Chesapeake Bay Stream and Floodplain Ecosystem Services

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A Community on Ecosystem Services

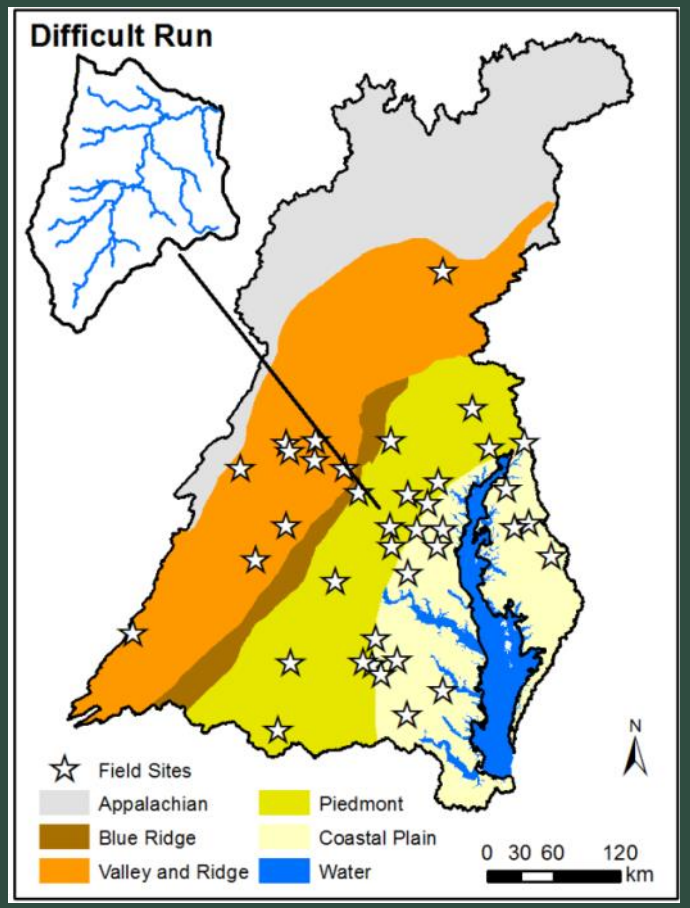
December 2016

U.S. Department of the Interior
U.S. Geological Survey

USGS

Introduction

- **Chesapeake Bay Pilot**
  - Restoration and protection a priority for stakeholders
  - High development pressure
- **Motivation**
  - Lack of information on ES and values applicable to local scale
- **Project Goal**
  - Provide ES information on streams and floodplains at scale useful to inform decision-making



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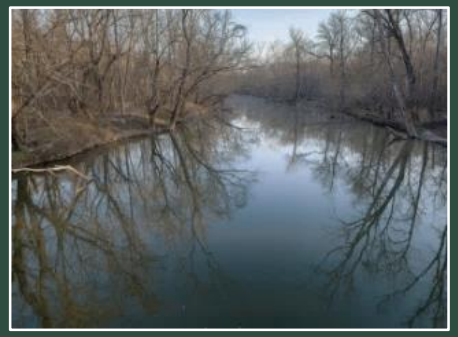
Floodplain Ecosystem Services

Capacity of floodplain to **retain sediment, nutrients, and flood waters** provides critical ecosystem services to local and downstream communities

