A Geomorphologist's Perspective on Stream Restoration in Mined Lands

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National International Technical Forum

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Sponsored by the Office of Surface Mining

Brief History of Stream Restoration

See

Lave, Rebecca, 2008, The Rosgen Wars and the Shifting Political Economy of Expertise (Ph.D. Dissertation), University of California, Berkeley, 251 p.

Restoration = 3rd Wave of the Environmental Movement

Reaction to "highest and best use" of water resources

Wild & Scenic Rivers Act: 1968, National Environmental Protection Act: 1969, Clean Water Act: 1972, Flood Control Act: 1990

~ 1978-1982: Stream restoration consulting firms

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1986: Rosgen Natural Channel Design short courses (>15,000 students by 2008)

1994, 1996: Rosgen classification system published

Academia (& others): "War" on Rosgen, but asleep at the wheel in selling alternatives to an established industry

1990s: Government funding explodes; >$1,000,000,000/ year industry

2000s: Stream mitigation banking: private-sector source of restoration funding

Who is this cowboy Dave Rosgen?

Lave, 2008:

- “Rosgen has been so successful … because he has provided structure that the stream restoration field desperately needs: a common language for communication, a set of shared methods and standards of practice, and the primary means of disciplinary reproduction and training.”

Who Rides a White Horse?

Lave, 2008:

> "The Rosgen Wars are thus not simply a conflict over truth* and practice, but also a struggle for control over the field of stream restoration, and the authority to produce new knowledge."

Kite, 2009:

> "… no single profession or discipline should assume to possess ownership of the certification process for watershed restoration professionals."

* Dylan, Bob, 1964: "… there are no truths outside the Gates of Eden."

Volume of Material Removed in Surface Mining of Coal (2007)

Correction based on conference comments follows

Short Tons of Coal	Metric Tons of Coal	Coal Density	Coal Volume (m^3)	Overburden Ratio	Overburden Volume (m^3)	**Volume Coal + Overburden** (m^3)
Appalachian Basin						
150,000,000	136,077,600	1.32	103,089,091	~~10~~	~~1,030,890,909~~	~~**1,133,980,000**~~
Powder River Basin						
479,496,000	434,991,099	1.30	334,608,538	2	~~669,217,076~~	~~**1,003,825,614**~~

Info Sources:

Production: National Mining Asociation: http://www.nma.org/pdf/c_production_method.pdf

Coal Density: Wood, G.H., Kehn, J., Carter, T.M., and Culberston, W.C., 1983, Coal resources classification system of the U.S. Geological Survey: U.S. Geological Survey Circular 891, 65 p.

Overburden Ratios: (Includes Interburden) I pulled them out of a hat!

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Appalachian Basin: Coal Density 1.32						
150,000,000	136,100,000	**15**	2,250,000,000	1,856,000,000	103,000,000	**1,823,000,000**
Powder River Basin: Coal Density 1.30						
479,496,000	434,991,000	**2**	959,000,000	733,000,000	335,000,000	**1,068, 000,000**

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Overburden Ratio = Overburden Volume (yd^3) / Clean Coal Production (Short Tons)

Overburden Includes Interburden for multiple-seam mines!

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Compare to 1980 Mt. St. Helens Eruption: 1,010,000,000 m^3

Info Source:
Mt. St. Helens data: U.S. Geological Survey:
http://vulcan.wr.usgs.gov/Volcanoes/MSH/Publications/MSHPPF/MSH_past_present_future.html

Mt. St. Helens image: U.S. Geological Survey:
http://vulcan.wr.usgs.gov/Imgs/Jpg/MSH/Images/MSH80_eruption_mount_st_helens_05-18-80_bw.jpg

“The Rosgen Wars”

Critiques of Scientific Basis of Natural Channel Design
After Lave, 2008

Issue Raised by Rosgen Opponents	Relevance to Mined Lands
Infers processes & predicts channel evolution from form.	Form reflects regulations and costs, not fluvial processes
Relies on incorrect models for calculating sediment transport	Needs work
Focuses too narrowly on isolated reaches	Must be watershed based
Overemphasizes channel stability	Stability is essential
Too interventionist	No choice!
Relies too heavily on bank-full discharge	Typically over-designed to PMF

Completed Fill, Kayford Mountain, WV: Stable through >100 mm (>4 in) Rainfall, July 2001

