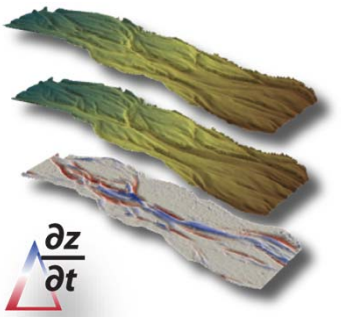
SEDIMENT BUDGET SEGREGATION & SPATIAL MASKING



Joe Wheaton
USBR Lecture Series

ICRRR
Intermountain Center for River Rehabilitation and Restoration

Day 2: March 8th, 2012

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SEDIMENT BUDGET

Components:

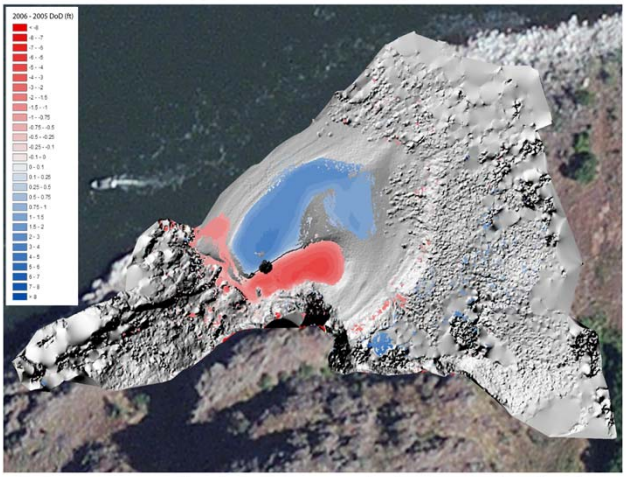
- Areal/Volumetric
- Raw/Thresholded
- +/- Estimates
- Percentages
- ECDs
- Change in Storage

Morphological Sediment Budget:

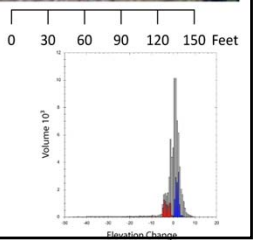
$$Q_{b_{IN}} - Q_{b_{OUT}} = \frac{\Delta V_{DoD}}{\Delta t}$$

Bedload Flux Difference | Change in Storage

$$\Delta V_{DoD} = \Sigma V_{Deposition} - \Sigma V_{Erosion}$$



Attribute	Raw	Thresholded DoD Estimate:	± Error Volume	% Error
AREAL:				
Total Area of Erosion (ft²)	30,009	3,895		
Total Area of Deposition (ft²)	46,330	6,425		
VOLUMETRIC:				
Total Volume of Erosion (ft³)	25,108	7,629 ± 1,164		15%
Total Volume of Deposition (ft³)	48,855	11,462 ± 2,323		20%
Total Volume of Difference (ft³)	73,963	19,091 ± 3,488		18%
Total Net Volume Difference (ft³)	23,747	**3,834 ± 2,599**		68%
PERCENTAGES (BY VOLUME)				
Percent Erosion	34%	40%		
Percent Deposition	66%	60%		
Percent Imbalance (departure from equilibrium)	16%	10%		



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ACROSS MULTIPLE YEARS…

- Is budget indeterminant, equilibrium, degradational or aggradational?

	EROSION				DEPOSITION				NET CHANGE				
EPOCH:	Volume (m^3)			Vol Error as a %	Volume (m^3)			Vol Error as a %	Volume (m^3)			Vol +/- Error as a %	Vol % Imbalance
2004-2003	2,268	±	1,592	70%	1,156	±	700	61%	-1,112	±	1,739	51%	-16%
2005-2004	5,794	±	2,097	36%	4,811	±	1,752	36%	-983	±	2,732	26%	-5%
2006-2005	1,858	±	1,504	81%	1,289	±	765	59%	-569	±	1,687	54%	-9%
2007-2006	8,581	±	2,978	35%	6,605	±	2,424	37%	-1,976	±	3,840	25%	-7%
TOTAL	**18,501**	**±**	**8,171**	**44%**	**13,861**	**±**	**5,640**	**41%**	**-4,640**	**±**	**9,999**	**NA**	**-7%**
Average	4,625	±	2,043	56%	3,465	±	1,410	48%	-1,160	±	2,500	39%	-9%

