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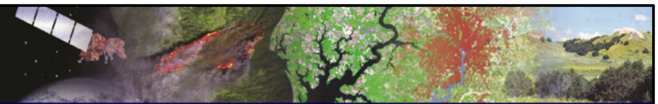

Potential GIS data for mapping floodplains in the Chesapeake Bay watershed

Daniel Jones
Physical Scientist
Eastern Geographic Science Center (EGSC), Reston VA

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

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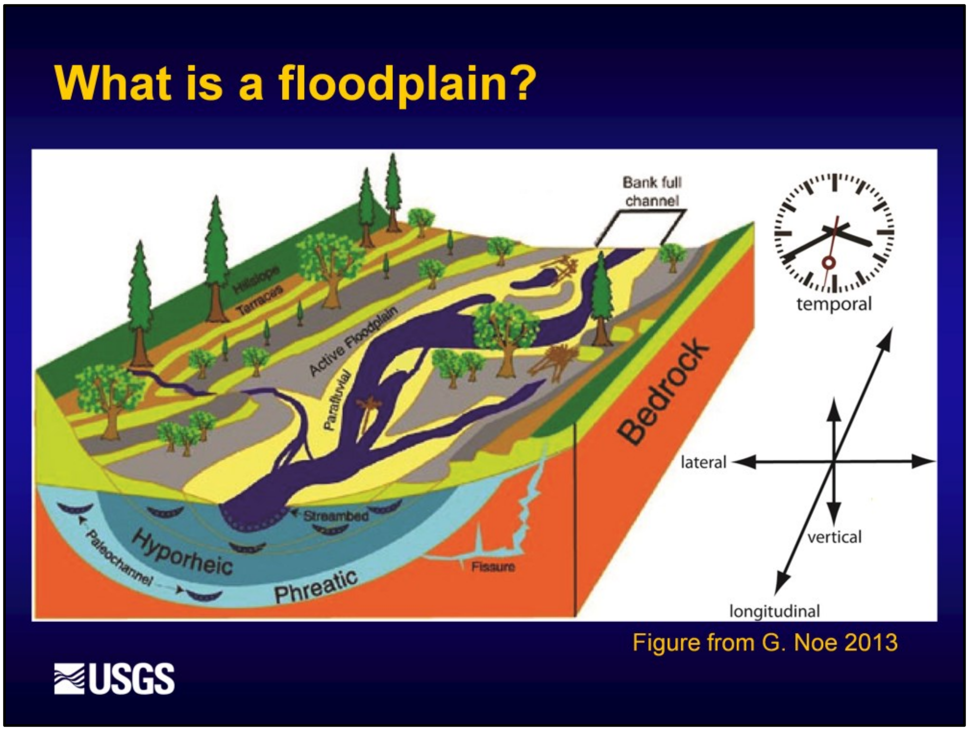
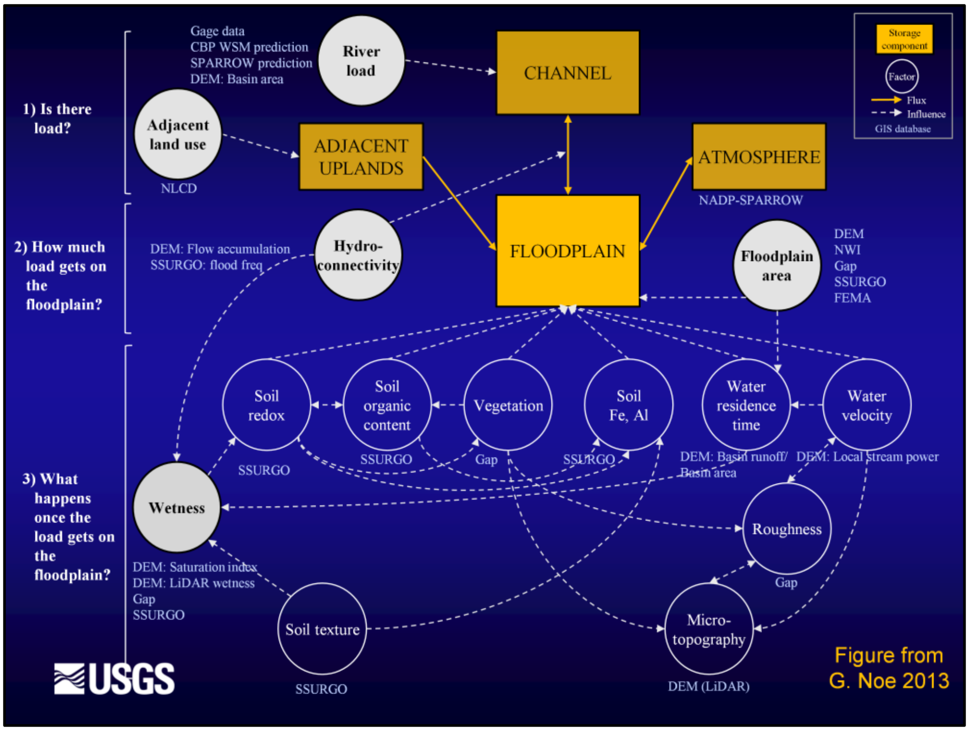


Distinct landscape features with important biologic, hydrologic, geomorphic, and biogeochemical functions.

Have distinguishing characteristics that include low slopes, well drained soils, intermittent periods of inundation, flood tolerant plant species, and boundaries defined (in part) by abrupt slope breaks.

Dynamic landscape element that is variable through time and space, and across regions.