Ecosystem Services of Interest



Nutrient/Sediment Retention

Flood Attenuation

Carbon Sequestration

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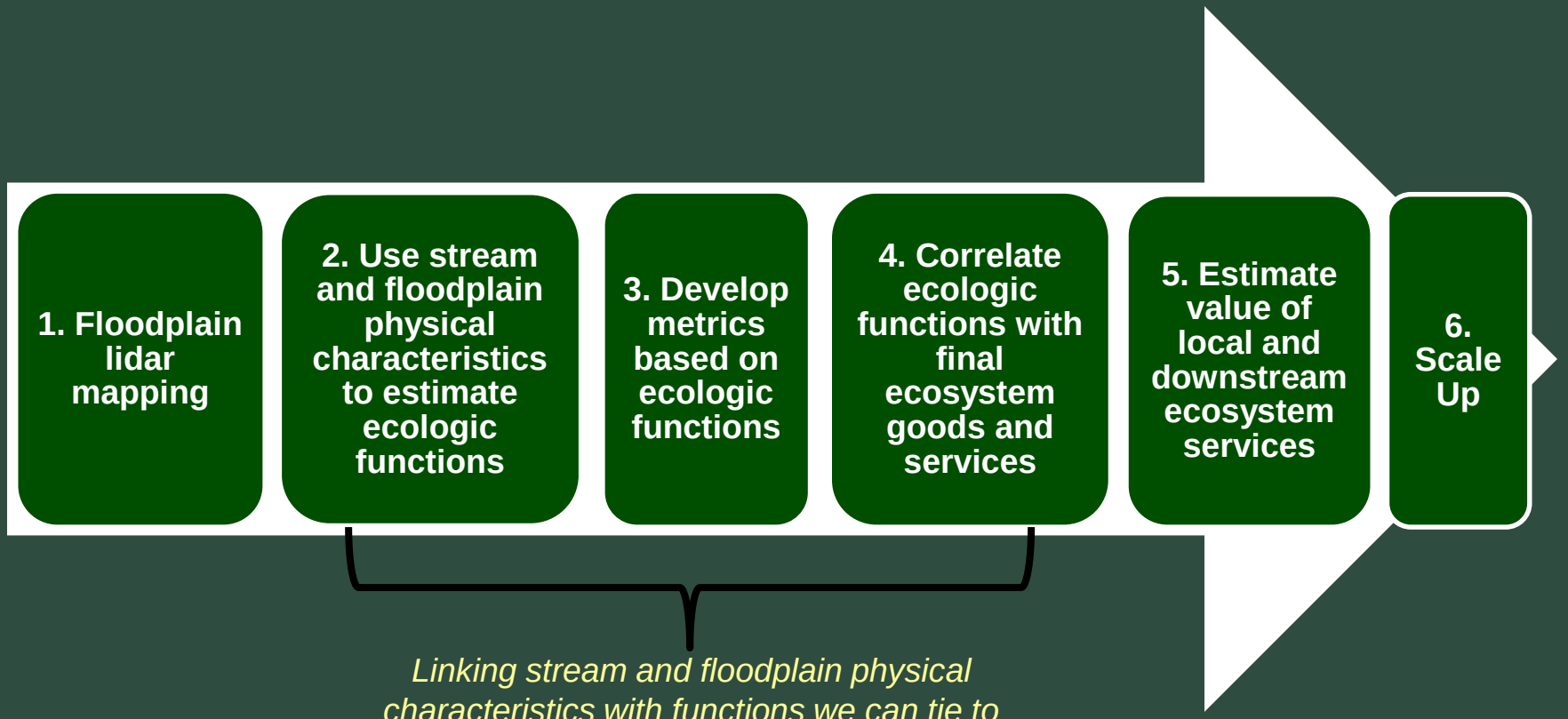
Photos courtesy of Chesapeake Bay Program

