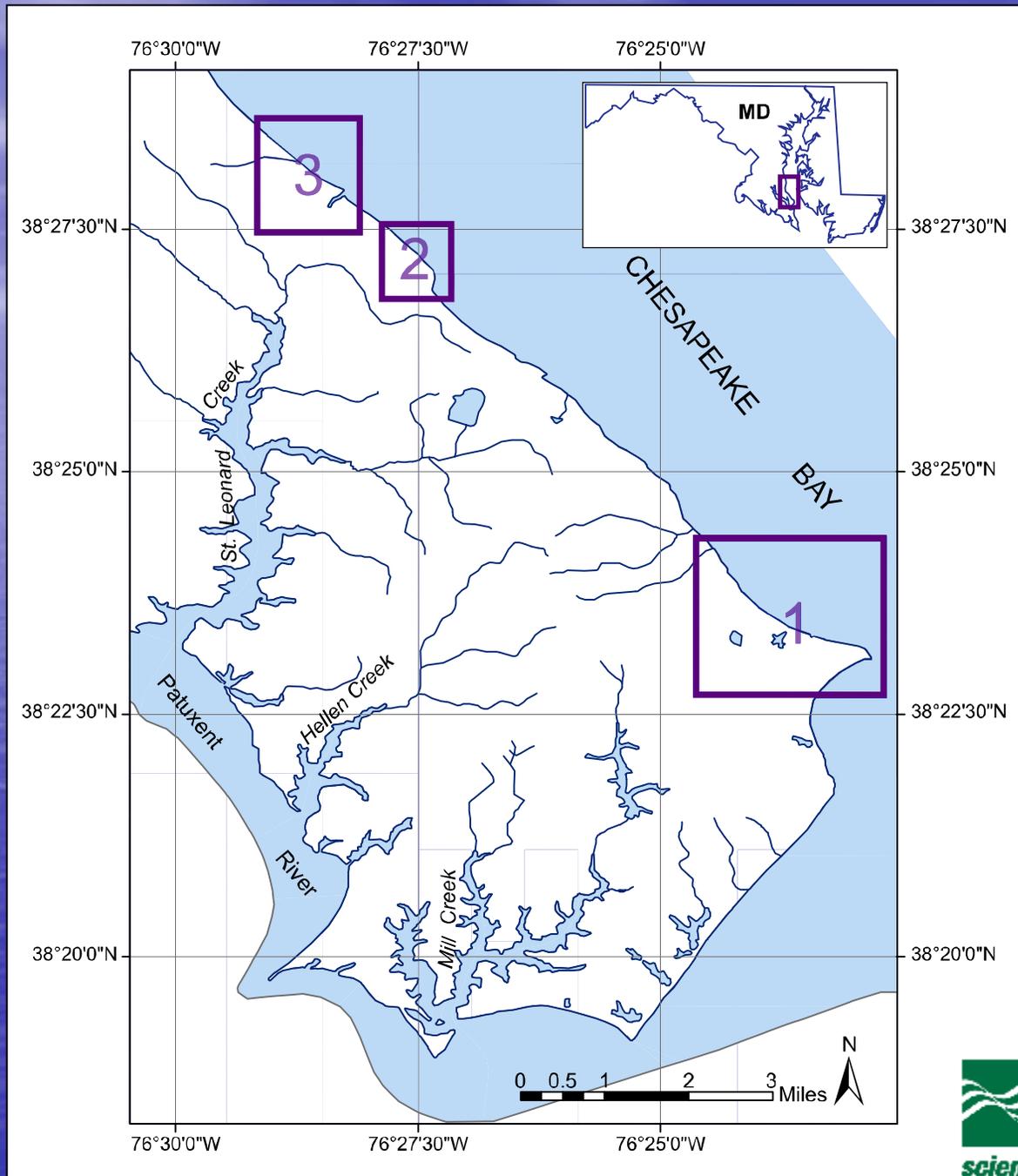
The second is slope failure and bluff top retreat until a stable angle of repose is attained. Along the Calvert Cliffs, the stable angle is 35 degrees.

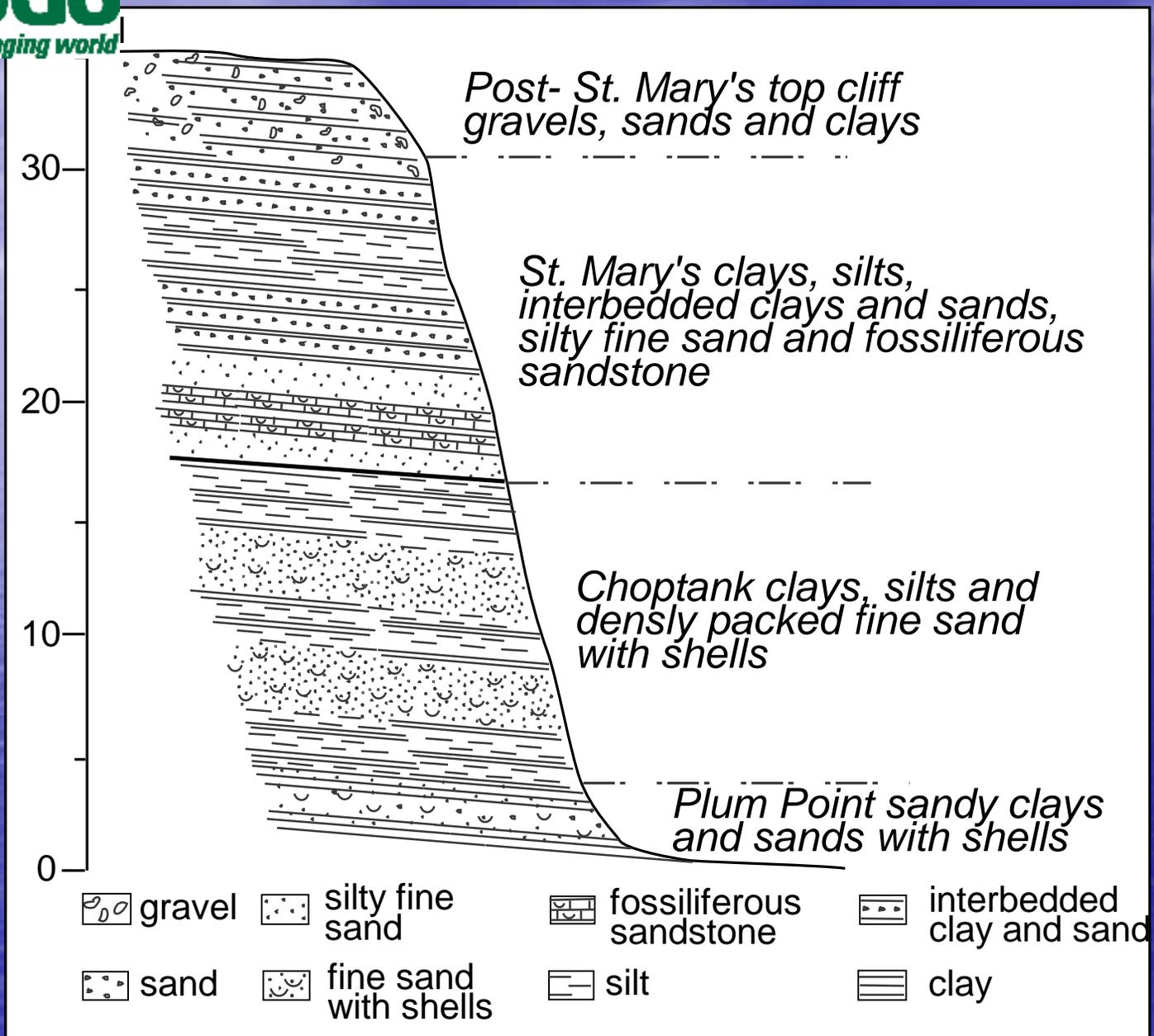
Once the first process ends, the bluff top recedes until the stable slope angle is reached. IN CALVERT COUNTY THIS TAKES PLACE IN ONLY 30 YEARS—THE LENGTH OF A MORTGAGE.

In short, any attempt to stop bluff recession by retarding wave erosion of the toe of the bluff results in immediate bluff top retreat.



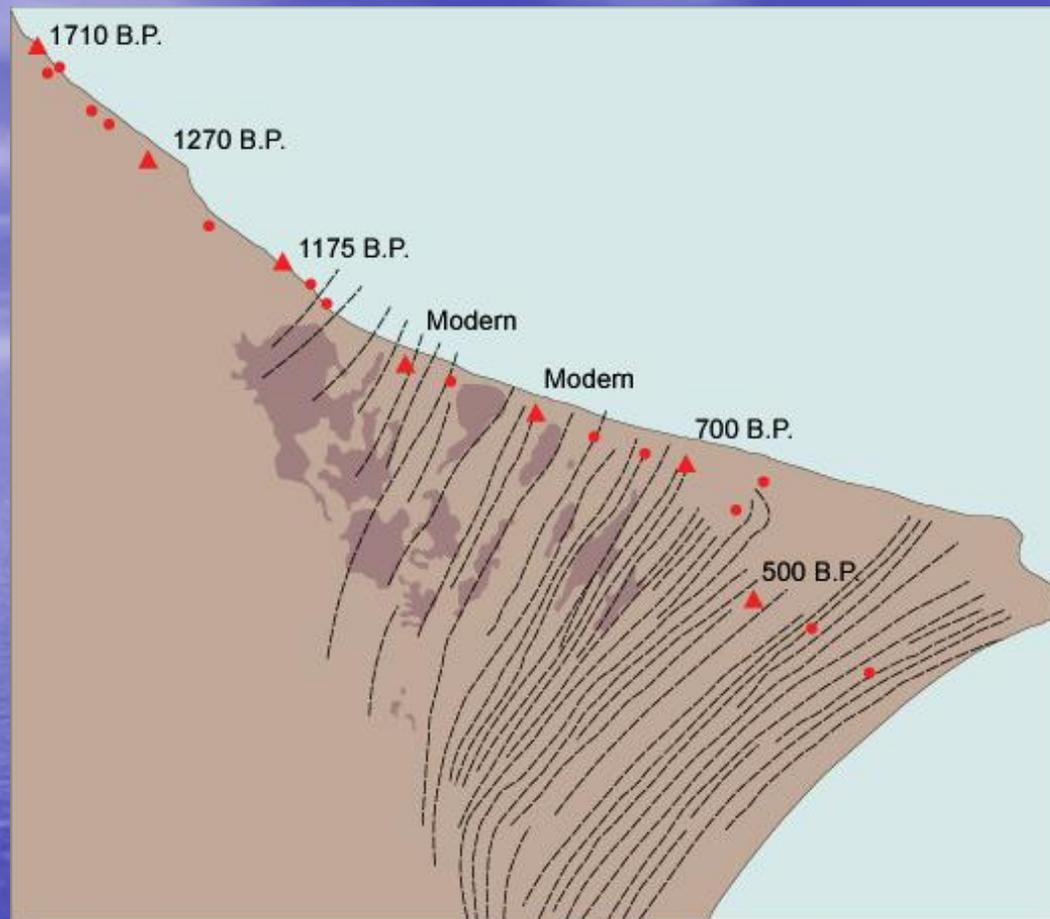






# Cove Point

Cove Point is a cusplate foreland comprised of former active beach ridges that is migrating southward along the western shore of the Bay. It moves southward driven southward by strong winter winds over the maximum "fetch" from the north and northeast. A thesis study by Michael Beardslee of the Univ. of MD dated the movement.