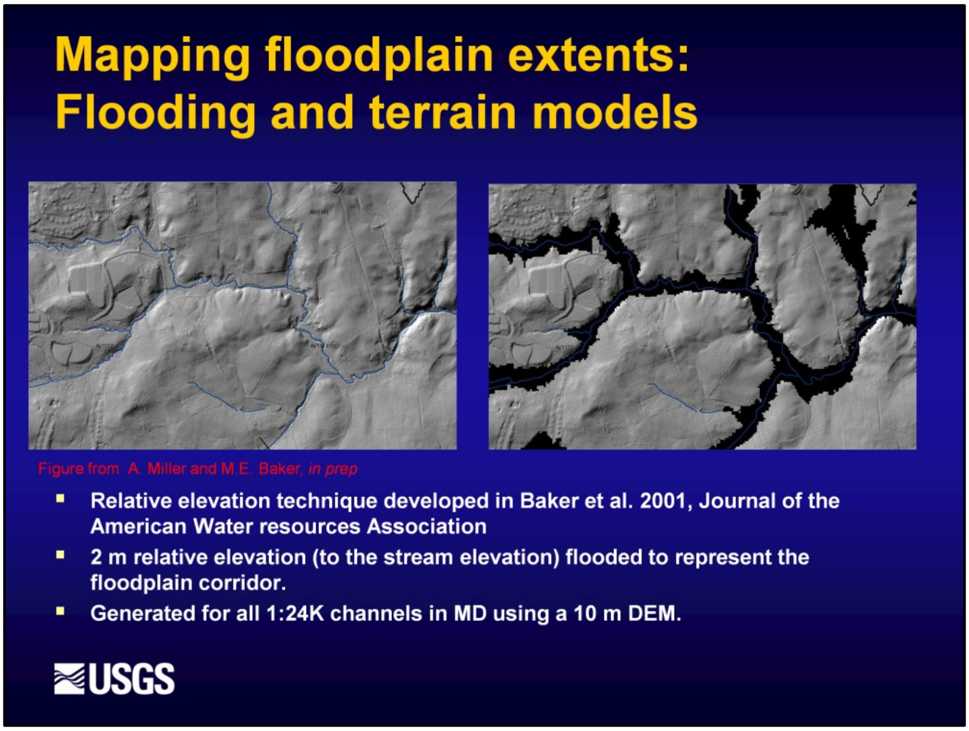
Conceptual model of factors influencing floodplain retention of nitrogen, phosphorus, and sediment

Floodplains are conceptually complex and associated with a variety of ecosystem services, with their form and function influenced by a variety of factors.

FPs play an important role in the regulation of nutrients, sediments, and flood waters. They can offer substantial retention/attenuation of flood waters, and filter overland RO coming from upland contributing areas. Their extent and effectiveness varies through space and time, and therefore cannot be considered static landscape elements.

Key to an accurate representation is not only being able to identify them in the landscape, but to also represent their variable nature, allowing their extent to vary with variable atmospheric conditions through time. Variability in hydrology, geomorphology, and climate alter the function of different areas within the floodplain.

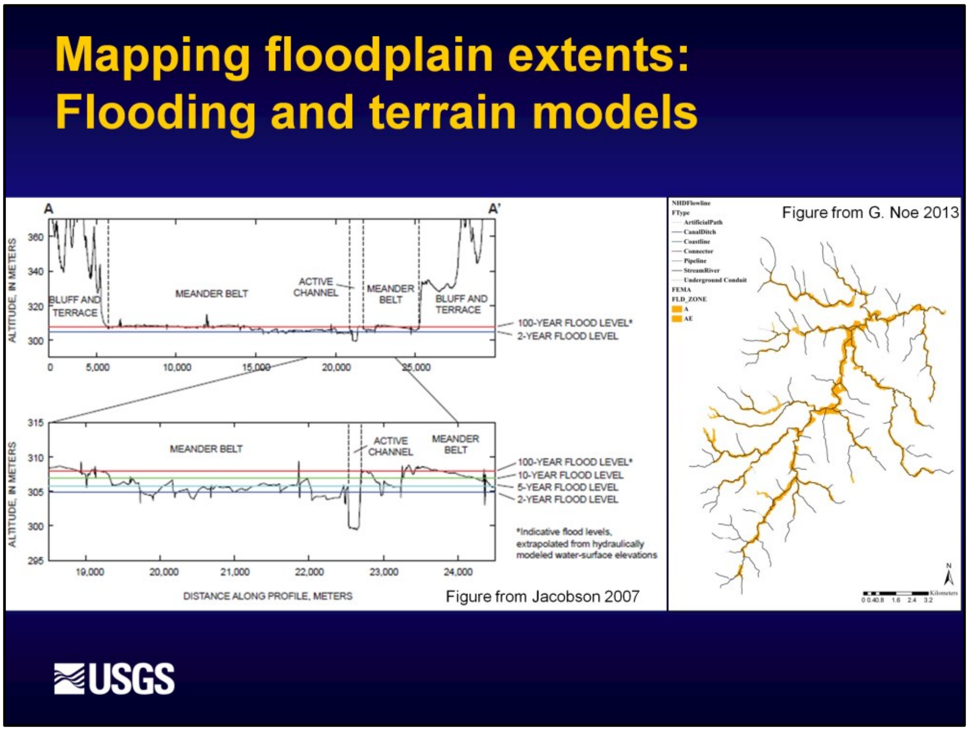
While field surveys provide the most accurate FP delineations, a number of methods have been used to extract FP features from geographic datasets.



DEM elevations were lowered along NHD stream lines (see left image) to enforce drainage along the NHD network and assure that the stream was in the lowest part of the valley. Adjacent, connected upland areas within 2 m of the stream elevations were then flooded to varying extents based on stream order (i.e., higher order streams were allowed to flood more than lower order streams; see right image).