Project Approach



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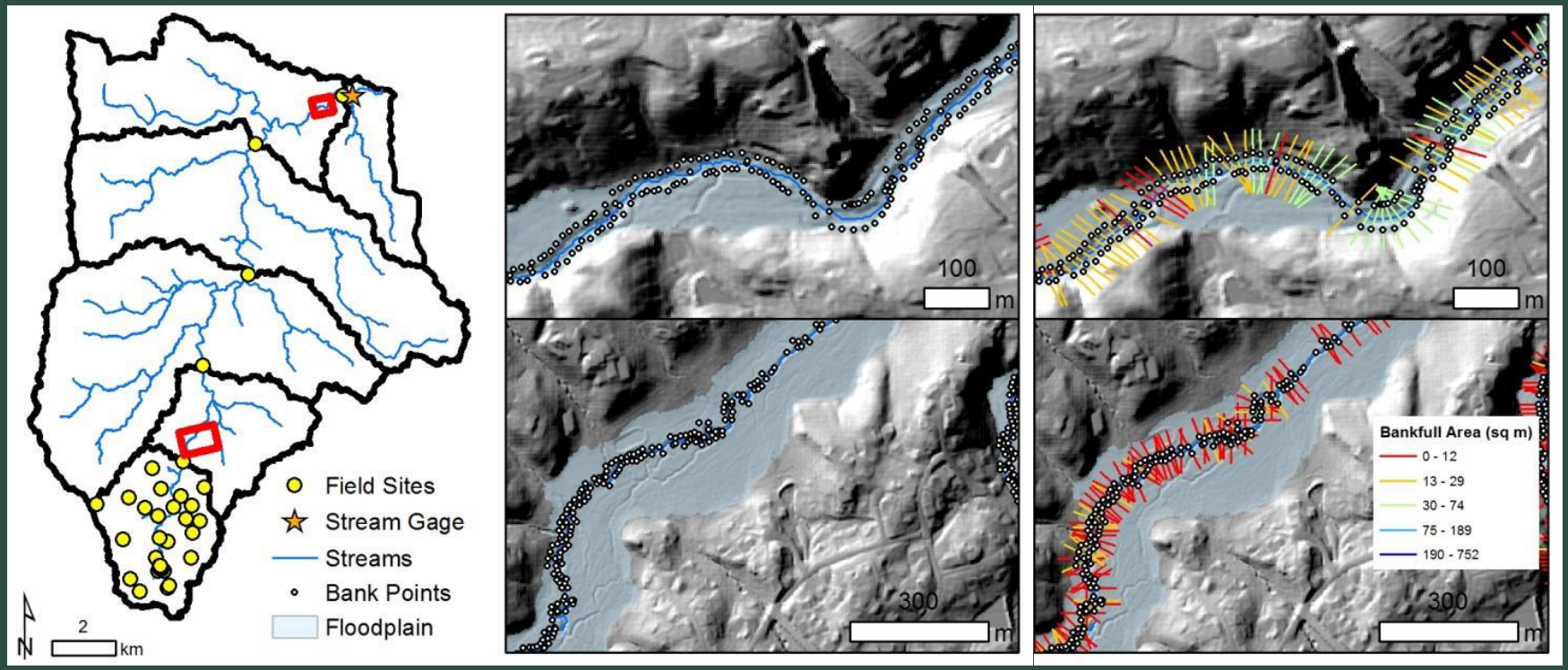
Lidar Mapping



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Sediment and Nutrient Retention Linking Functions to Services

Ecosystem Function → **Ecosystem Service**

Floodplains retain sediment and nutrients

Loads of sediment and nutrients are reduced

Improved water quality

Opportunity to:

- view the environment
- to swim, wade, boat
- catch fish

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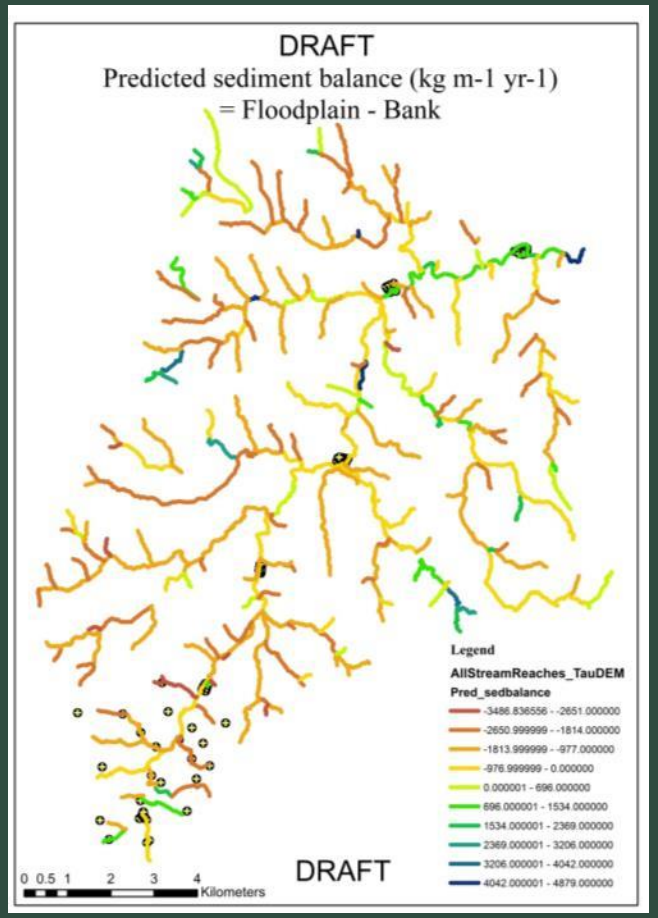
Photos courtesy of Chesapeake Bay Program

Quantifying Sediment and Nutrient Retention

- **Field estimates of sediment, nitrogen, & phosphorus**
  - Bank erosion
  - Floodplain deposition
  - Net flux