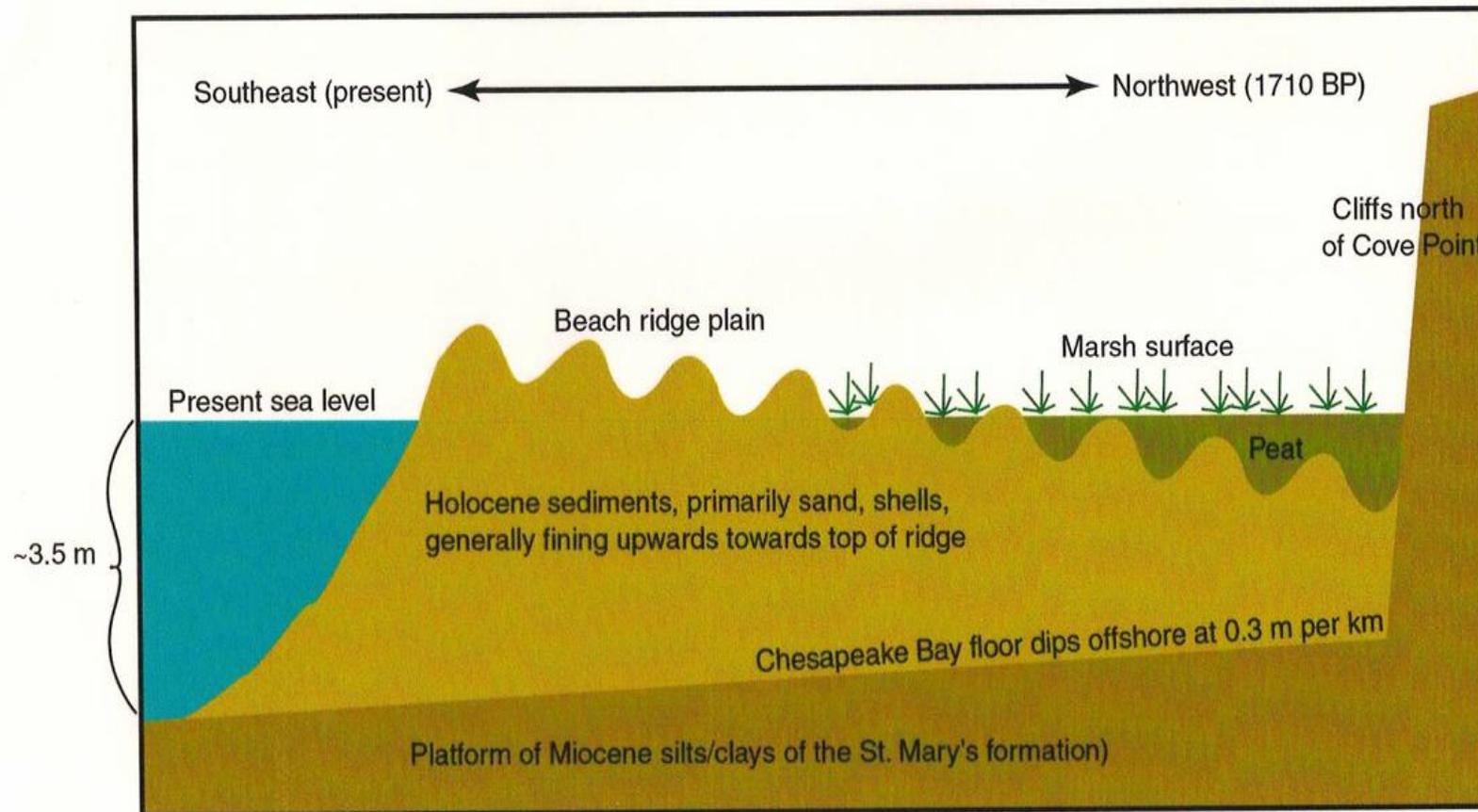


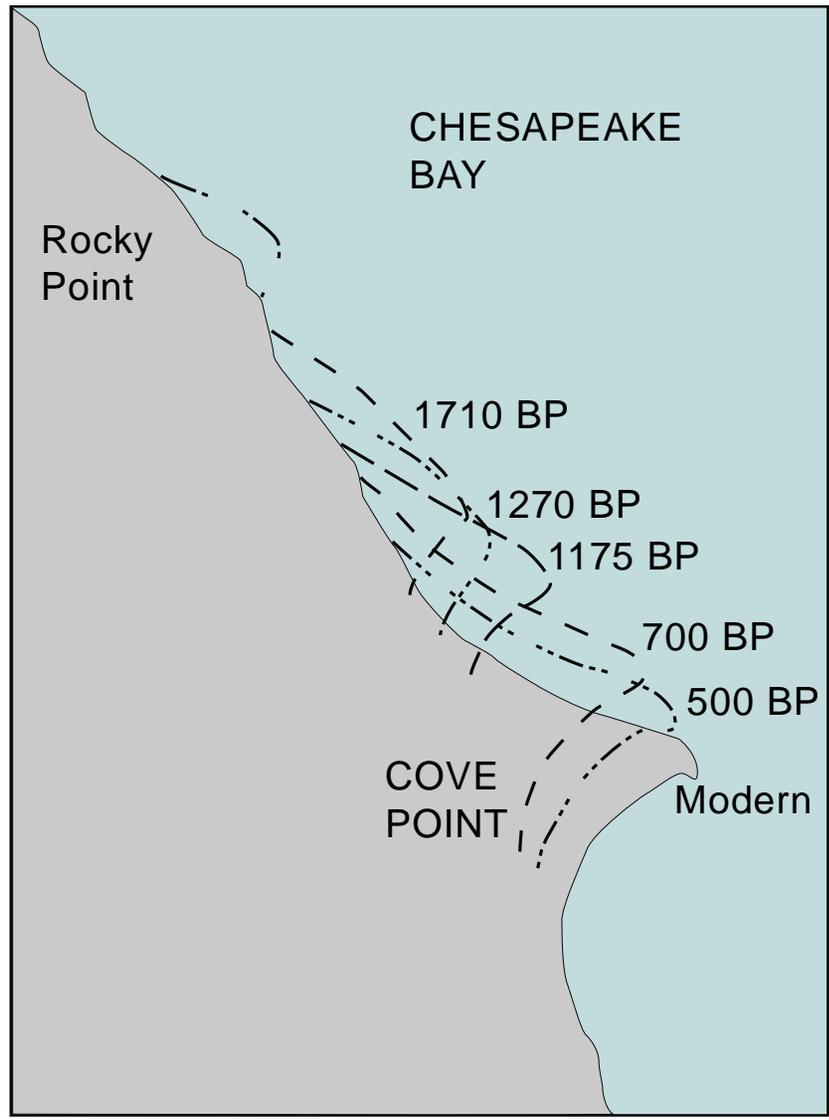
-  1996 GPS Shoreline
-  1938 Beach Ridge
-  1990 Pond
-  Vibracore
-  Vibracore with Radiocarbon Date



Materials dated were wood pieces, three phragmites rhizomes, and one organic sediment.

## Cove Point Cross-section



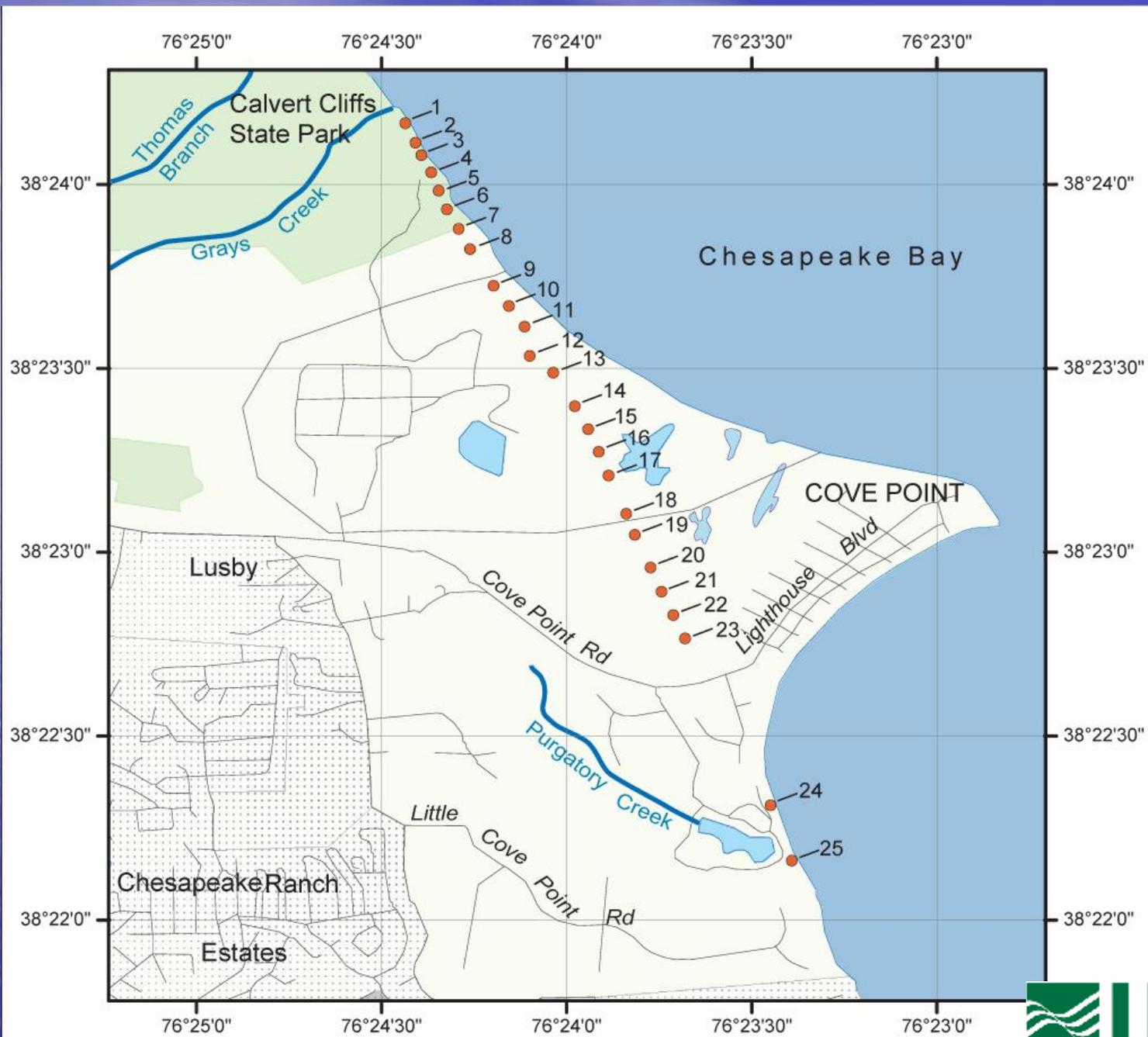


— present shoreline  
- - former shorelines (from radiocarbon dates)