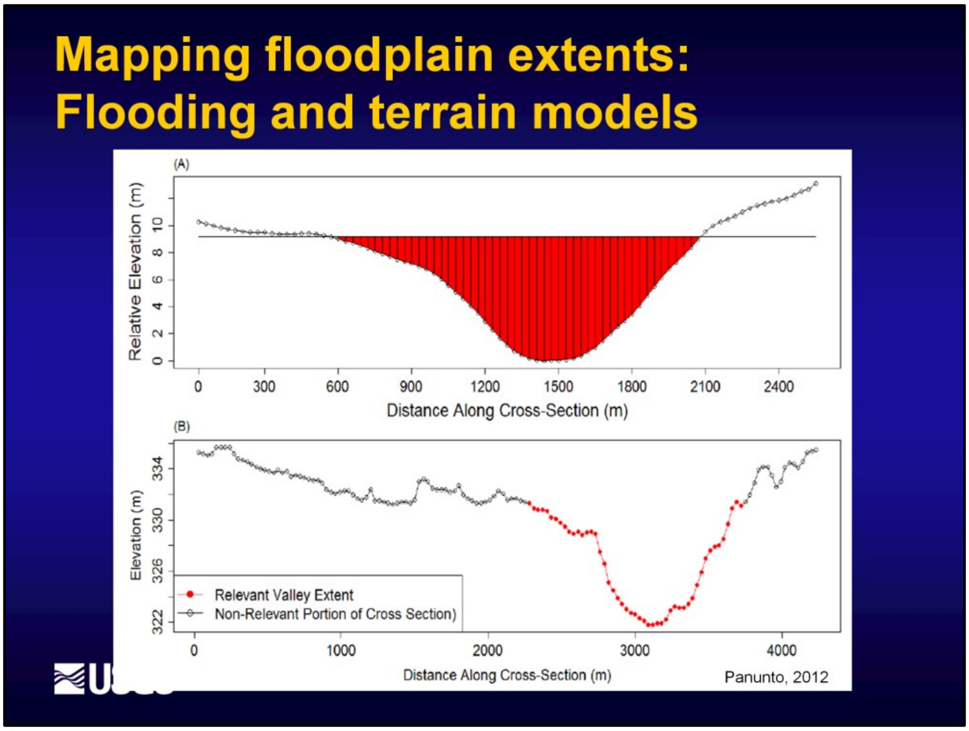
A similar technique is currently being used by the Nature Conservancy to identify the Active River Area (five primary components of the *active river area*:1) material contribution areas; 2) meander belts; 3) floodplains;
4) terraces; and 5) riparian wetlands). More information is available here: http://www.floods.org/PDF/ASFPM_TNC_Active_River_%20Area.pdf.

Baker 2001- Identified areas of "perennially saturated" soils as having a positive flow accumulation (inflow [mlday'] — outflow [mlday-1}) greater than one standard deviation (SD) above the mean for their focus region (Lower Michigan) [*this is their stream map*]. Areas of positive flow accumulation less than this threshold were characterized as "unsaturated“ and further subdivided into seasonally inundated and dryland categories. "Seasonally inundated" riparian areas were identified using vertical proximity (< 1 m) to an interpolated phreatic surface. This interpolation assumed that any stream channel or lake is a representation of the water table surface. Phreatic estimates were derived using Michigan Rivers Inventory 1:100,000 hydrography maps and their DEM values as input for a surface interpolation operation in Arc/Info. The resulting estimate of the water table surface was subtracted from the DEM to generate a "depth to water table" map likely to be increasingly inaccurate with increasing distance from any water body. Their rationale was that root uptake and prolonged seasonal inundation of riparian soils was often dependent upon a shallow water table less than 1 m (the vertical resolution of our DEM) from the surface. "Dryland" areas were those with neither high rates of predicted ground water delivery (< 1 SD) nor close proximity to the water table (> 1 m).

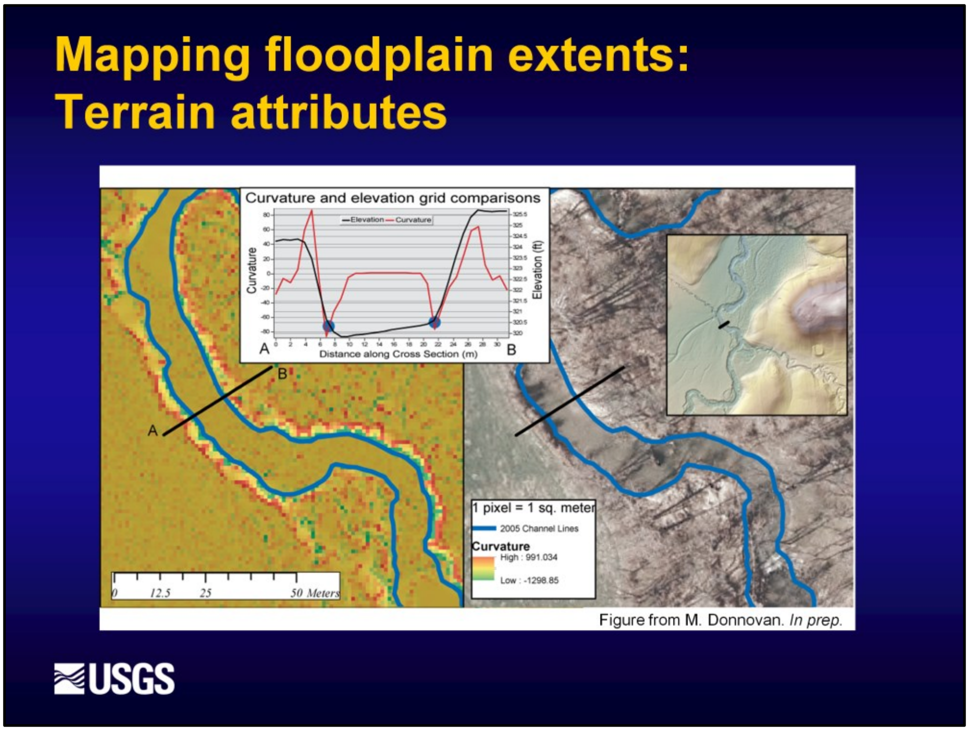


Given that the active channel location and elevation is known, adjacent non-channel uplands are inundated to a specified relative elevation to the channel, based on a specified flood return frequency interval (e.g., 100 yr. flood). Methods are based in part on relative elevations to the stream and overland flowpaths.

Although FEMA has mapped floodplains in many places, they may only have mapped areas with structures at risk of flooding. Also, there may be other issues with the DFIRMs like the use of variable source data and the scale of stream lines and elevation data used that could impact their applicability to our endeavor.