- **Stream reach predictions of flux of sediment, nitrogen, & phosphorus**



Courtesy of Greg Noe

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Sediment and Nutrient Retention Translating Services to Values

Link loads to water quality

Link water quality to final services

Valuing final services

Lower nutrient and sediment loads

Improved water quality

Opportunity to:
- view the environment
- to swim, wade, boat
- catch fish

Willingness to Pay for recreation

Proxy
Replacement costs of wastewater treatment

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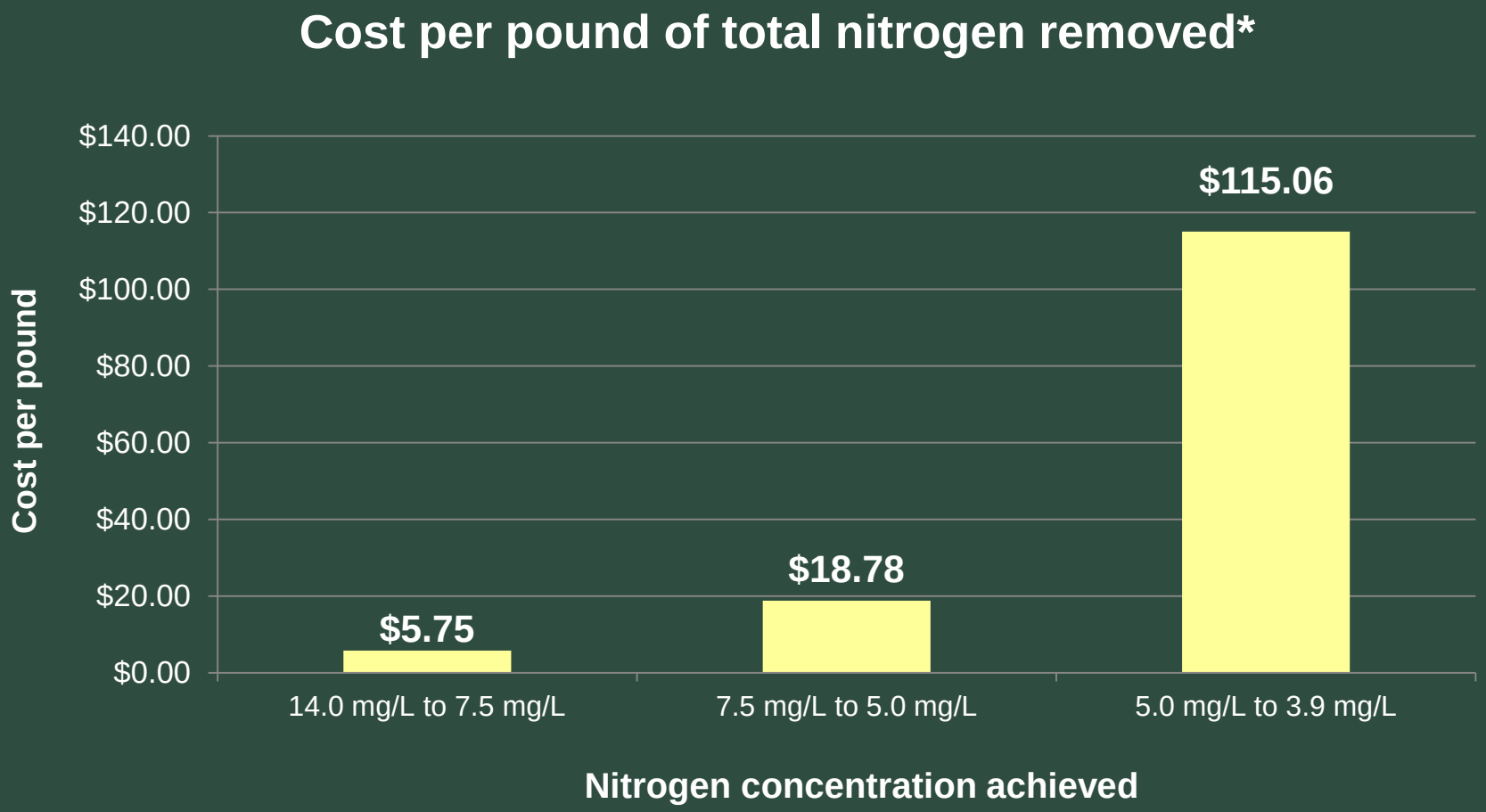
Photos courtesy of Chesapeake Bay Program

Replacement Cost Method

- Estimating consumer surplus is ***currently intractable***
- As a proxy, assessing replacement costs of nutrient and sediment retention services provided by floodplains
- $V_e = \sum_i R_i * P_i$

Photo courtesy of DC Water

Difficult Run Preliminary Results



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*These data are preliminary and are subject to revision. They are being provided to meet the need for timely 'best science' information. The assessment is provided on the condition that neither the U.S. Geological Survey nor the United States Government may be held liable for any damages resulting from the authorized or unauthorized use of the assessment.