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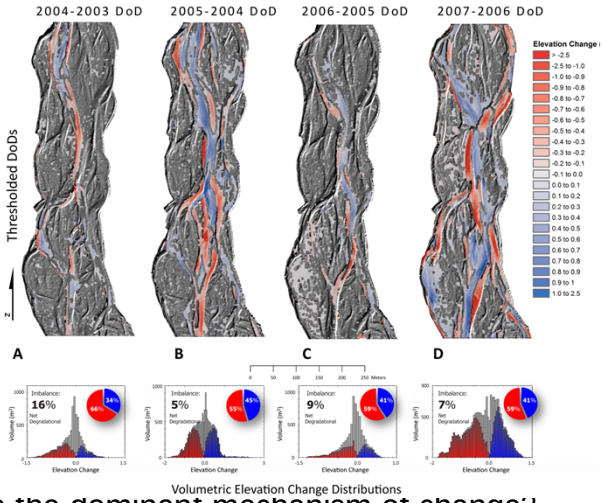
WHAT MORE CAN WE SAY OR ASK?

Best estimate of gross reach-scale sediment budget



e.g. What is the dominant mechanism of change?

Where in the reach is contributing the most?

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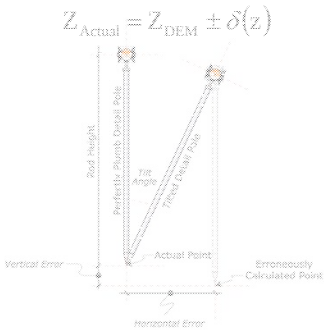
LET'S SAY MORE…

1. *Reliability Uncertainty:* Of the predicted changes, what can we actually distinguish from noise?

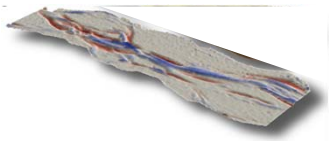
$$Z_{Actual} = Z_{DEM} \pm \delta(z)$$

We want: $\delta(z) << \frac{\partial z}{\partial t}$

But, $\delta(z) \approx \frac{\partial z}{\partial t}$



2. *Structural Uncertainty:* Geomorphically, **what do the calculated changes mean?**



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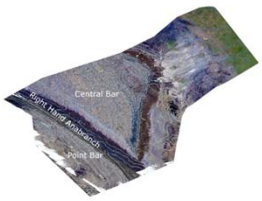
USE MASKS TO SEGREGATE DoD

A



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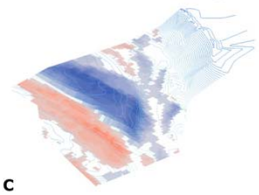

C

D

What are the individual mechanisms of net change?

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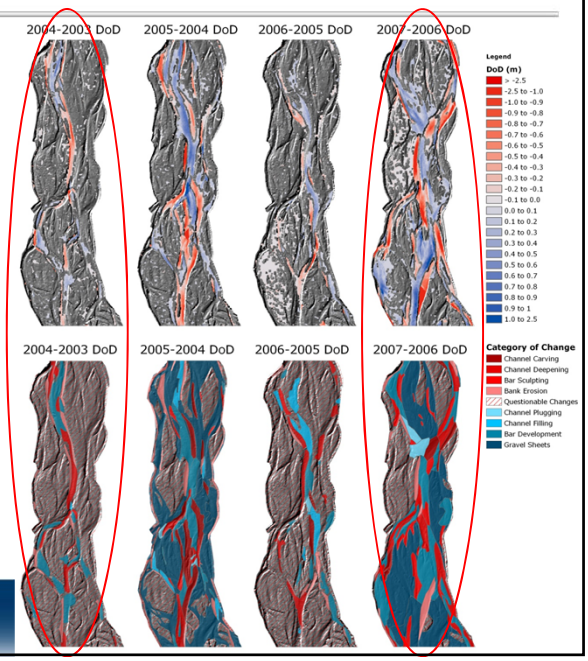
ARTICULATE THE ARM-WAVING AS MASK