Mountain-Top Mining *vs.* Long-Term Erosion

Mining Outcome	Natural Rate of Erosion	Geologic Time Equivalent
Pottsville Group Sandstone Erosion at Mountain Tops		
Summit Lowering – 50 to 100 m	5.7 m (~20 ft) / million years	9 to 18 million years
Appalachian Plateaus Bedrock Valley Incision		
Valley Filling – 50 to 200 m	27-63 m (~90-210 ft) / million years	0.8 to 7.4 million years

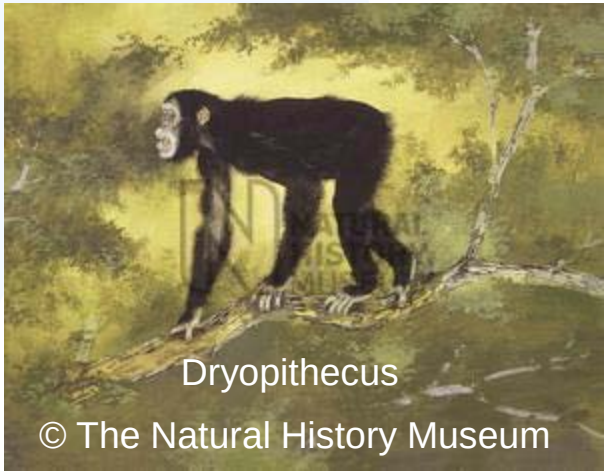
Mining will lead to accelerated erosion, so "recovery" will be sooner than suggested by geological rates.

Even if rates accelerate 100 fold, "recovery" will take tens of thousands of years or longer.

Info Sources:

Natural Rates of Pottsville Sandstone Erosion: Hancock & Kirwan, 2007

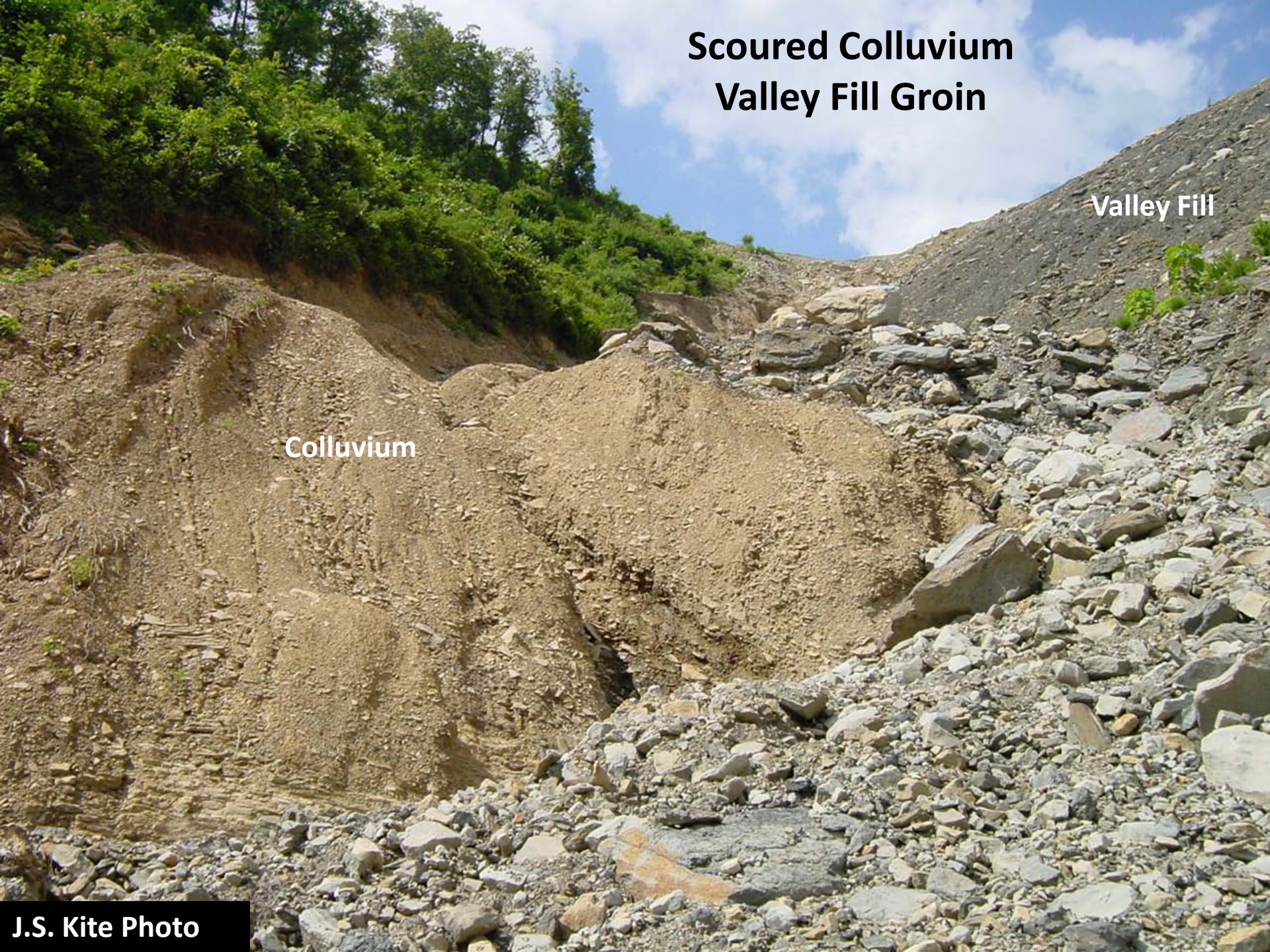
Natural Rates of Valley Incision: Granger et al., 1997, Springer et al., 1997