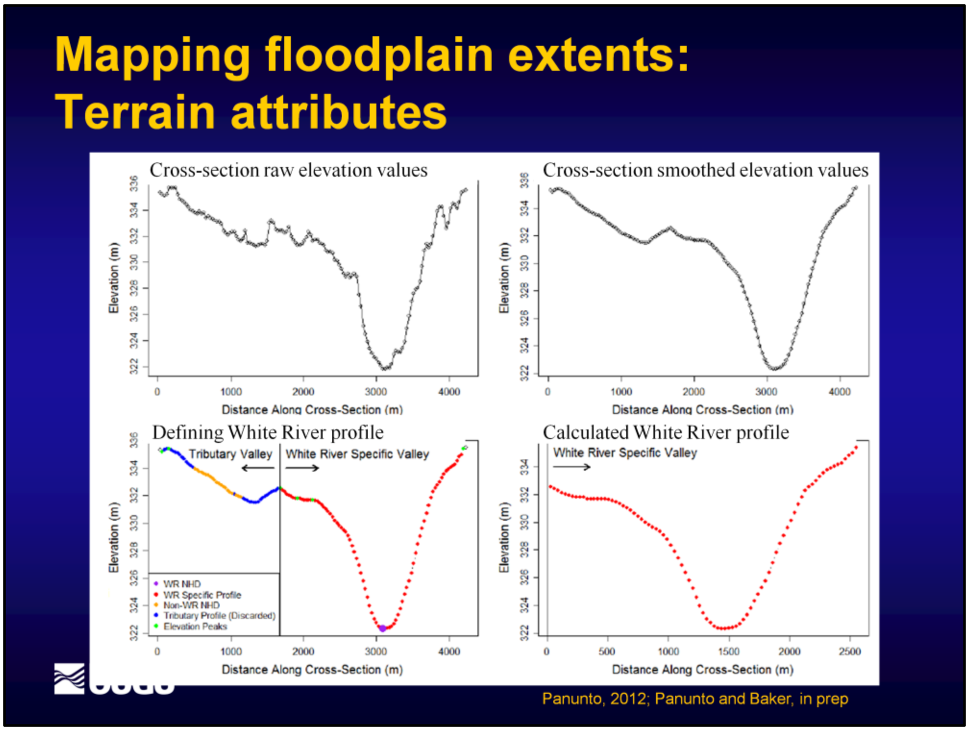


Transect increments are selected to calculate hydraulic radius and/or depth/width ratio (Panunto 2012). This figure also shows a tributary valley on the left of the bottom panel and how Matt's approach isolates the two valleys.

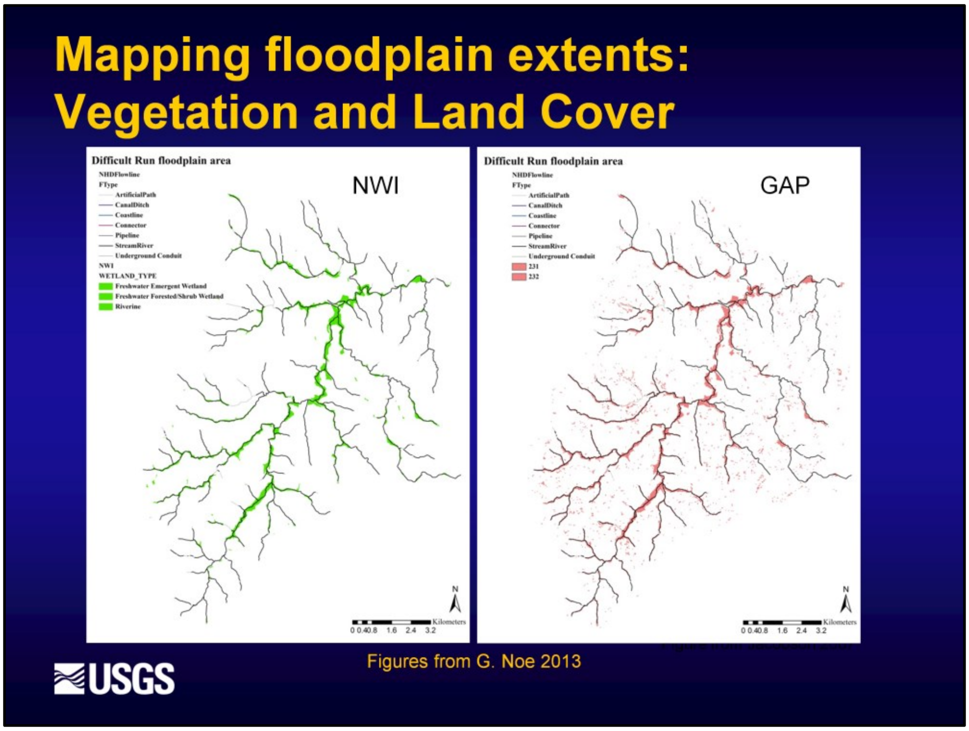


FP boundaries can often be characterized by distinct slope breaks separating the riparian/FP lowlands from adjacent upland areas. Curvature, a measure of changes in slope, can be used to distinguish these abrupt shits, and subsequently delineate FP extent.

Curvature can be used to delineate the top of bank and edge of wetted channel using local peaks/troughs in curvature. The red values are high, while the green are low. The blue lines are manually drawn channels using the curvature map as a guide. On the right, you can see that the lines match up well with the satellite imagery from the same year…It's not feasible for the entirety of Maryland/CB watershed, but it could be helpful in deriving some relationships to apply to larger scale models.



This figure shows how Matt Panunto's algorithm delineates river valley extent. First the elevation profile is smoothed to reduce noisy elevation values. Second local elevation maxima (peaks) are identified. Finally, the maxima that produce the greatest hydraulic radius (~depth to width ratio) are used to select the valley extent (Panunto 2012, Panunto and Baker, *in prep*). This function is an unpublished R script.