# The Fossil Bluff Line

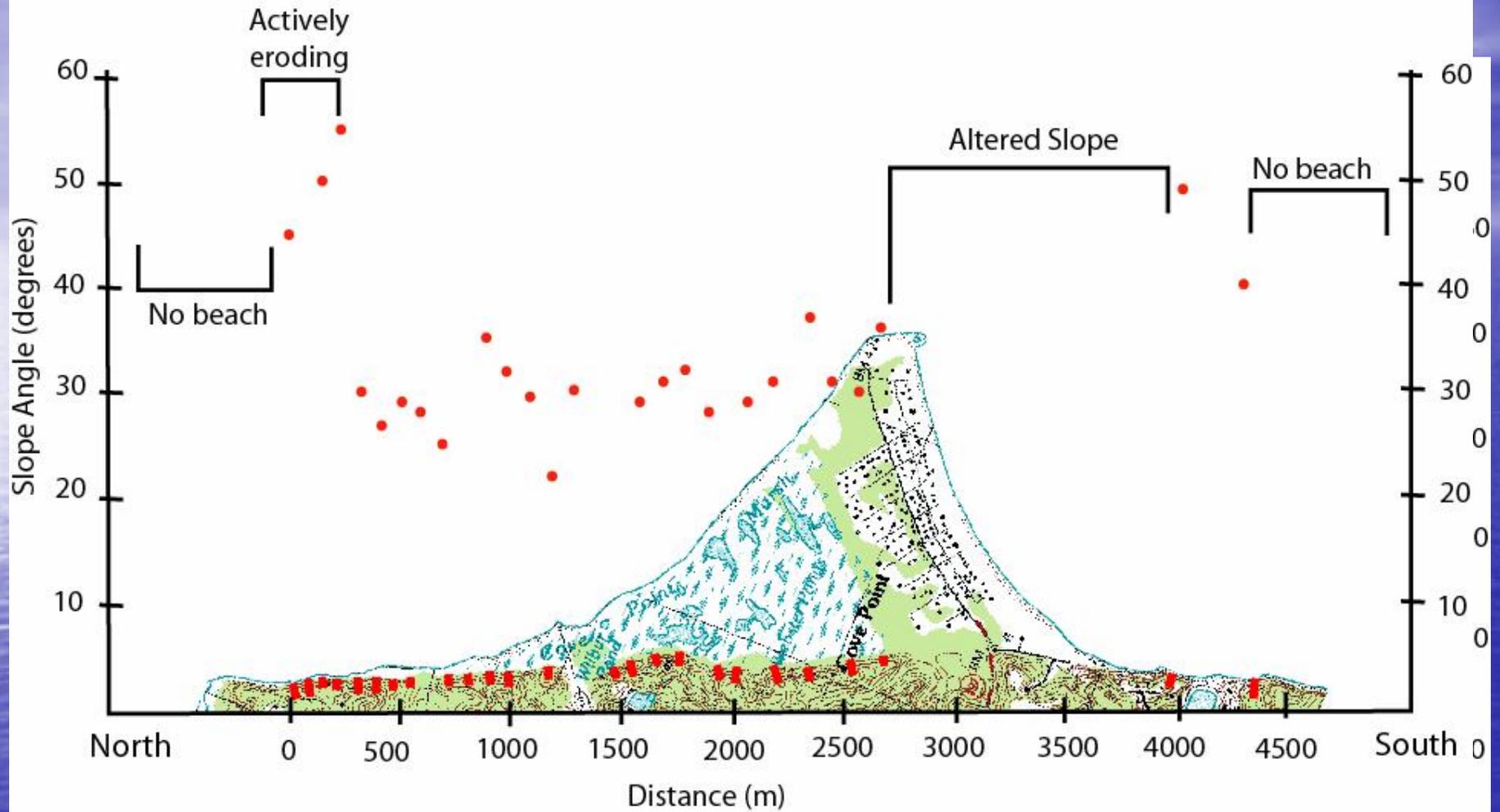
As Cove Point migrated southward it progressively protected actively eroding bluffs from wave action. As a result, the bluff tops began to retreat to establish a stable slope or “angle of repose”. Martha Herzog studied this area to document progressive changes in the slopes over the past 1700 years to determine the rate of change by measuring slopes along this fossil bluff line.



# The Results were Surprising!

- There was no progressive change in slope.
- Rather, all slopes measured had become stabilized over the 1700 years preserved behind Cove Point.
- The mean stable slope angle determined was 35 degrees.
- Over a centennial time scale all slopes had attained stability.

# Cove Point, Maryland



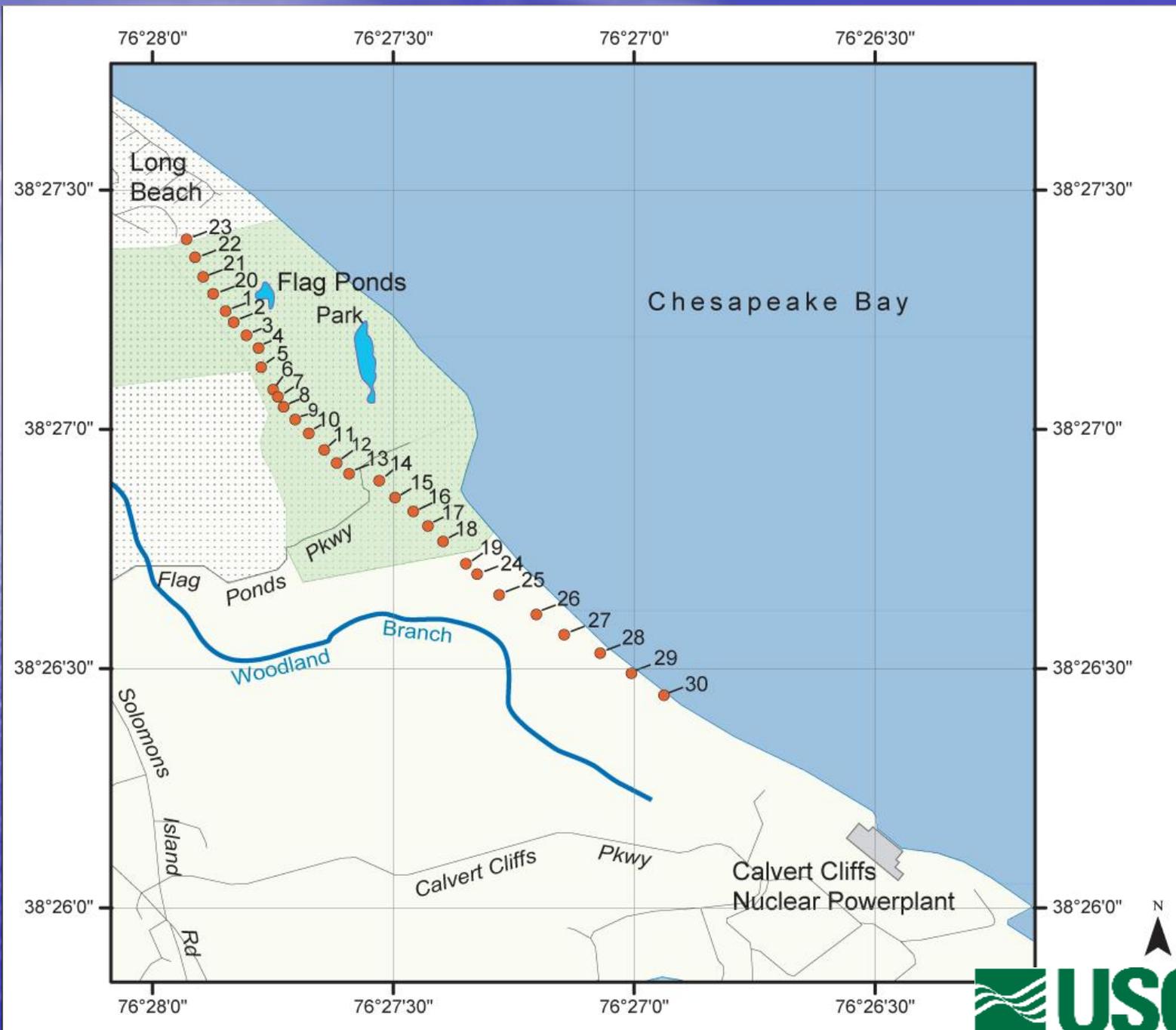
# Flag Ponds Nature Area.

Flag Ponds is a series of sand spits deposited southward along the western side of the Bay derived from sediment from eroding bluffs to the north. These spits progressively protected bluffs from wave attack as well. It provided a second "fossil bluff" line for measuring the rate of change in slopes. Pollen studies of sediments overlying the formerly active beach deposits at the base of the fossil bluff contained Ragweed pollen. This pollen is a time marker for the beginning of European settlement in the area. Hence, these spits were at most 400 years old.



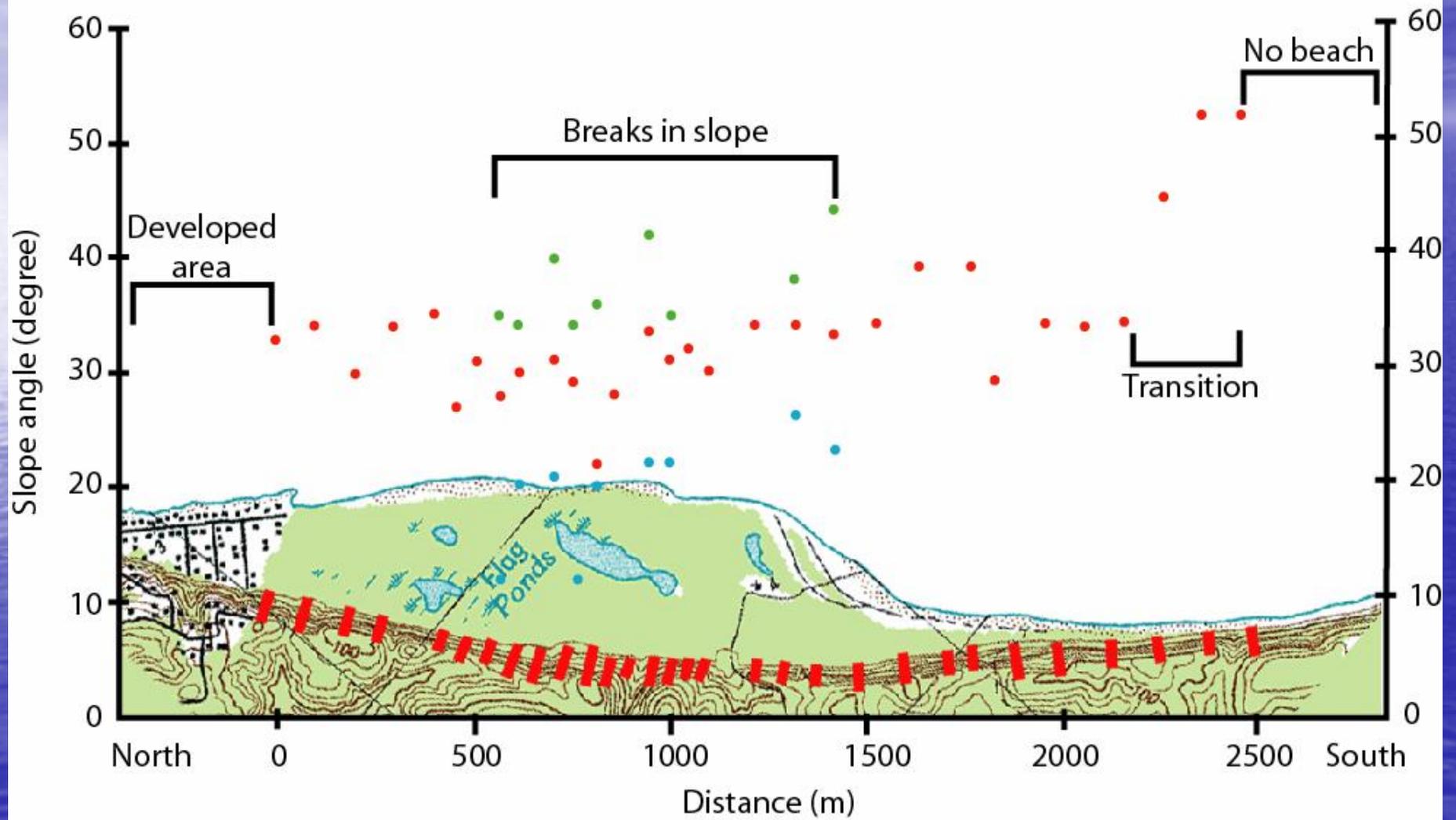


Slope Angles were again  
Measured.