Flood Attenuation
Linking Functions to Services

Ecosystem Function → **Ecosystem Service**

Floodplains store water during precipitation events

Stream peak flows are reduced

Adjacent community flooding reduced

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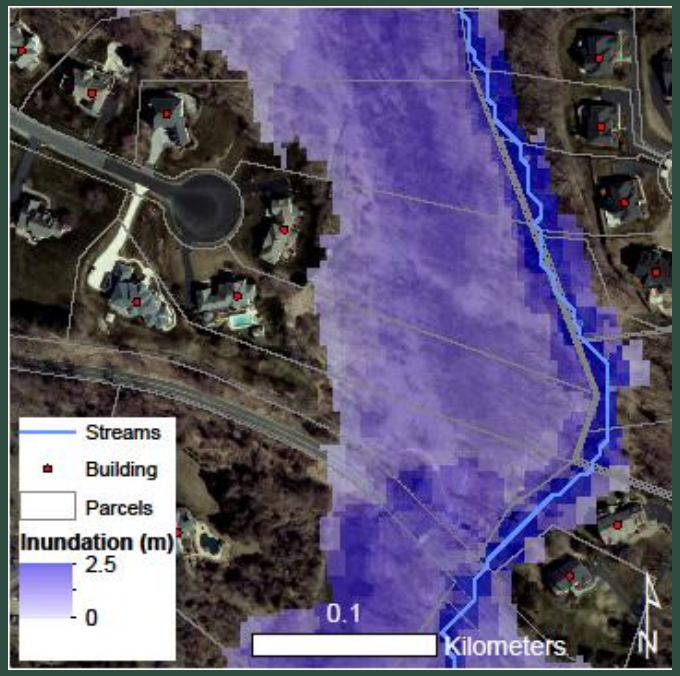
Photos courtesy of Chesapeake Bay Program

Quantifying Flood Mitigation

Estimate inundation for baseline (*w/ floodplain*) and counterfactual scenarios (*w/o floodplain*) using GIS Flood Tool[1]

h = 8.2 ft



h = 22.2 ft

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[1]Verdin et al., (2016). *A software tool for flood inundation mapping*. USGS Report 2016-1038.
Basemap imagery from ESRI and Digital Globe data

Flood Attenuation
Translating Services to Values

Method Development: Translating flood attenuation to services and economic values

Link water storage to flood attenuation

Link flood attenuation to avoided damages

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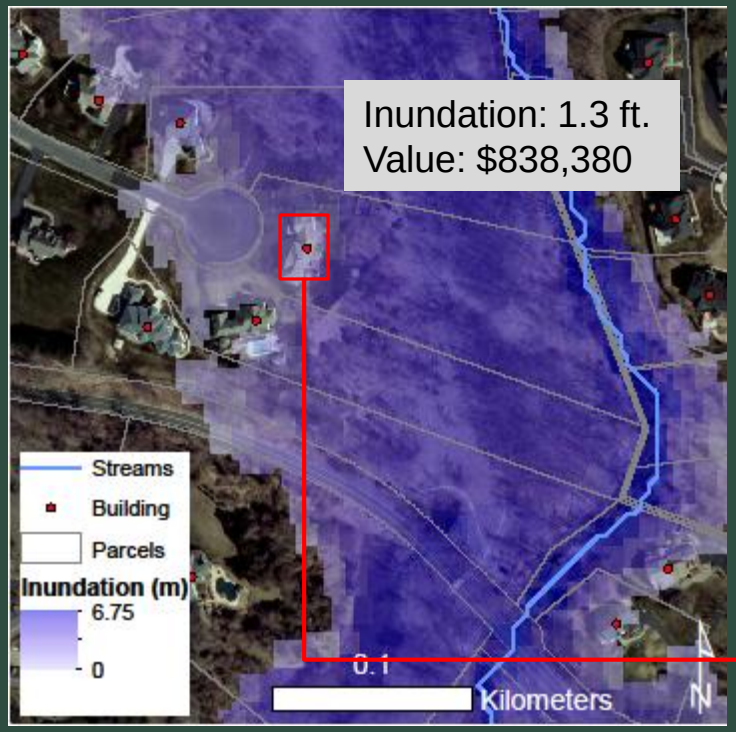
Photos courtesy of Chesapeake Bay Program