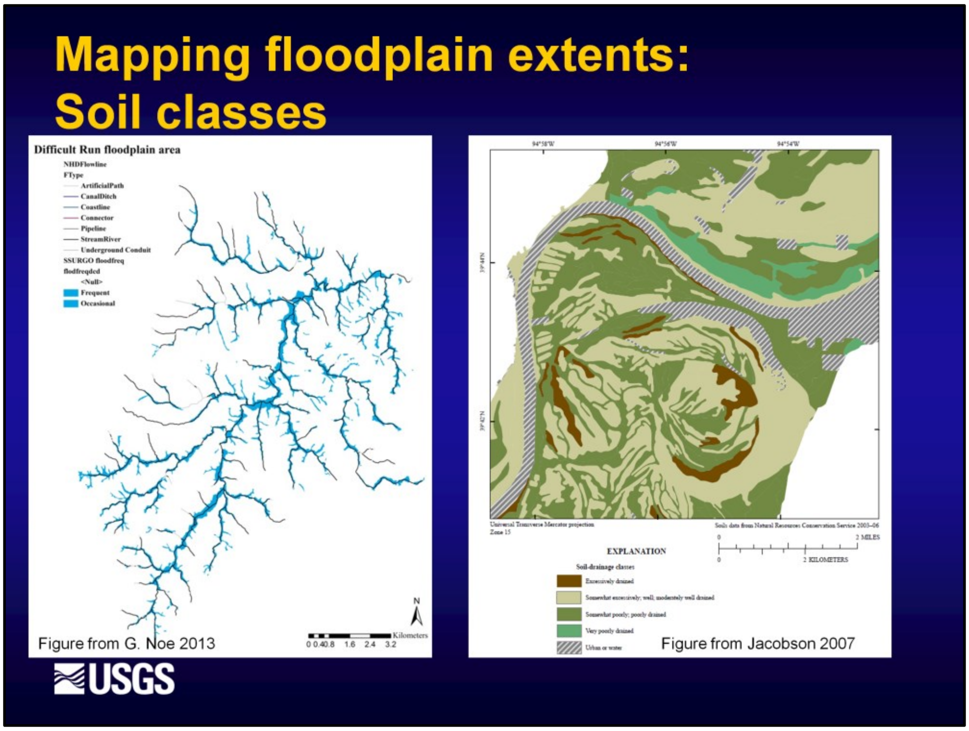


FP areas often harbor distinct flood tolerant vegetation species that could be used to delineate FP extent. However, FPs must be vegetated and common vegetation datasets (NCDL, NLCD) may not provide sufficient detail to distinguish FP vs. non-FP species.

GAP code 232 =Southern Piedmont Small Floodplain and Riparian Forest
GAP code 231 is the same but for large rivers, and is only in the Potomac gorge.

NWI was burned into the GAP but that GAP supplements NWI with spectral based detection of wetness and/or depressional landform information.

GAP tends to be more liberal in its prediction of FP areas.



Soil characteristics including flooding frequency, drainage class, and texture can be mapped in relation to channel segments to approximate floodplain extents.

However, while SSURGO data is often representative of long-term conditions, it may not be indicative of current conditions in highly altered (i.e., urbanized) watersheds.

Summary of caveats

Terrain methods
- Computer intensive and discontinuous
- Requires ground truthing

FEMA
- Large gaps in coverage
- 100 yr (or more) floodplain

NWI
- Maps various wetland types
- wetland ≠ floodplain, floodplain ≠ wetland
- Only natural vegetation systems could ID floodplain

GAP
- Partially based on NWI
- Only natural vegetation systems could ID floodplain
- Wetland vegetation systems can be classified as floodplain with varying degrees of wetness
- Mapped for entire watershed

USDA SSURGO
- Some gaps in coverage
- County variability in mapping of characteristics

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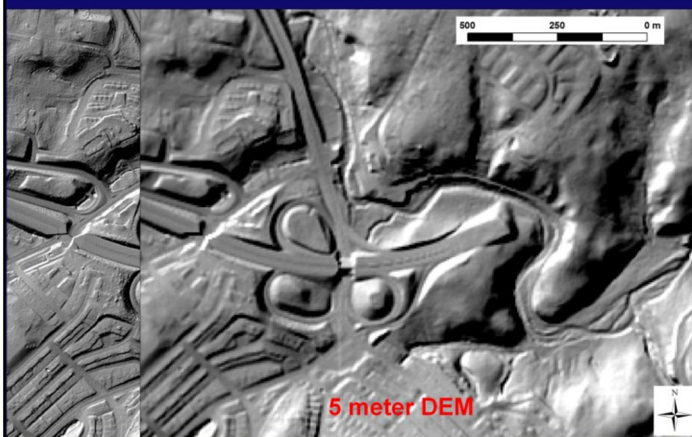
Terrain – computationally intensive; data resolution; discontinuities
Flooding – single event extent; climate and land use change; gaps in coverage; computationally intensive
Vegetation and Land Use – must have vegetation; data resolution and detail
Soils – variable coverage, quality, and resolution; include non-stream corridor areas

As is the case with all methods, resolution is KEY.

As is the case with all methods, resolution is KEY.

At 1 m resolution the FP is clearly distinguishable from the surrounding upland areas. This figure shows a highly urbanized channel in Baltimore with road and housing features clearly visible in the topography.

Resolution is key



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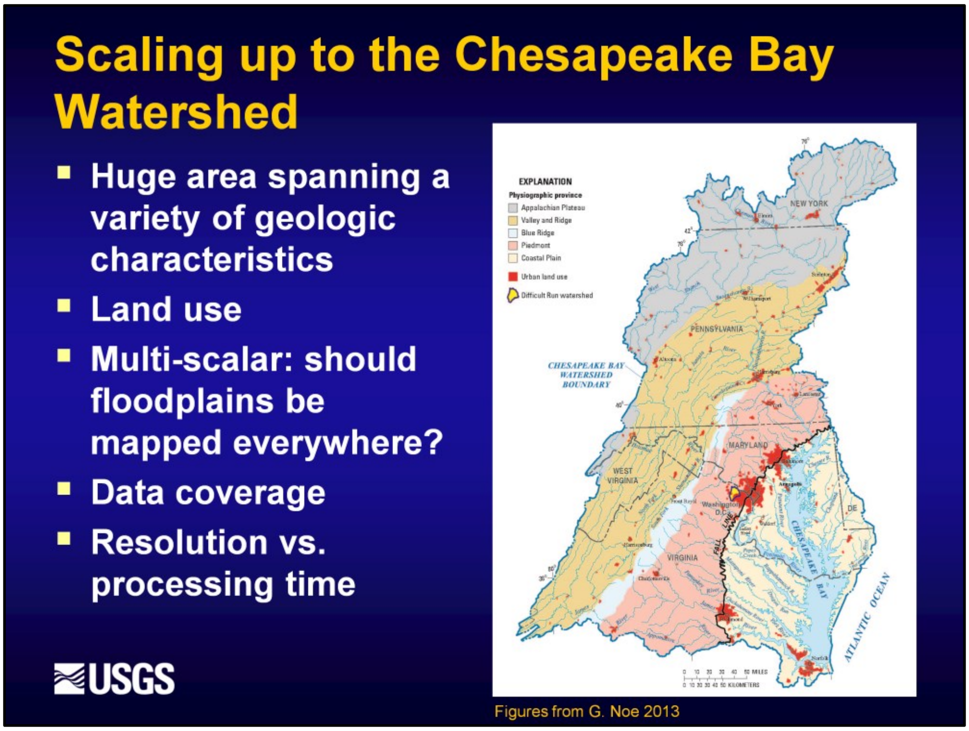
At 5 m, the FP and urban features are still visible and should not pose a problem for delineation.