Here again all protected slopes had failed and evolved into stable slopes with a mean slope angle of 35 degrees and  
Within a time frame of 400 years! Clearly this was a rapid process!

# Flag Ponds, Maryland



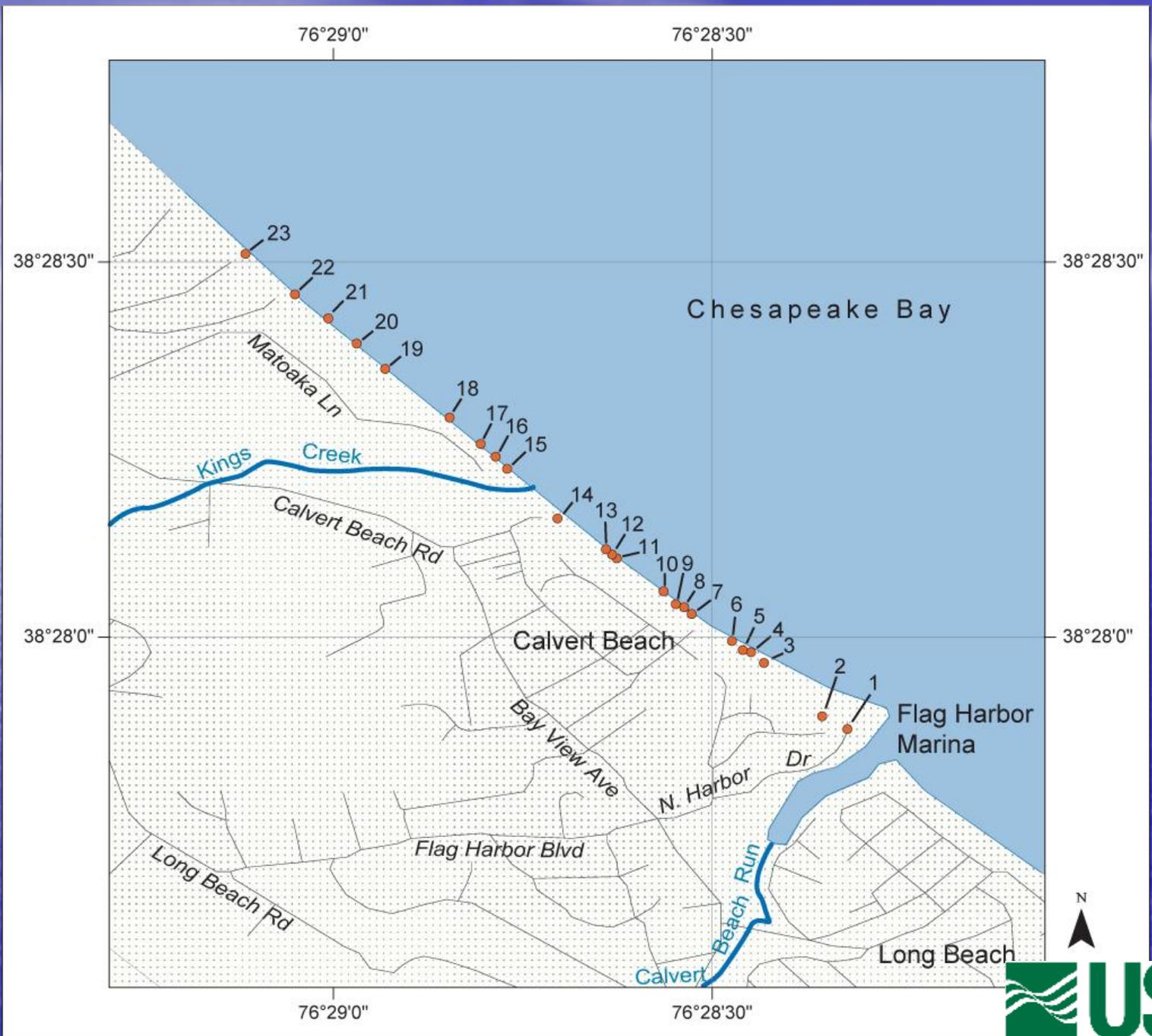
# Flag Harbor

Flag Harbor provided an accurate key to understand the process of slope evolution. The harbor had been created by dredging a channel to link a ravine eroded in the bluffs to establish a marina. The entrance to this channel was then protected by harbor jetties in 1947 to maintain the channel entrance. The northern jetty progressively trapped sediment moving southward along the shore.

For our study, this provided progressive south to north protection of a very young "fossil bluff" behind this wedge of sediment.



Again we measured the  
Slopes.



Photos showing a south to  
north progression in slopes.









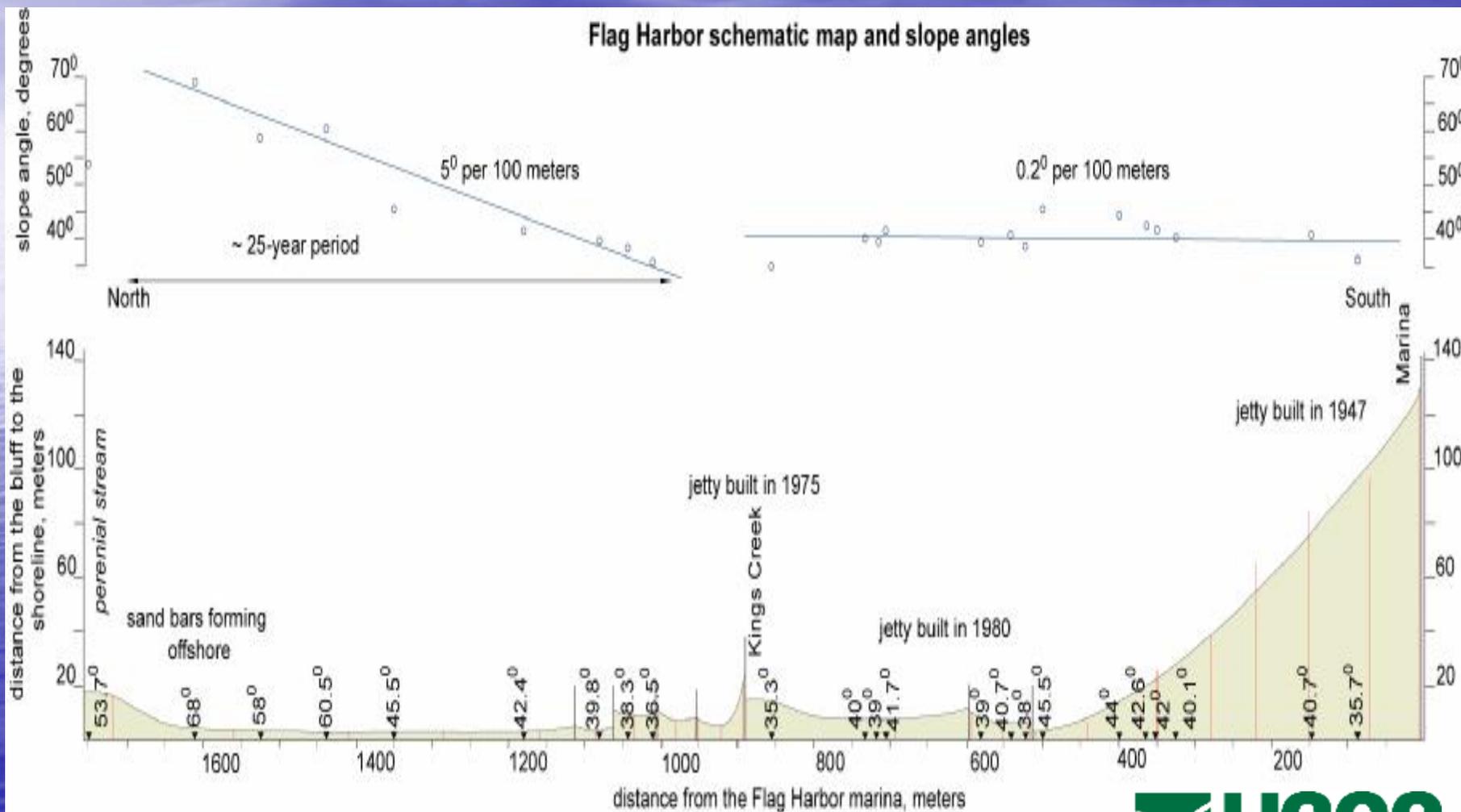


This time there were rates we could relate to in our modern time frame.

The slopes protected since 1947 had all failed and currently had mean slope angles of 40-45 degrees. As important, they were still failing as they tried to attain a stable slope angle.

To the north the progressive change from active wave action and bluff-sloughing to slope retreat through bluff top failure was documented. Once artificially protected, the slope angles changed from 70 degree to 45 degree slopes in 25 years!!

Flag Harbor schematic map and slope angles



# The Conclusion Again:

There are two processes acting on eroding sea cliffs.

The most obvious process is bluff retreat.

The second is slope failure and bluff top retreat until a stable angle of repose is attained. Along the Calvert Cliffs, the stable angle is 35 degrees.

Once the first process ends, the bluff top recedes until the stable slope angle is reached. **IN CALVERT COUNTY THIS TAKES PLACE IN ONLY 30 YEARS—THE LENGTH OF A MORTGAGE.**

In short, any attempt to stop bluff recession by retarding wave erosion of the toe of the bluff results in immediate bluff top retreat.