- Qualitative geomorphic interpretations are easy (and useful)
- Translate these to quantitative analyses by using as classification mask for DoD segregation



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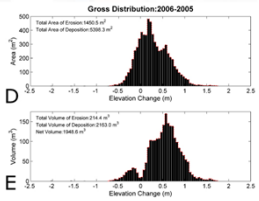
THREE TYPES OF MASKS

Just a way of spatially segregating budget to ask questions and query budget results.

1. Standard Classification
2. Classification of Difference
3. Geomorphic Interpretation

Just polygons...

Segregates both DoD & its Elevation Change Distribution...



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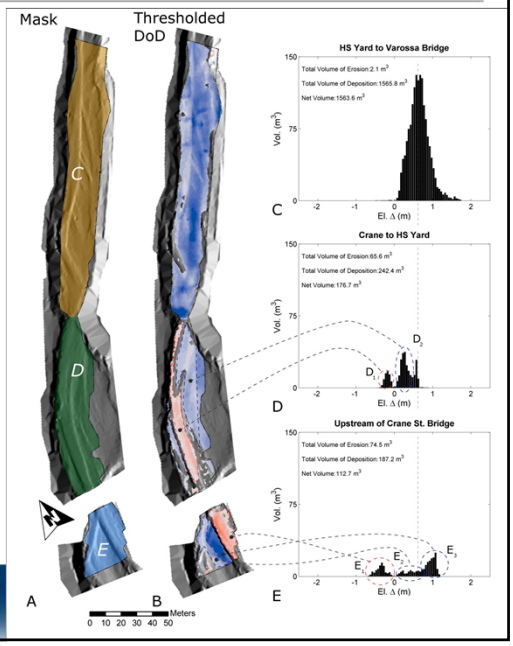
1. STANDARD CLASSIFCATION

- Any classification that is of:
  - The pre-survey
  - The post-survey
  - Or Time Independent
- Examples:
  - Morphological Units
  - Habitat Classification
  - Administrative Bndys
  - Reaches



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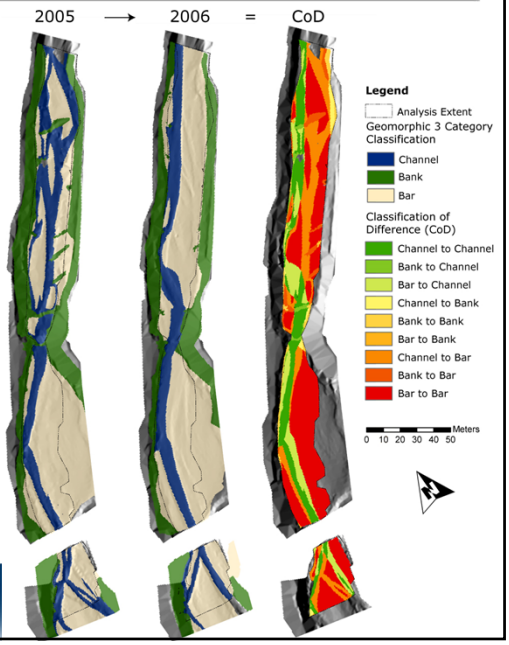
2. CLASSIFICATION OF DIFFERENCE

- The difference is defined by all possible combinations of class change or stability
- Same classification used for earlier and later surveys
- Good for looking at correlation between geomorphic change and categorical change
- The N^2 problem