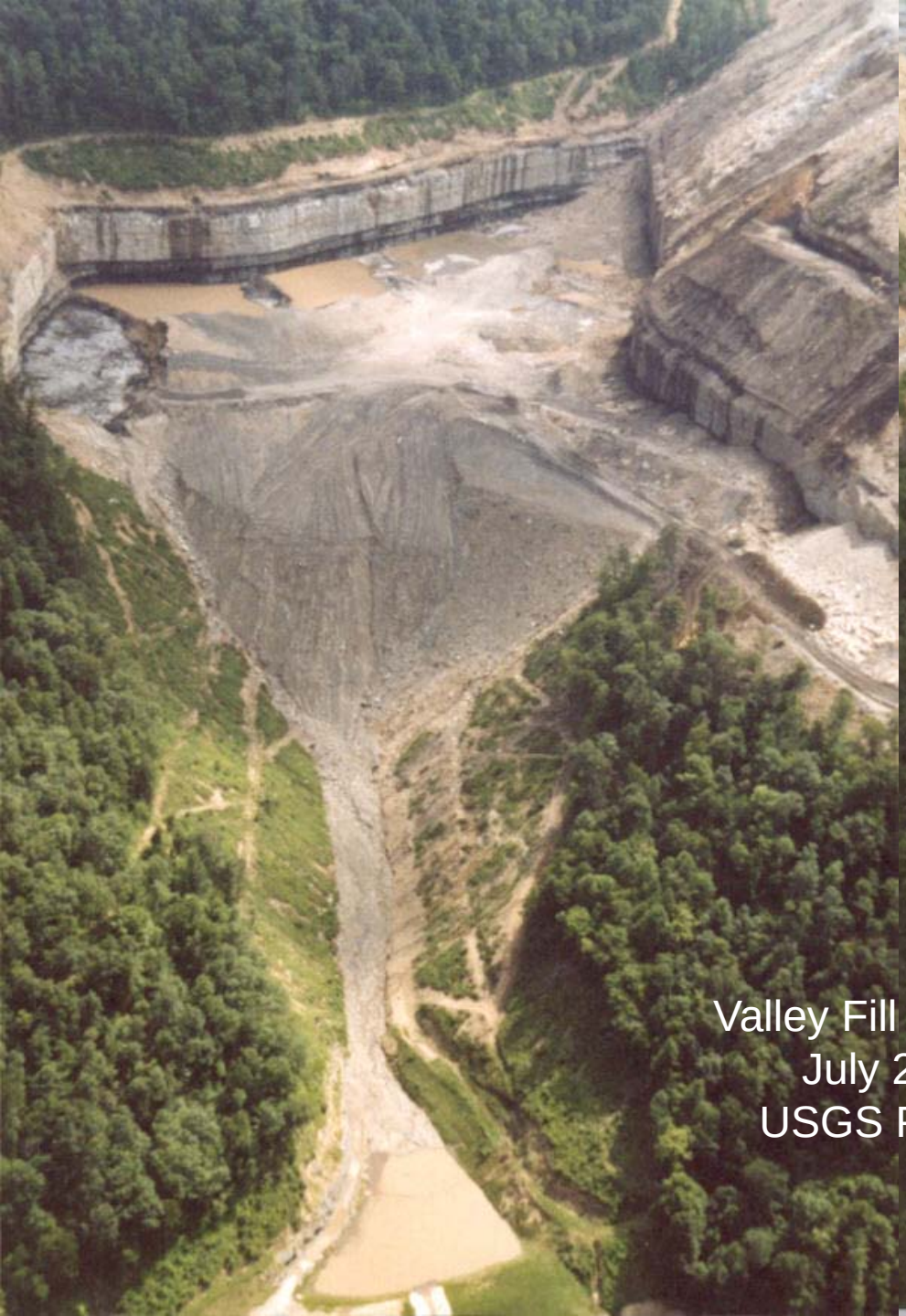


http://piclib.nhm.ac.uk/piclib/webimages/0/1000/900/1972_med.jpg

Valley Fills after >100 mm (>4 in) 6 hr Rain, July 2001

Scour of Colluvial Slope in Valley Fill "Groin," July 2001