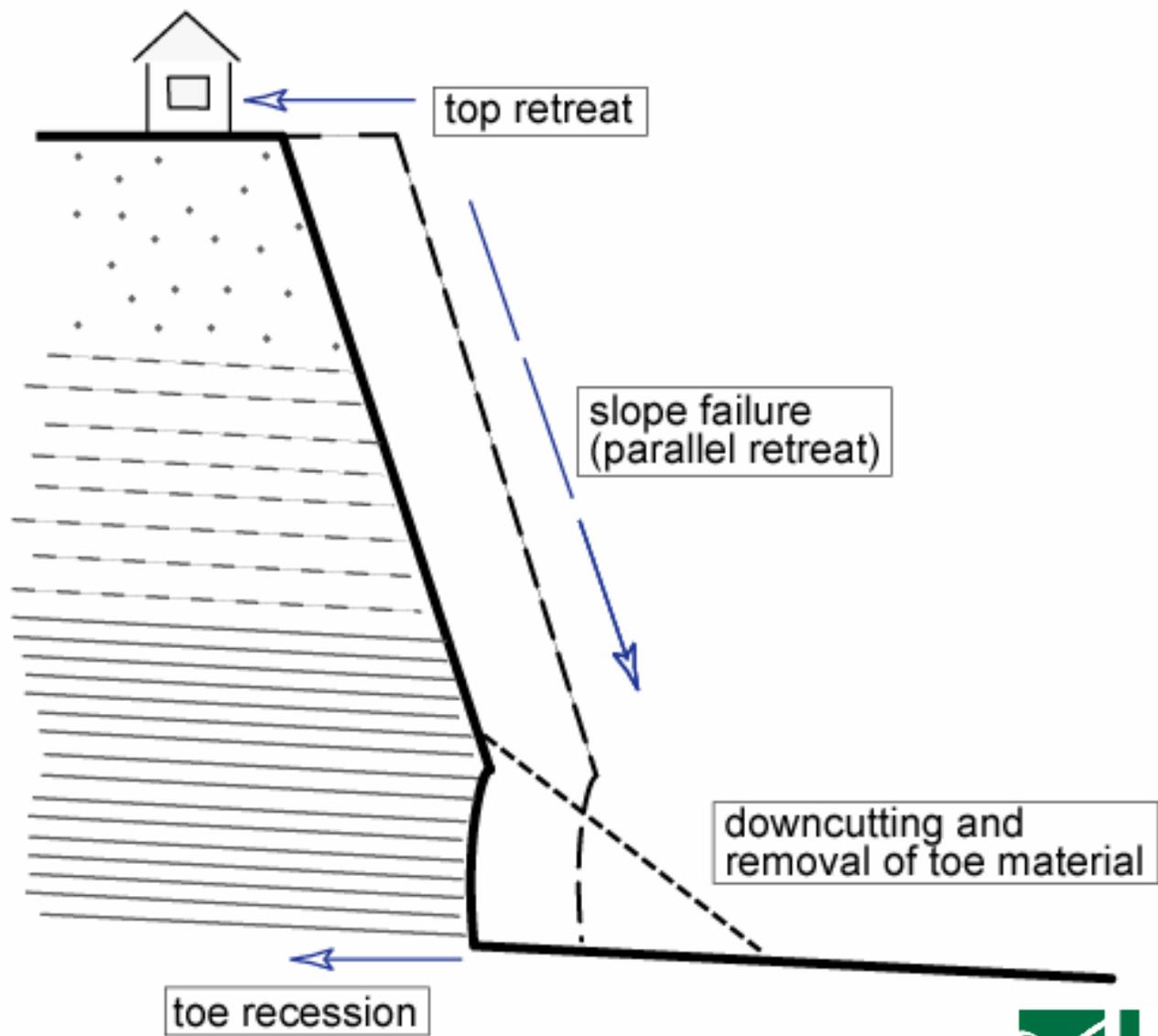
# The Dilemmas

Let the bluffs erode or protect  
them from receding?



Consider Current Bluff Retreat:

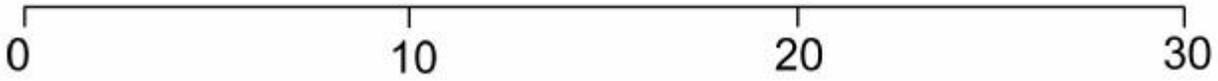
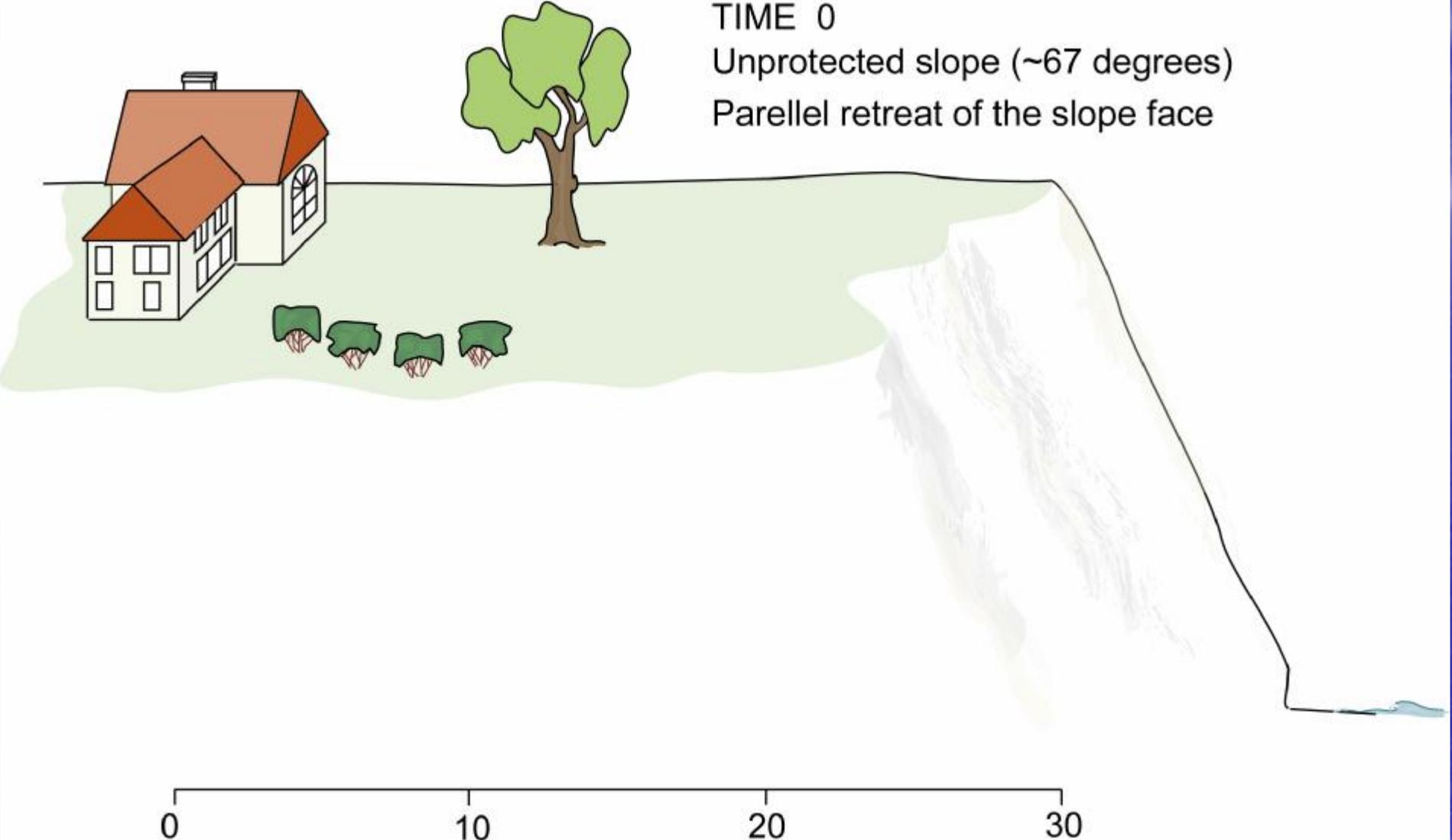




# Example 1:

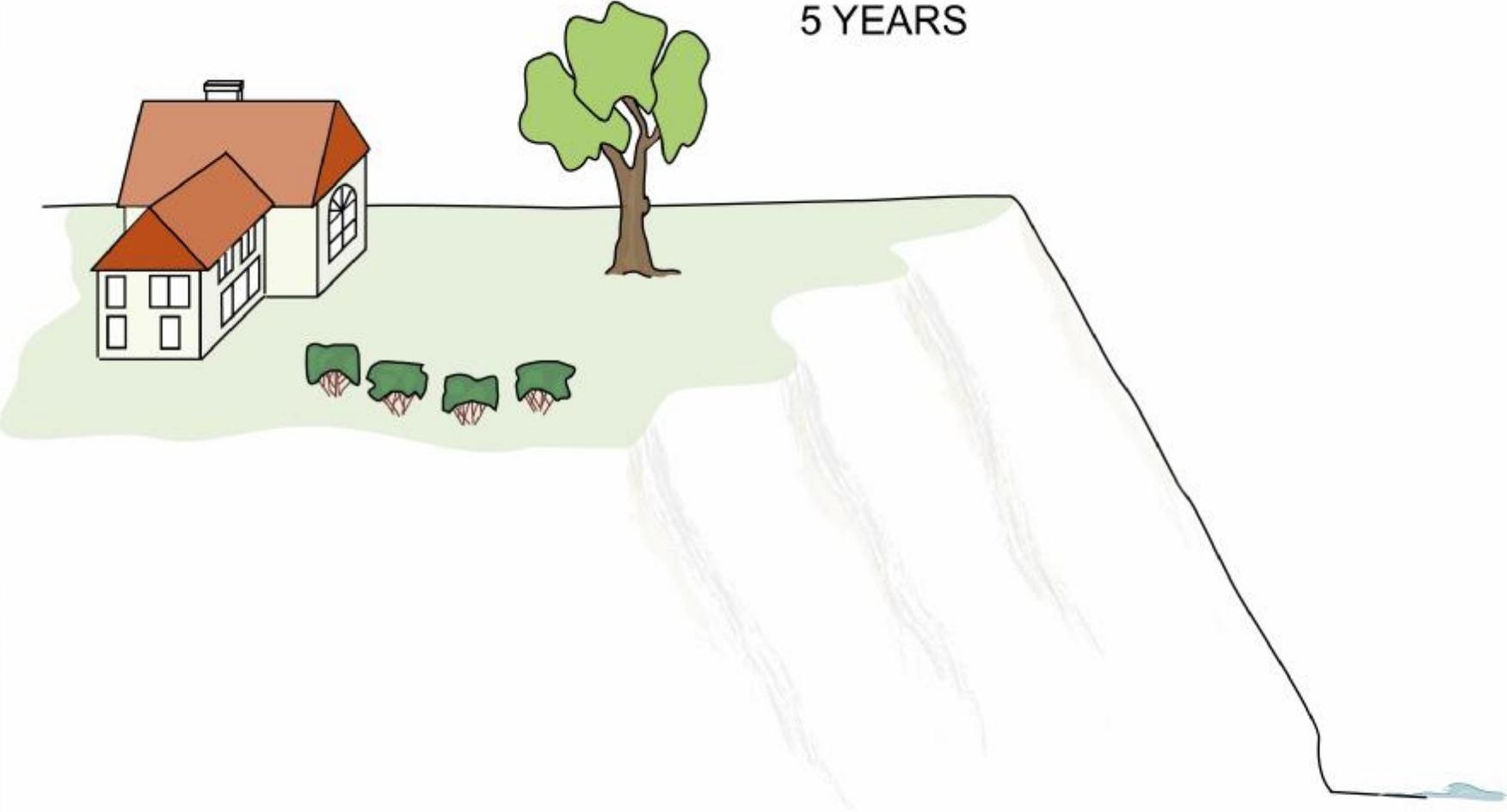
- A 20 m (60 ft) bluff standing and receding at 1 m (3 ft) per year and with
- A house located 30 m (100 ft) from the bluff edge.