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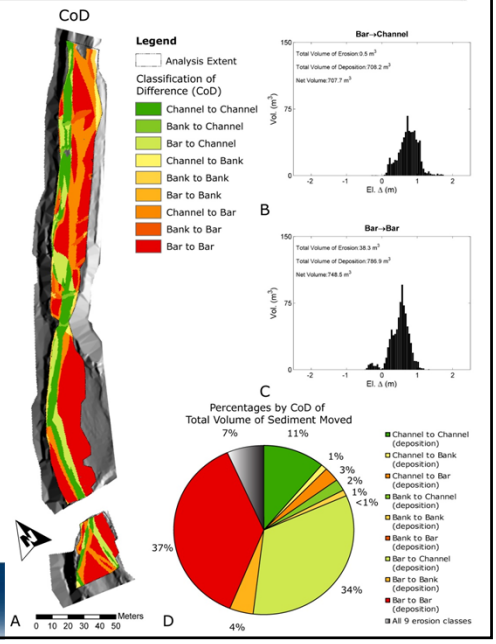
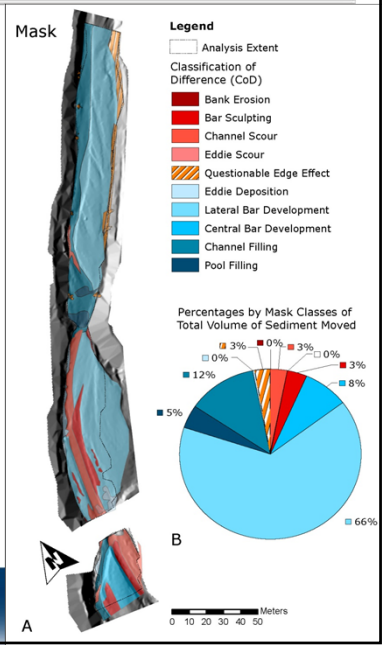
CoD APPLIED…

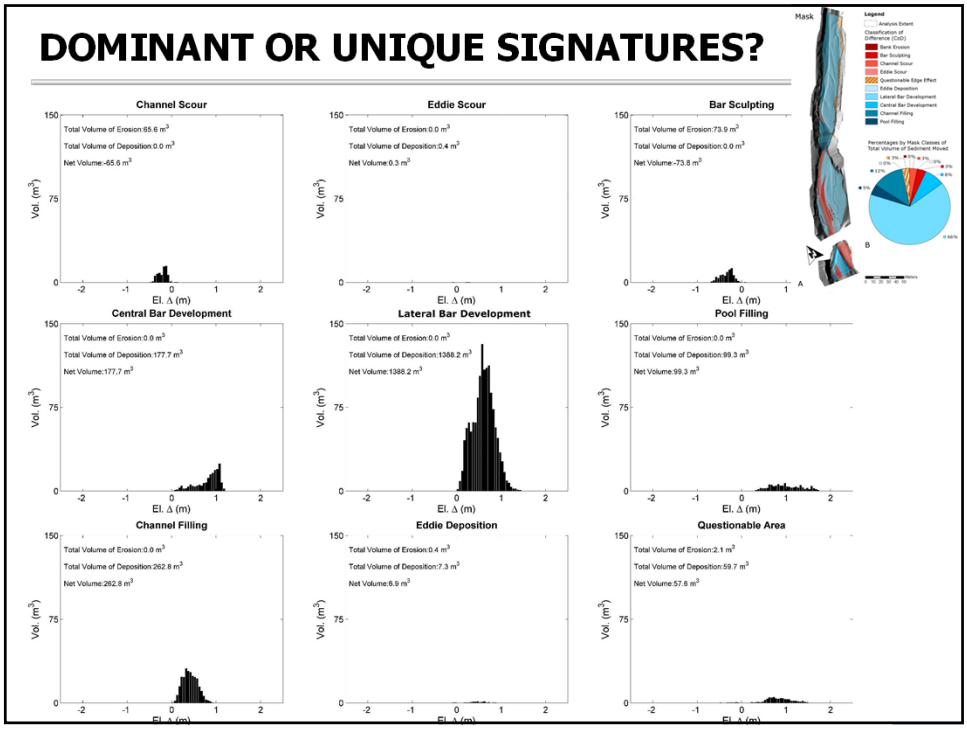
- The largest class was in a stable class (bar to bar)
- Inferences about processes can be made (i.e. bar to channel erosional)