At 10 m the important features are visible, but at a reduced clarity which may pose an issue for delineation purposes.

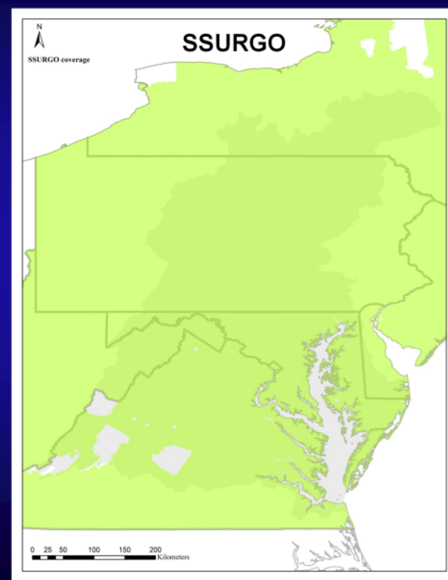
At 30 m all FP and urban features are lost making delineation next to impossible.



Scaling up to the full CBW brings in new difficulties the need to be considered.
- are methods appropriate across all provinces and land uses present within the bay?
- at what drainage scale should we ‘ignore’ floodplains?
- what data is available where and at what quality?

Scaling up to the Chesapeake Bay Watershed

- Huge area spanning a variety of geologic characteristics
- Land use
- Multi-scalar: should floodplains be mapped everywhere?
- Data coverage
- Resolution vs. processing time



Figures from G. Noe 2013

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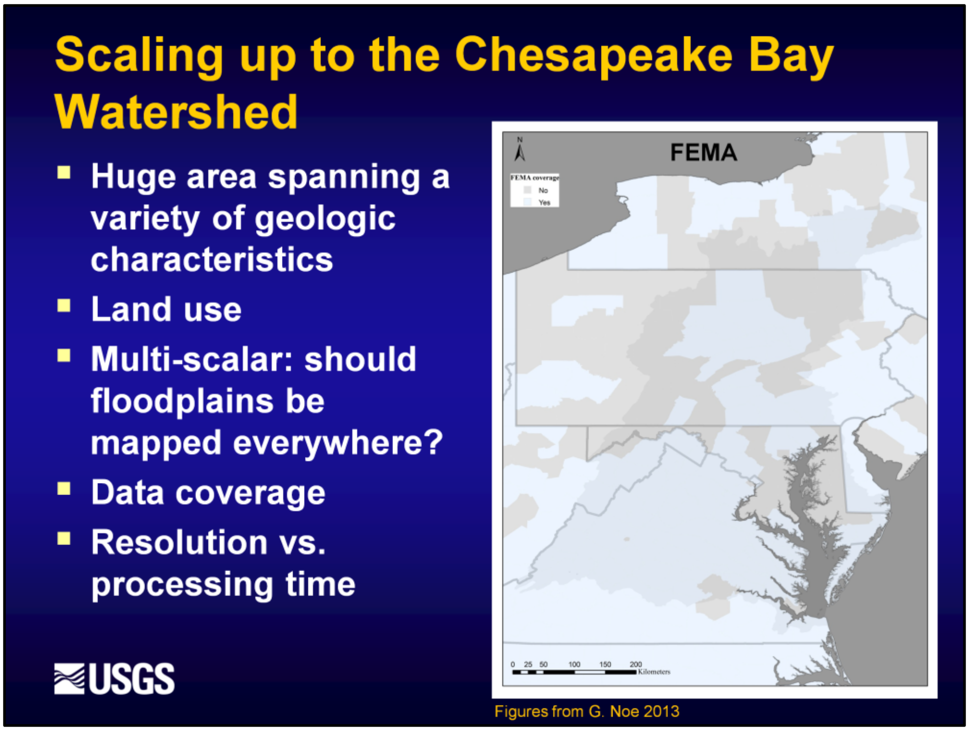
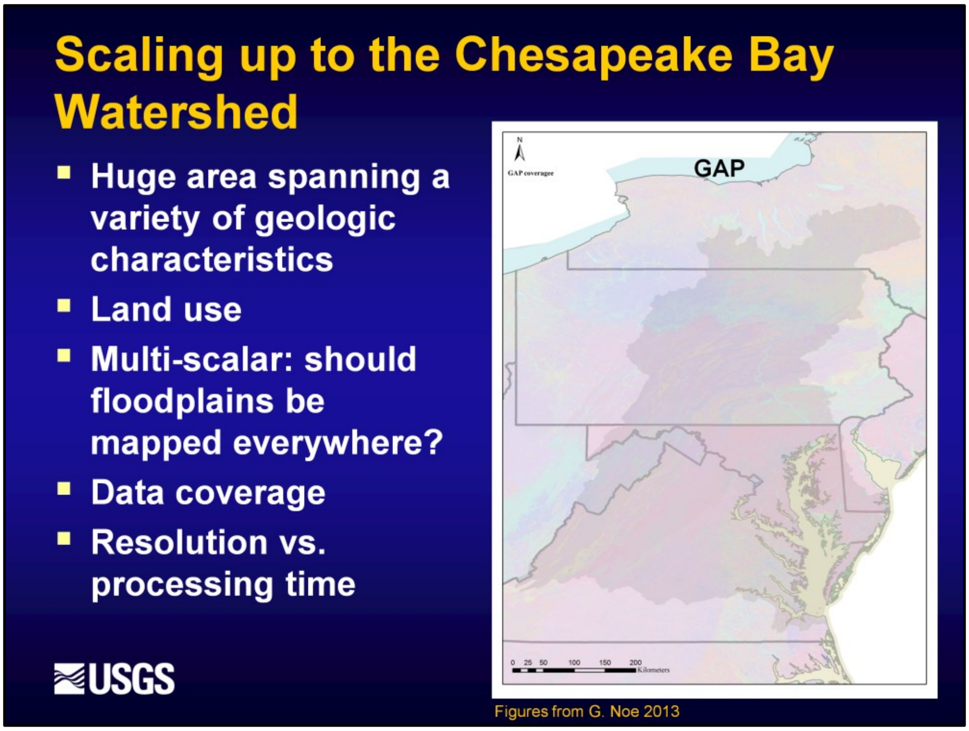
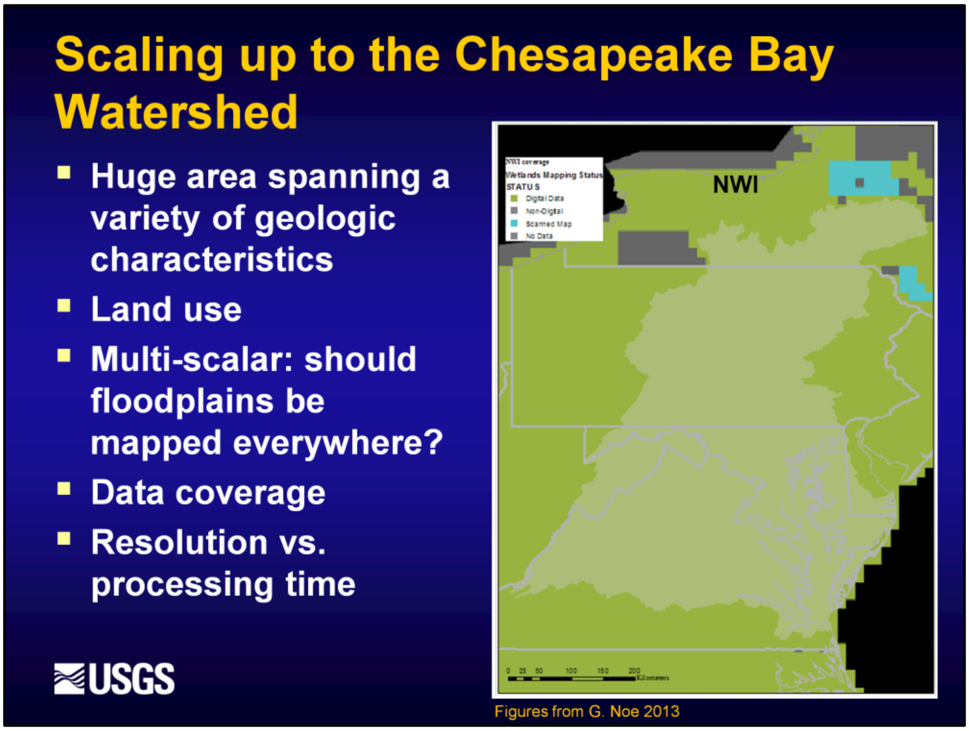
SSURGO data is available across the Bay region, but may not be representative of modified areas (urban and agricultural areas), especially areas that have undergone some form of transformation since the last SSURGO update (e.g., recent urban development).