TIME 0  
Unprotected slope (~67 degrees)  
Parallel retreat of the slope face



distance, m  
scale 1:1

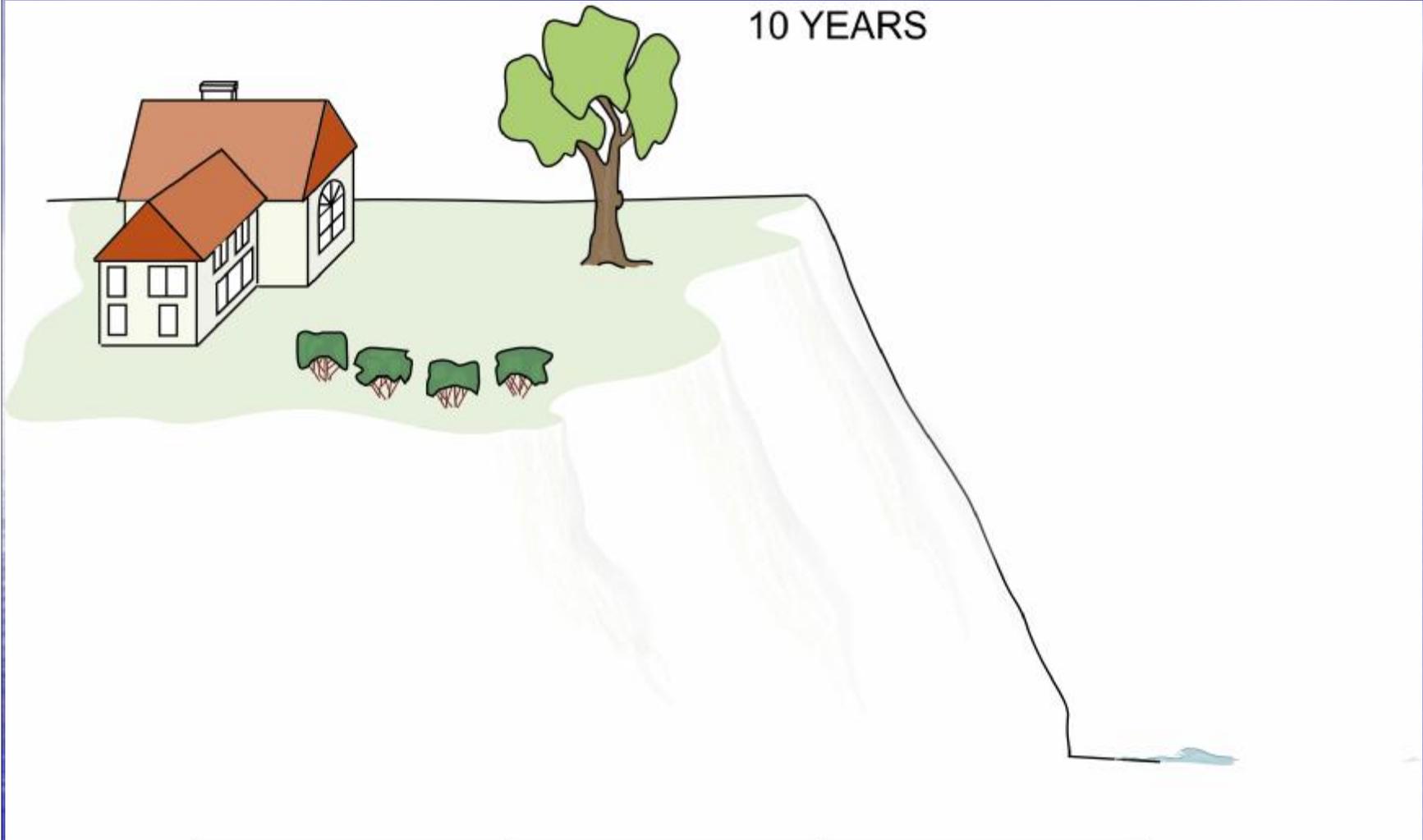
5 YEARS



0 10 20 30

distance, m  
scale 1:1

10 YEARS



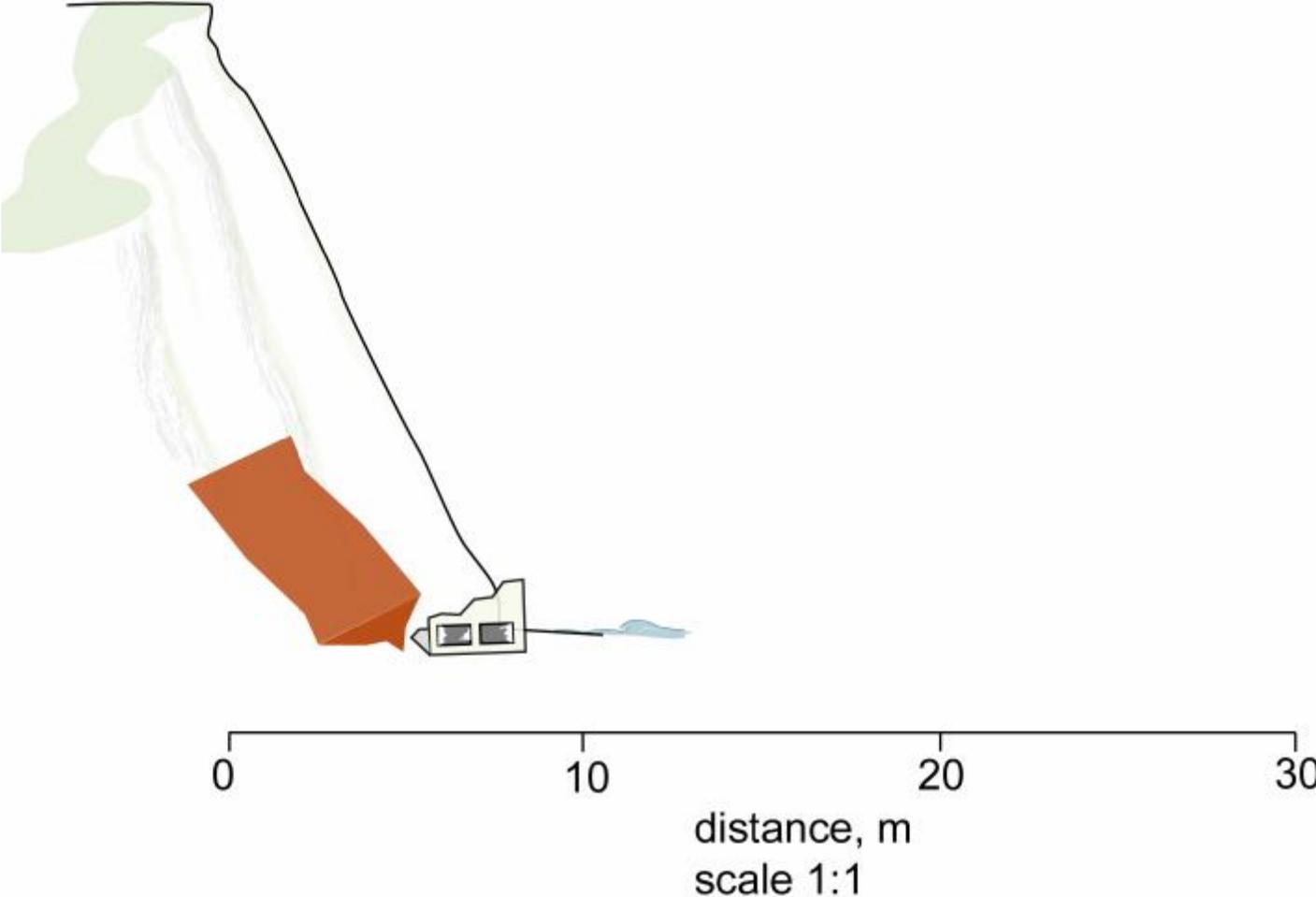
distance, m  
scale 1:1

20 YEARS

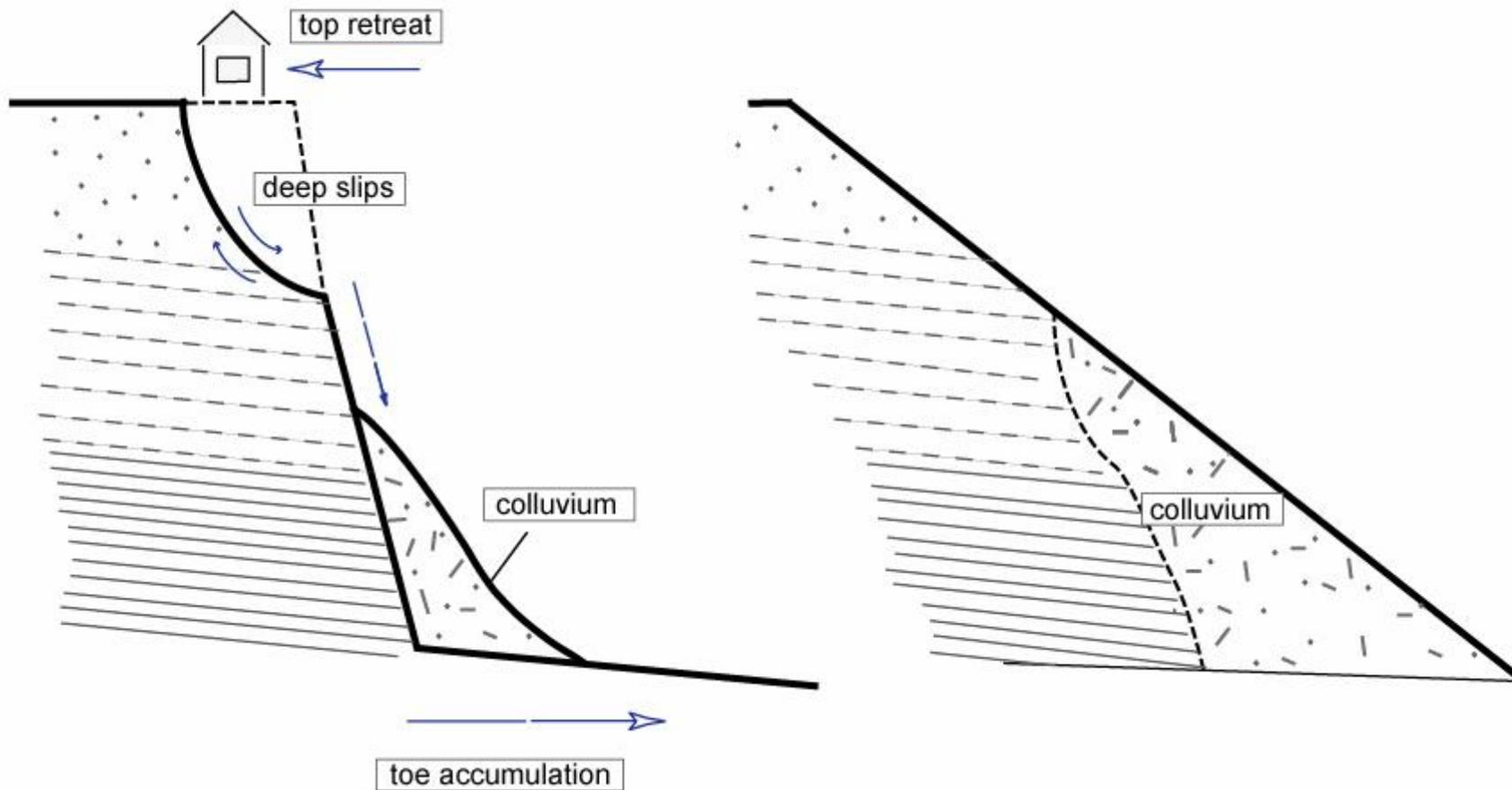


distance, m  