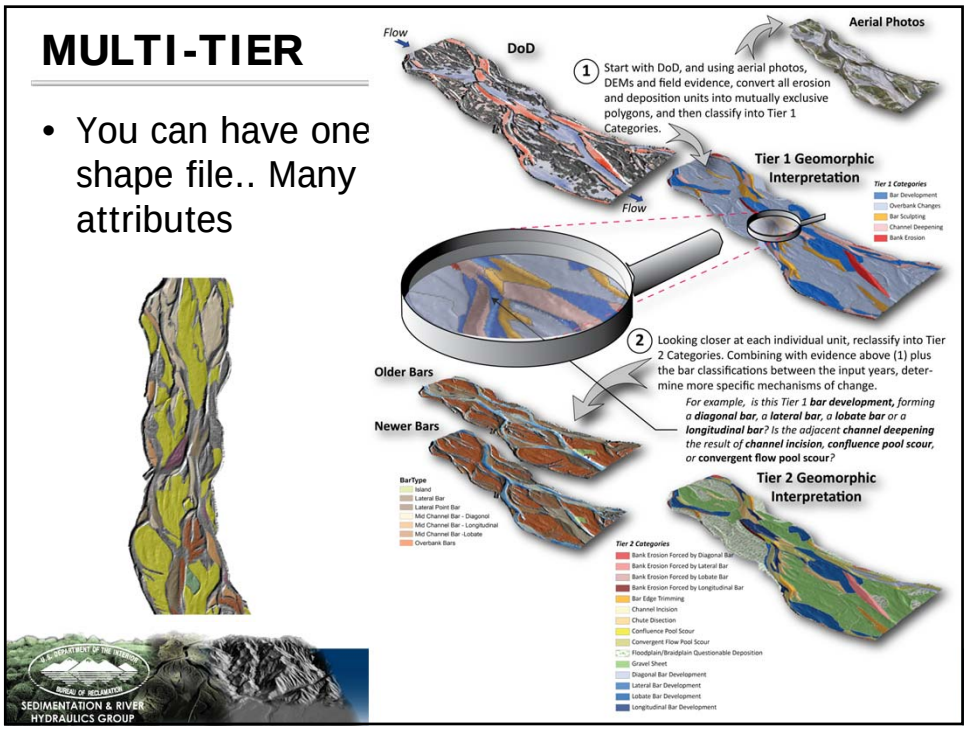


3. GEOMORPHIC INTERPRETATION

- Instead of mask being based on one point in time, this is based on the change surface itself (i.e. the DoD)
- Multiple lines of evidence can be used beyond DoD
- You define geomorphic processes of interest

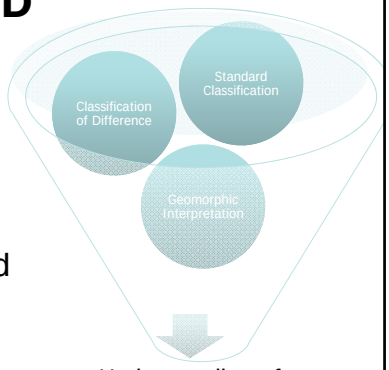






THREE DIFFERENT WAYS OF INTERPRETING SAME DoD

- Are the conclusions contradictory?
- Does the spatial masking/segregation tell us something that the gross analysis can not?
- Does this allow for more explicit and quantitative hypothesis testing?
- Are unique or distinctive signatures of change (in ECDs) present?
- Sensitivity to single interpretation..