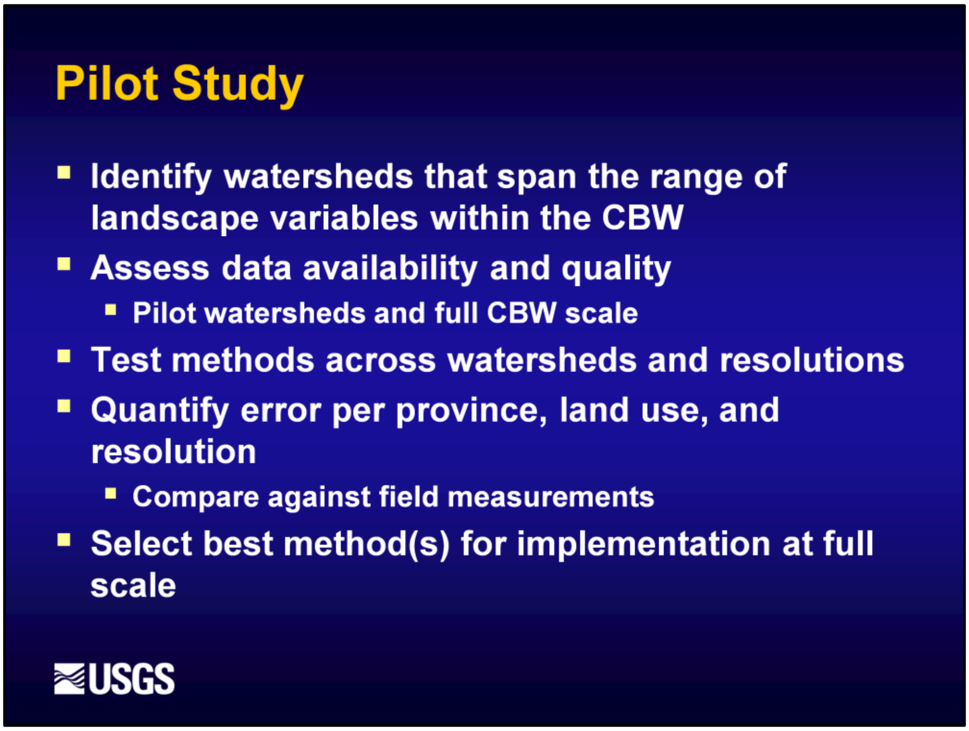
FEMA's floodplain mapping has variable coverage across the Bay and is largely constrained to areas with infrastructure that require flooding insurance.



GAP data is available at the entire Bay scale but may not be applicable in more urbanized settings or in areas that lack FP vegetation.



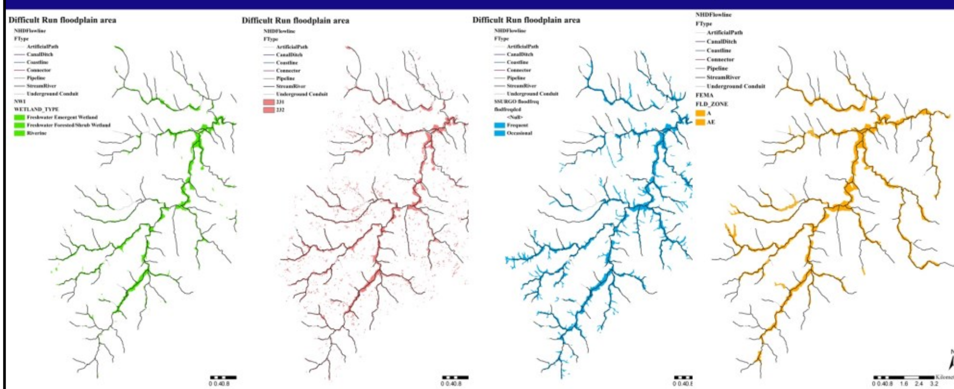
NWI is also available at the full Bay scale but carries the same caveats as the GAP dataset.