scale 1:1

30 YEARS



# And Evolution of a Stable Slope



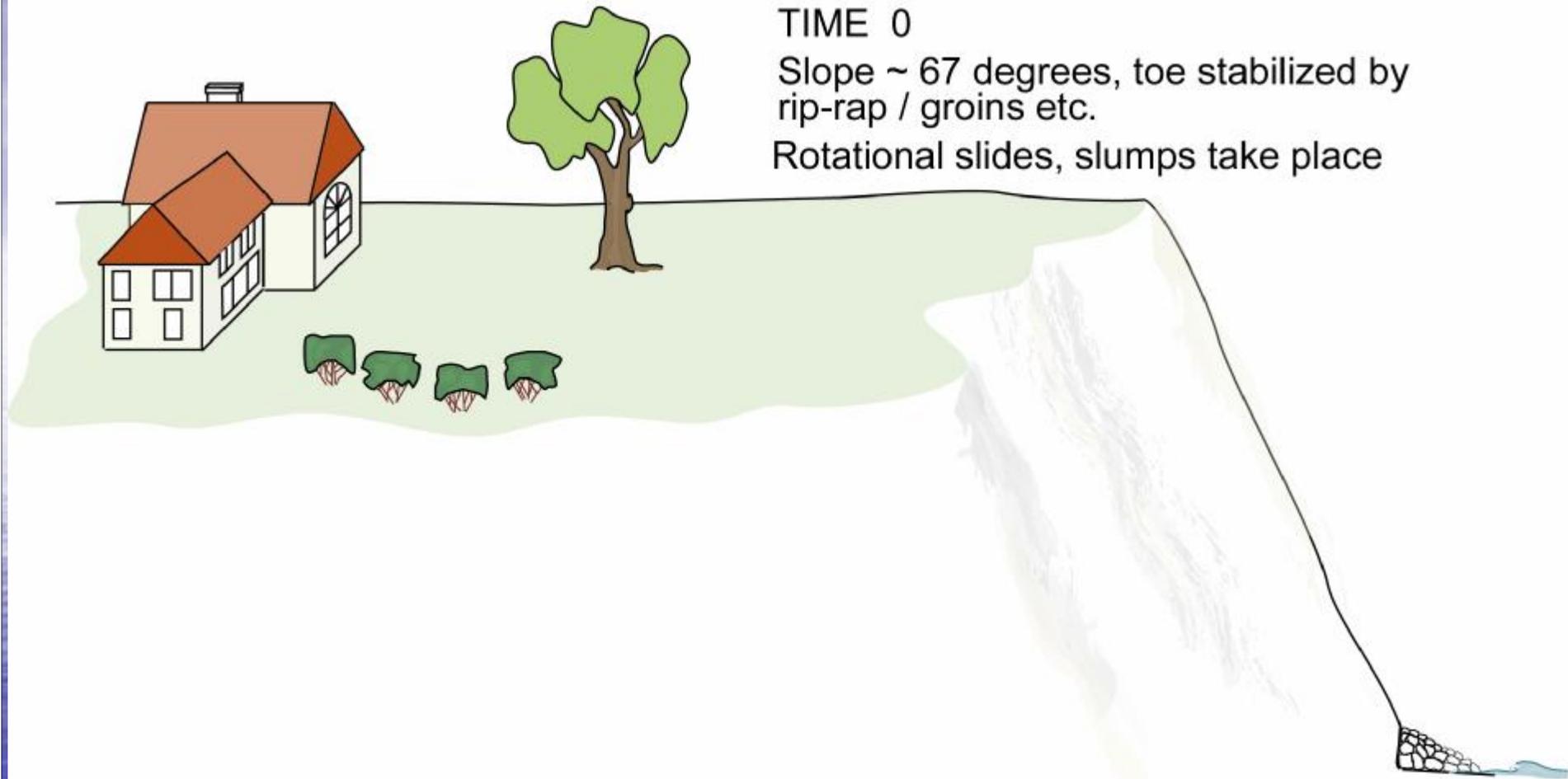
## Example 2:

- Here is that same house, but this time we have protected the toe of the slope with armor stone or “rip rap”.

TIME 0

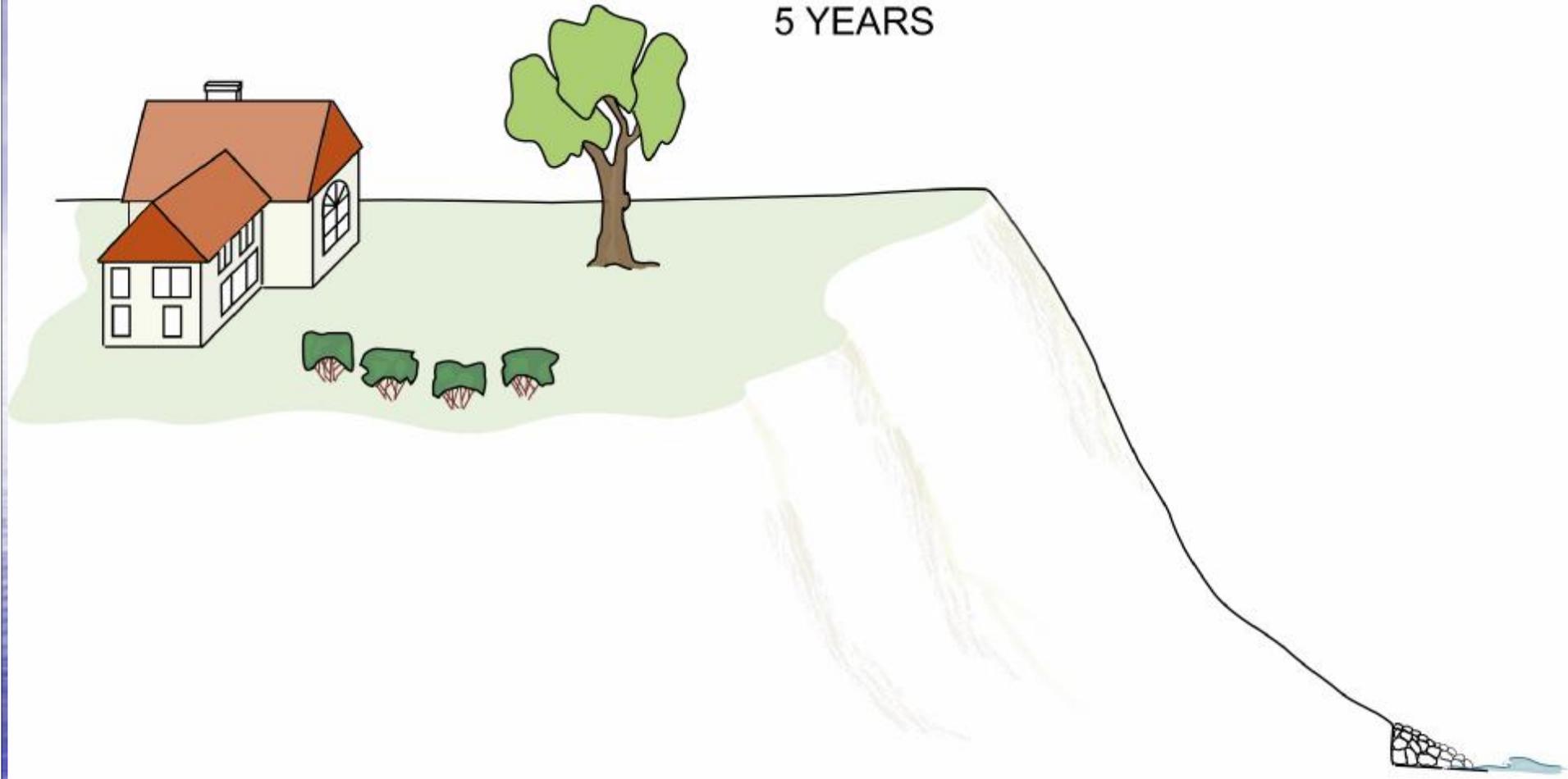
Slope ~ 67 degrees, toe stabilized by rip-rap / groins etc.