Understanding of DoD Budget

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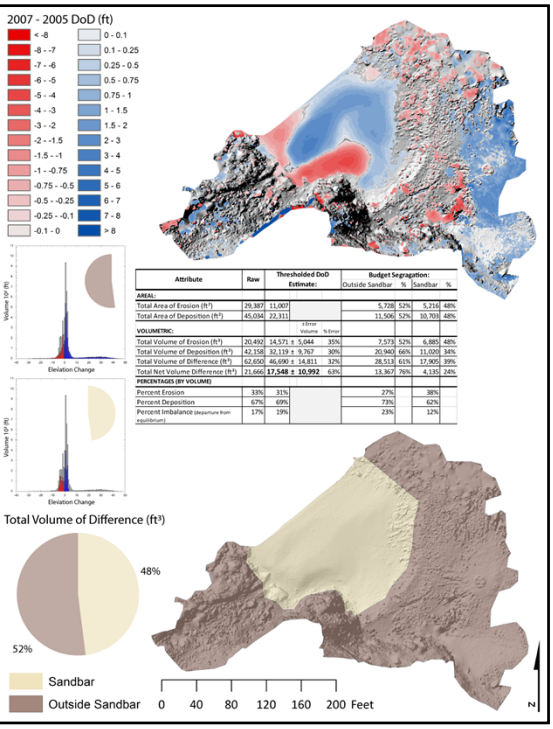
SIMPLE AREA MASK

- How much of change is in sandbar, or outside sandbar?



Attribute	Raw	Thresholded DoD Estimate:	Budget Segregation: Outside Sandbar	%	Sandbar	%
AREAL:						
Total Area of Erosion (ft²)	29,387	11,007	5,728	52%	5,216	48%
Total Area of Deposition (ft²)	45,034	22,311	11,506	52%	10,703	48%
VOLUMETRIC:			Volume	% Error		
Total Volume of Erosion (ft³)	20,492	14,571 ± 5,044	35%	7,573	52%	6,885	48%
Total Volume of Deposition (ft³)	42,158	32,119 ± 9,767	30%	20,940	66%	11,020	34%
Total Volume of Difference (ft³)	62,650	46,690 ± 14,811	32%	28,513	61%	17,905	39%
Total Net Volume Difference (ft³)	21,666	**17,548 ± 10,992**	63%	13,367	76%	4,135	24%
PERCENTAGES (BY VOLUME)						
Percent Erosion	33%	31%		27%		38%	
Percent Deposition	67%	69%		73%		62%	
Percent Imbalance (departure from equilibrium)	17%	19%		23%		12%	