To determine the best method(s) for FP delineation across the range of landscape settings within the CBW, a pilot study (end date 2015) of a number of CB subwatersheds will occur. Currently there is a partnership with West Virginia University to test FP delineation methods in 9 watersheds, with an additional 45 watersheds planned for FY15 and FY16.

Difficult Run pilot

NWI | GAP | SSURGO flood freq | FEMA



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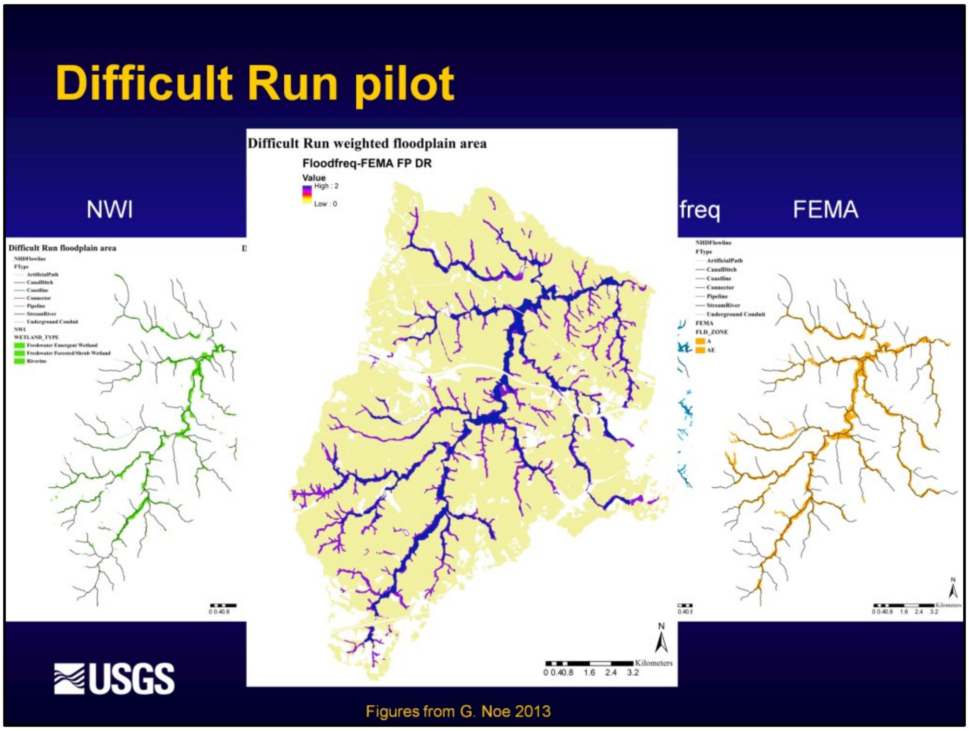
Figures from G. Noe 2013


Difficult Run pilot
NWI
freq
FEMA
Difficult Run weighted floodplain area
Floodfreq-FEMA FP DR
Value
High : 2
Low : 0
Difficult Run floodplain area
Kilometers
0 0.40.8 1.6 2.4 3.2
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USGS
Figures from G. Noe 2013

Thoughts

- Best method is likely a composite of terrain, flooding and soil-based methods
- Adaptable to
  - Physiographic province
  - Land use
  - Flood magnitude
- Ability to quantify certainty/error
- Final delineated extents can be used to estimate
  - Nutrient and sediment yields, retention capacity, residence times
  - Ecosystem services
  - Flood wave attenuation

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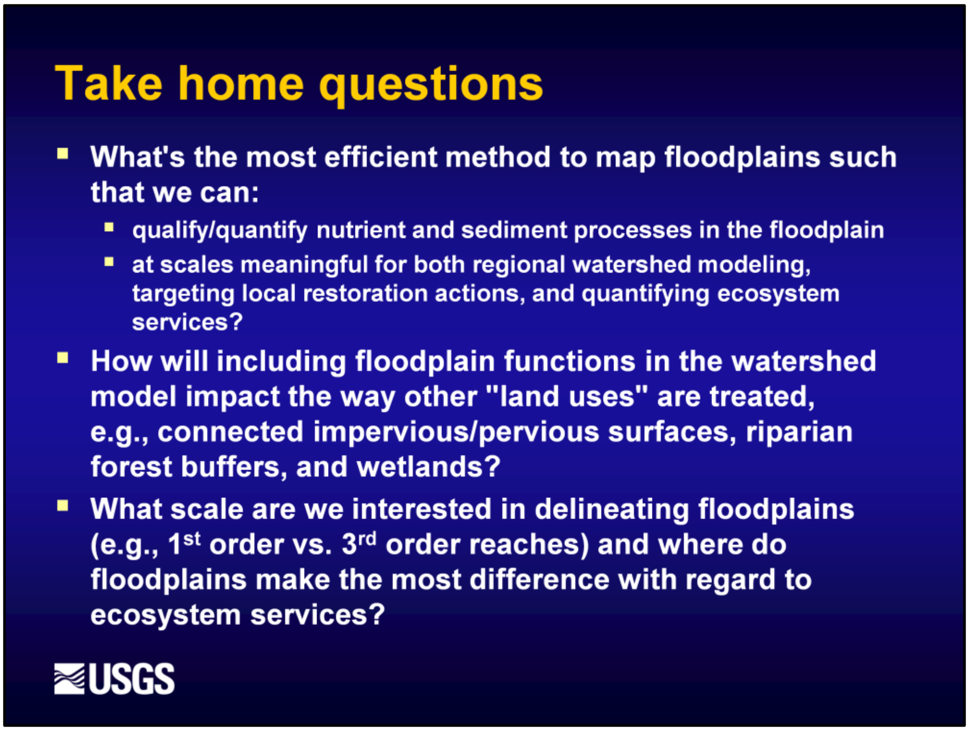

What floodplain definition (e.g., flood return interval, geomorphic definition, etc.) suits the CBW model?

I think the issue of what is floodplain vs. the functions to be modeled is very important.

Thank you!

dkjones@usgs.gov
703-648-5120