Rotational slides, slumps take place



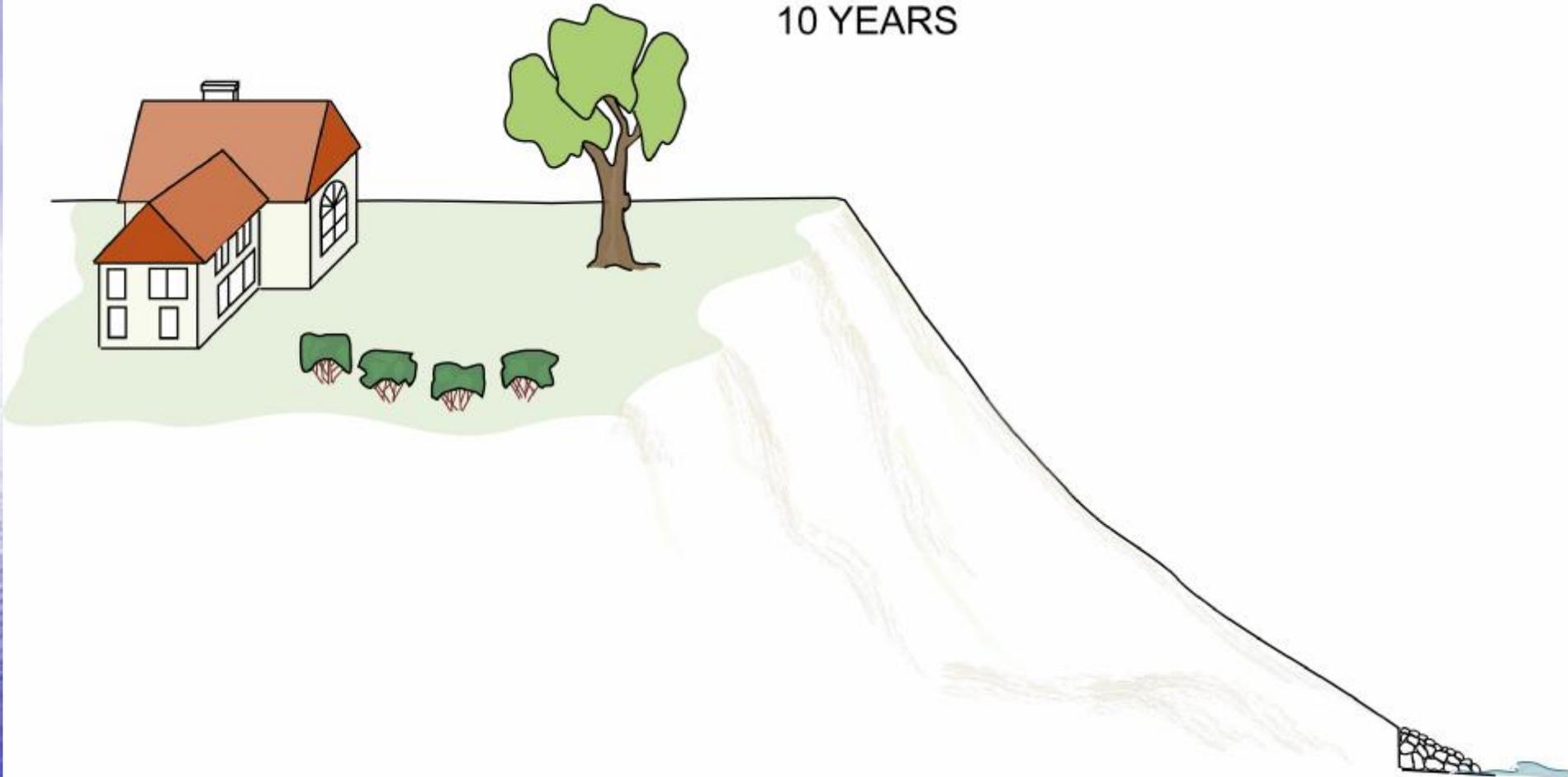
distance, m  
scale 1:1

5 YEARS



distance, m  
scale 1:1

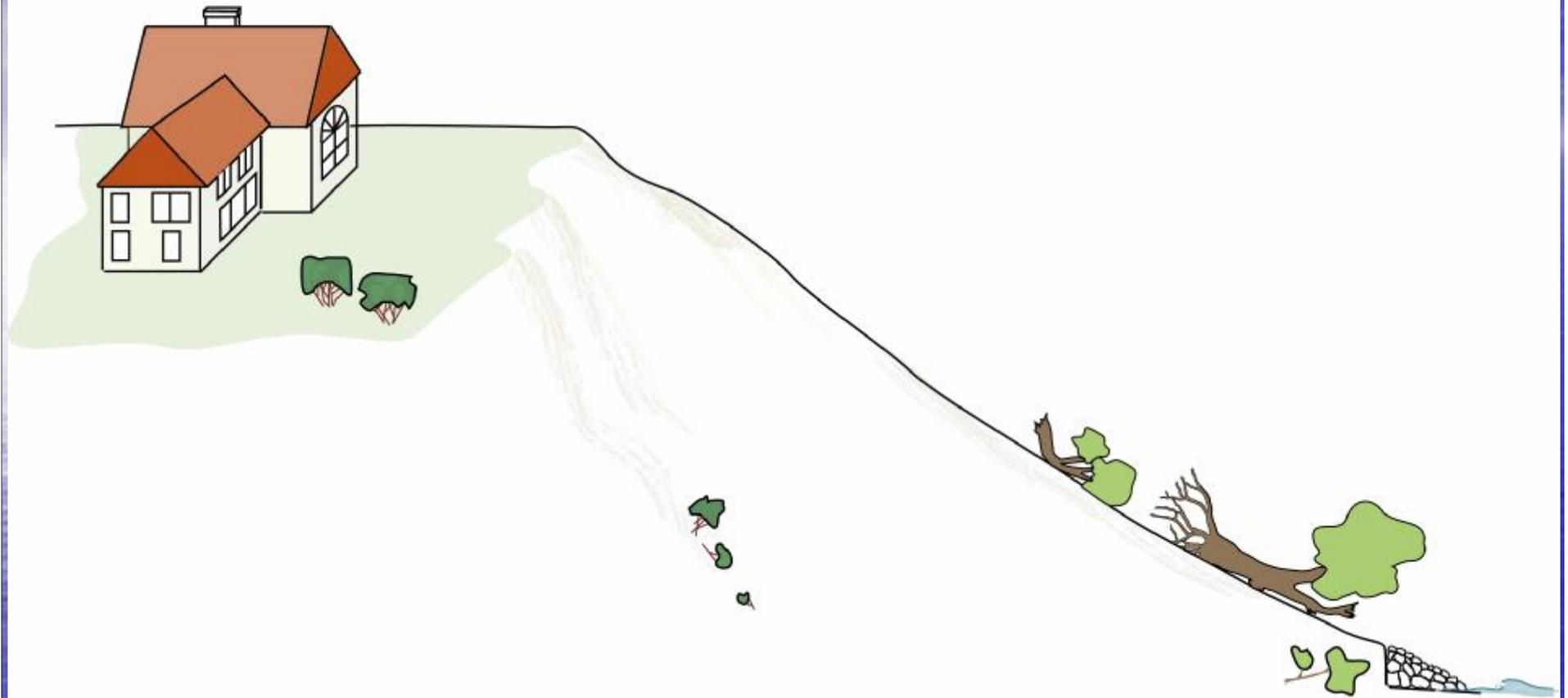
10 YEARS



0 10 20 30

distance, m  
scale 1:1

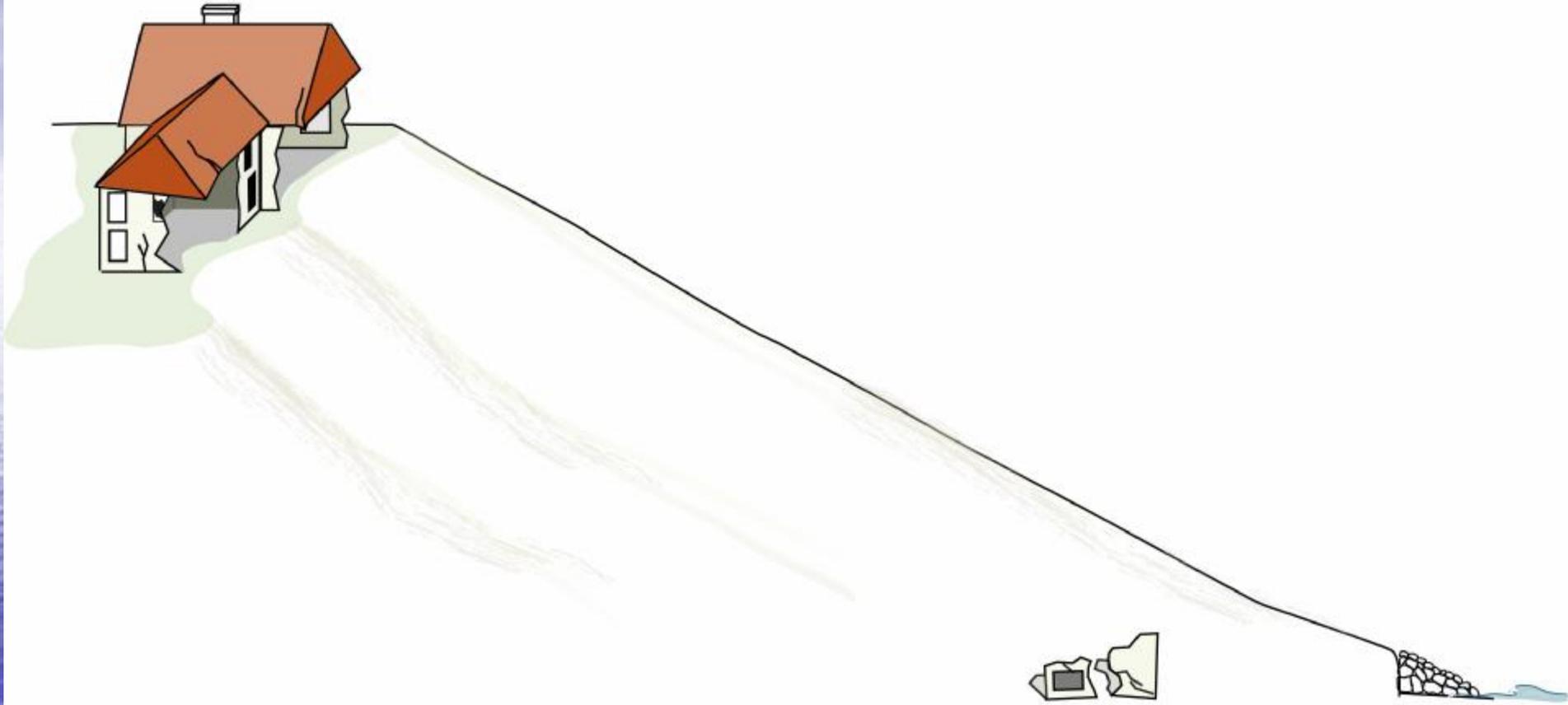
20 YEARS



0 10 20 30

distance, m  
scale 1:1

30 YEARS



distance, m  
scale 1:1

# So What Can We Do?

- The property owner doesn't want to hear this.
- The real estate interests certainly don't either.
- Can zoning help?
- Are setbacks possible?

If we choose setbacks, they aren't simple static lines.

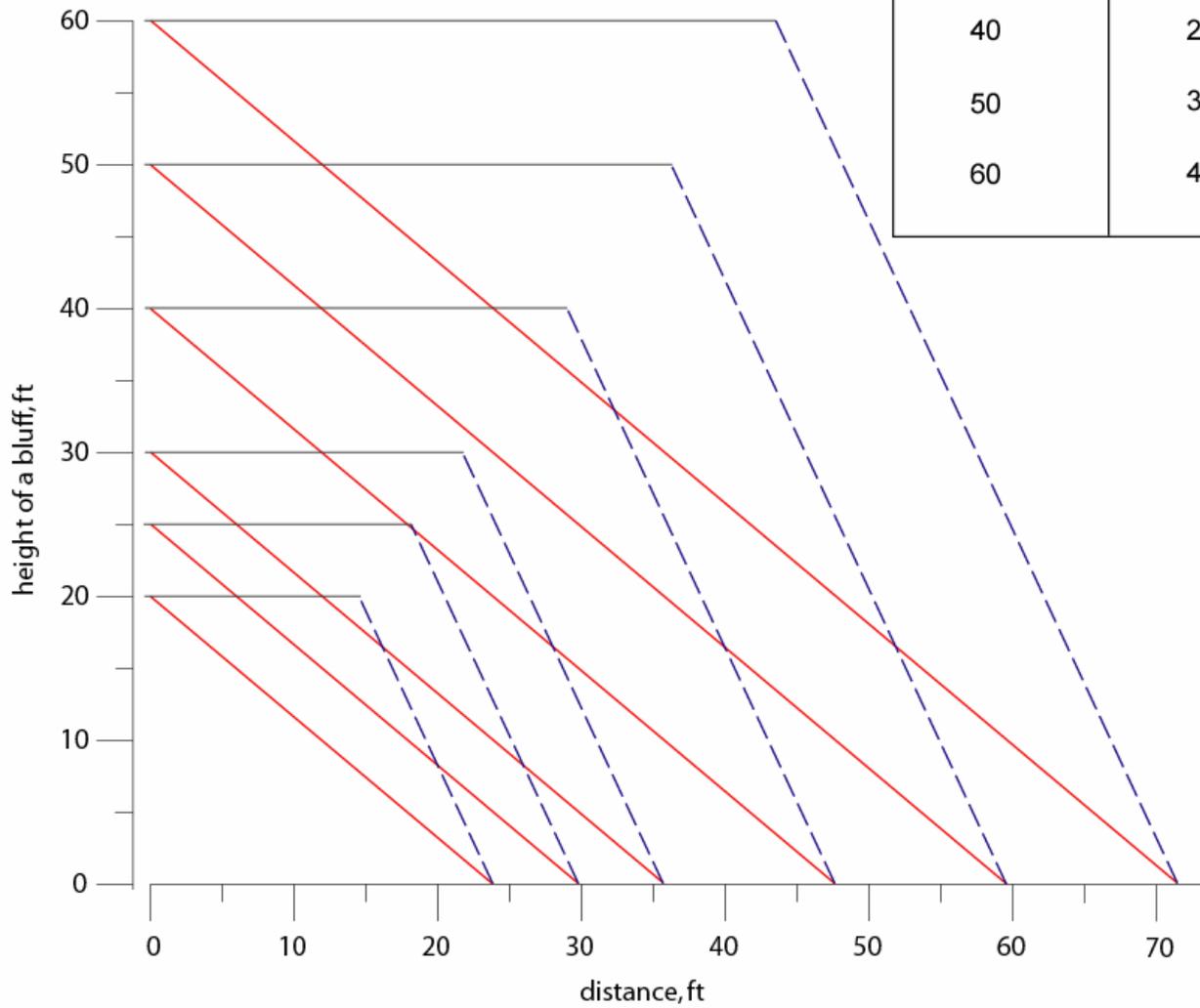
Here is an example of the degree of slope retreat as a function of bluff height.



Slope Set-Back Calculators for  
Calvert Cliffs, Calvert County, MD

40 degree angle of repose

bluff height, ft	set-back, ft
20	14.5
25	18
30	22
40	29
50	36
60	43.5



# Or Should We Just Let the Bluffs Retreat?

Is it cheaper to buy threatened properties rather than try to protect them?

Perhaps it would be more user friendly to help property owners to move their houses away from the brink.

Those of us in the scientific community can't make policy.

When push comes to shove, the tough decisions rest with state and local government. But our sense is that they don't want to hear this message either. BUT we will at least help to explain the realities.



Slope Set-Back Calculators for Calvert Cliffs, Calvert County, MD

45 degree angle of repose

bluff height, ft	set-back, ft
20	10
25	13
30	16
40	21
50	26
60	32