Estimating Flood Damages Avoided

Depth-Damage curves

- **Developed by FEMA using insurance claims**



$$Damage = 0.28 \times \$838{,}380 = \$234{,}736$$

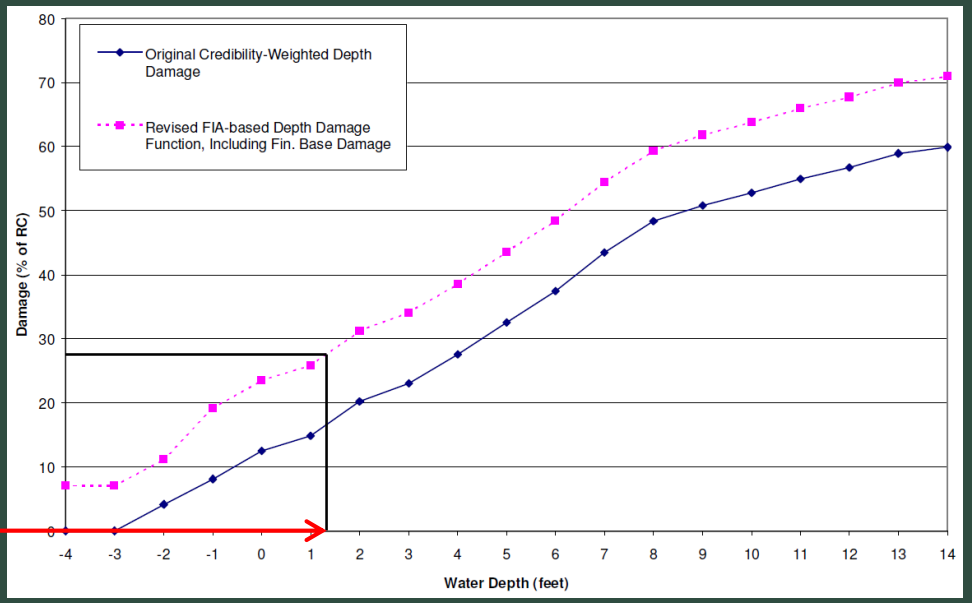


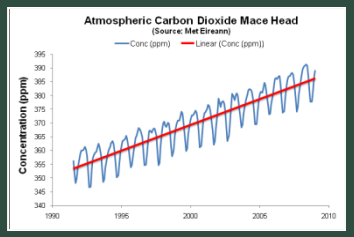
Figure from FEMA (2013). *Multi-hazard loss estimation methodology, Flood Model, Technical Manual.*
Basemap imagery from ESRI and Digital Globe data

Carbon Sequestration
Linking Functions to Services

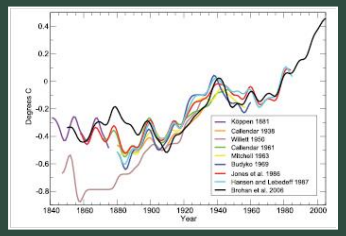
Ecosystem Function → **Ecosystem Service**