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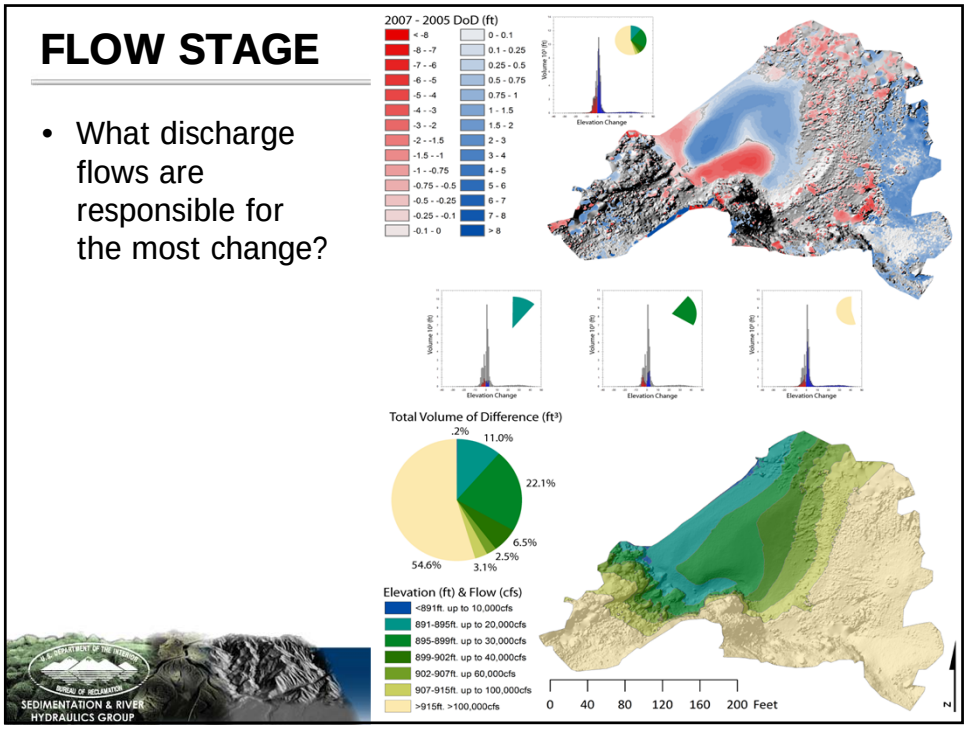
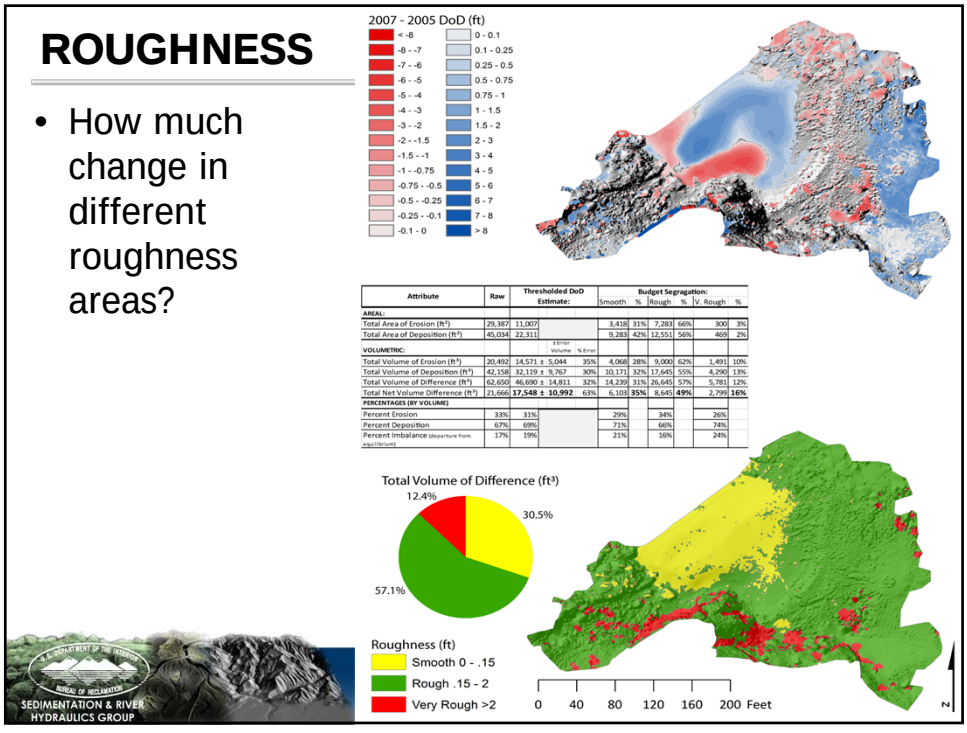
FLOW STAGE

- What discharge flows are responsible for the most change?



ROUGHNESS

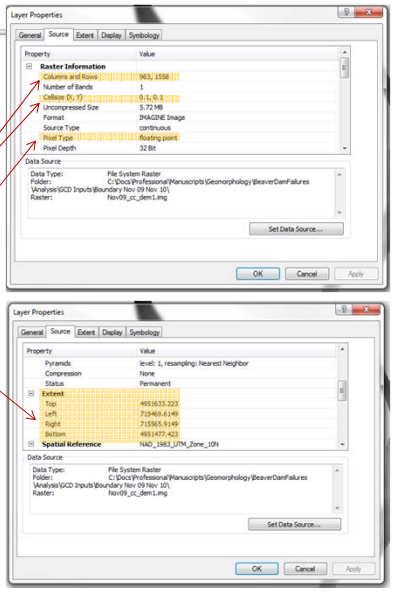
- How much change in different roughness areas?

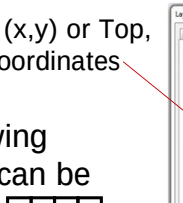


Attribute	Raw	Thresholded DoD Estimate:			Budget Segregation: Smooth	%	Rough	%	V. Rough	%
AREAL:										
Total Area of Erosion (ft²)	29,387	11,007			3,418	31%	7,283	66%	300	3%
Total Area of Deposition (ft²)	45,034	22,311			9,283	42%	12,551	56%	469	2%
			± Error Volume	% Error						
VOLUMETRIC:										
Total Volume of Erosion (ft³)	20,492	14,571 ±	5,044	35%	4,068	28%	9,000	62%	1,491	10%
Total Volume of Deposition (ft³)	42,158	32,119 ±	9,767	30%	10,171	32%	17,645	55%	4,290	13%
Total Volume of Difference (ft³)	62,650	46,690 ±	14,811	32%	14,239	31%	26,645	57%	5,781	12%
Total Net Volume Difference (ft³)	21,666	**17,548 ±**	**10,992**	63%	6,103	**35%**	8,645	**49%**	2,799	**16%**
PERCENTAGES (BY VOLUME)										
Percent Erosion	33%	31%			29%		34%		26%	
Percent Deposition	67%	69%			71%		66%		74%	
Percent Imbalance (departure from equilibrium)	17%	19%			21%		16%		24%	

RASTER TERMINOLOGY

- All rasters have the following primary properties
  - Number of columns & rows (must be integers)
  - Cell resolution (grid size)
  - Type (integer, floating point precision)
  - Lower left coordinates (x,y) or Top, Bottom, Right & Left coordinates (i.e. extents)
- From which the following secondary properties can be derived:
  - Width & Height





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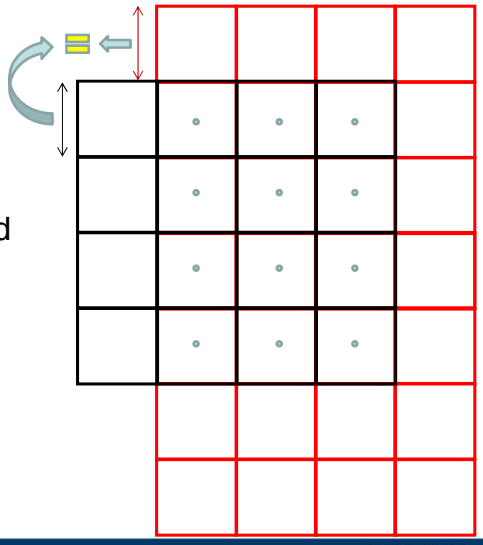
ORTHOGONALITY

- Orthogonal rasters must:
  - Share exact same grid resolution
  - Share the exact same grid centers (i.e. aligned in both easting and northing)



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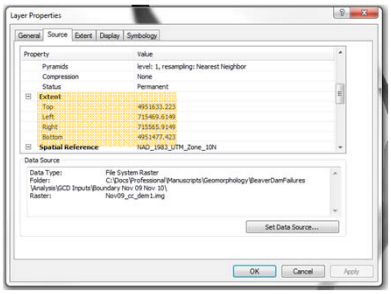
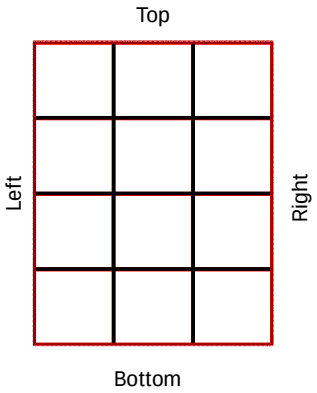
CONCURRENCY

- Grids are orthogonal and:
  - Share *exact* same extents





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