Floodplains store carbon in soils and biomass

Lower carbon inputs to the atmosphere



Lower atmospheric carbon



Reduced climate change

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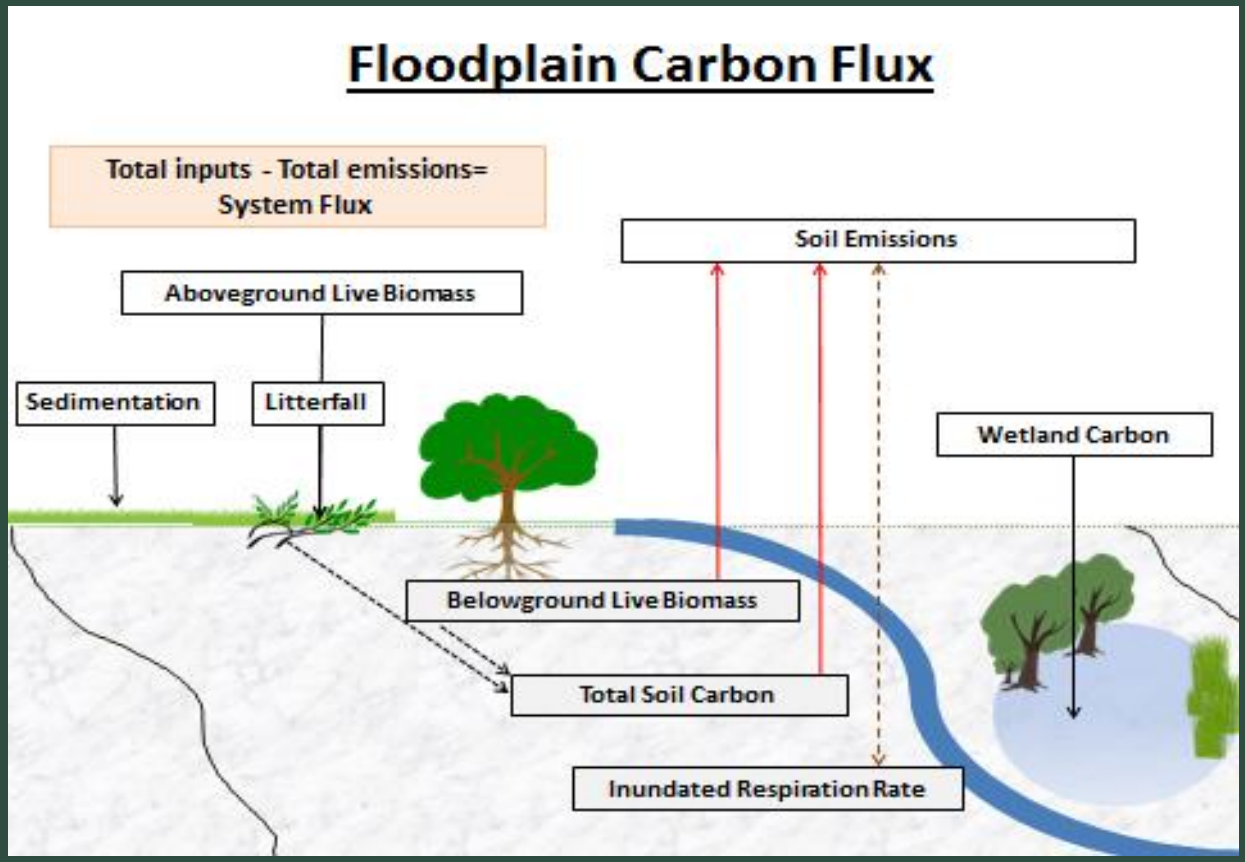
Photos courtesy of Chesapeake Bay Program

Determining Floodplain Carbon Flux

Using literature values to estimate carbon flux



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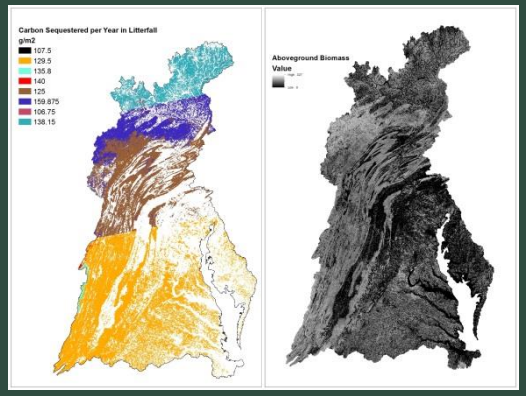
Carbon Sequestration
Translating Services to Values

Select relevant floodplain areas

Extract Carbon flux from geospatial datasets



Social Cost of Carbon

$43.32 per ton of CO_{2eq} per year

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Photos courtesy of Chesapeake Bay Foundation

Research Significance

- ES info provides decision-makers with critical data:
  - Nutrient and sediment retention capacity of floodplains
  - Flood mitigation capacity of floodplains
  - At local and watershed wide scales
  - Human impacts and values to understand tradeoffs
- Analysis may support targeting of conservation and/or restoration
- Research continues in Chesapeake Bay, new work underway in Delaware River Watershed
  - Grant from William Penn Foundation (FY17-19)
  - Refine USGS Toolkit

USGS


Questions??
DIFFICULT RUN