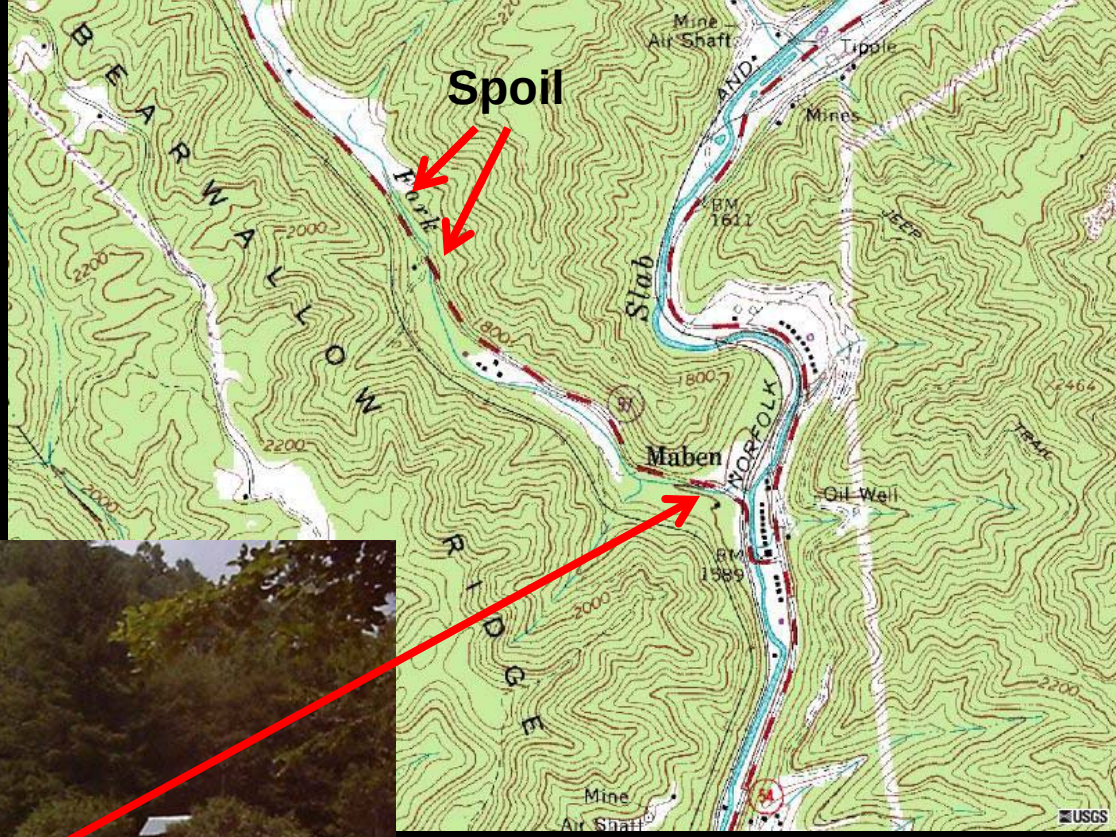

Scoured Colluvium
Valley Fill Groin
Valley Fill
Colluvium
J.S. Kite Photo



Valley Fill Failures
July 2001
USGS Photos

Old Mine Lands Present Restoration Challenges:

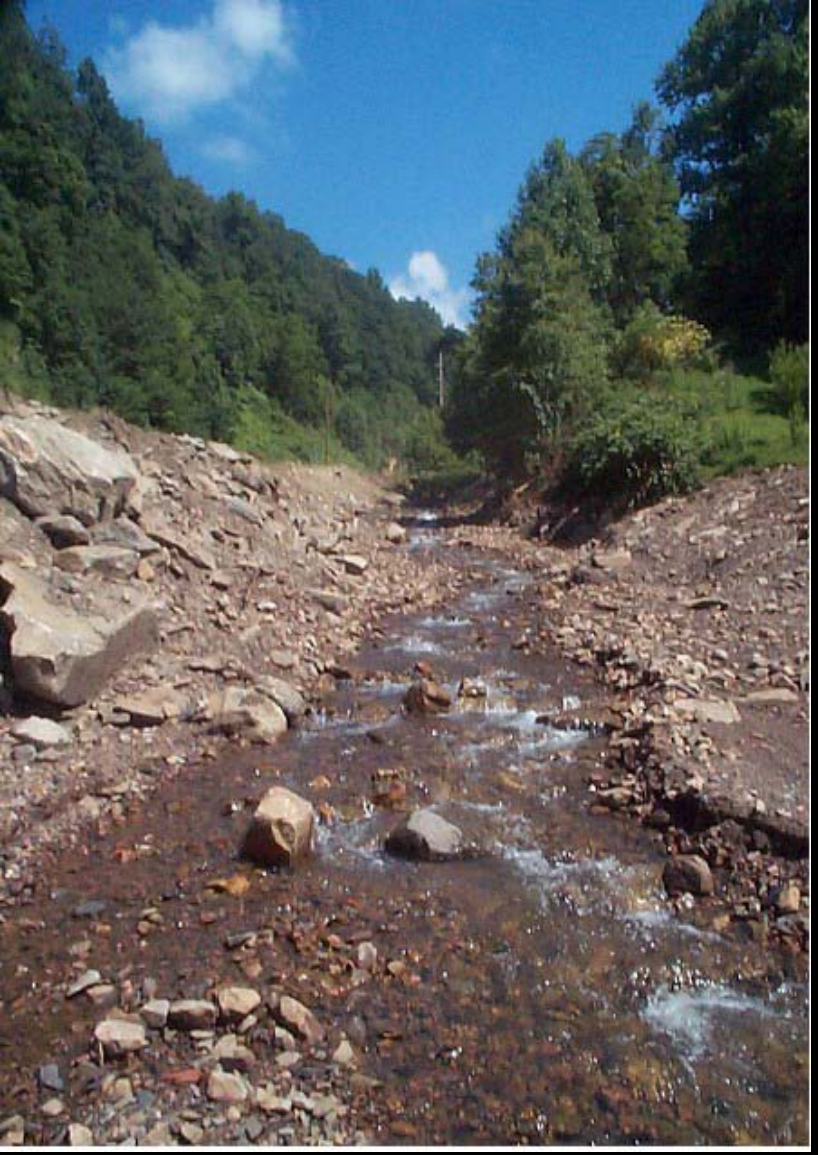
Marsh Fork near Maben, WV: July 2001



Mine spoil yielded bedload that extended far out of expanded channels and on to floodplains.

Runoff (1200 cfs/mi^2) neared the record for similar-size stream in the Ohio River basin.

Sediment Mobilized from Pre-SMCRA Mines July 2001



Wholesale modification of lower Laurel Creek, NPS Photo

Legacy Sediment Mobilized by July 2001 Debris Flows in Mined Lands

Delta bar in Kanawha River *at* the mouth of Loop Creek, Deepwater, USGS Photo

Minden Hyper-Concentrated Flow (2001)

J.S. Kite Photos

Triggered by runoff from a suburban neighborhood draining over mine spoil that was reclaimed to AOC (Approximate Original Contour) in 1994.

AOC Reclamation is Very Unstable
in High-Rainfall Events
Minden (2001)
NPS Photo

Where is Stream “Restoration” Need Greatest?

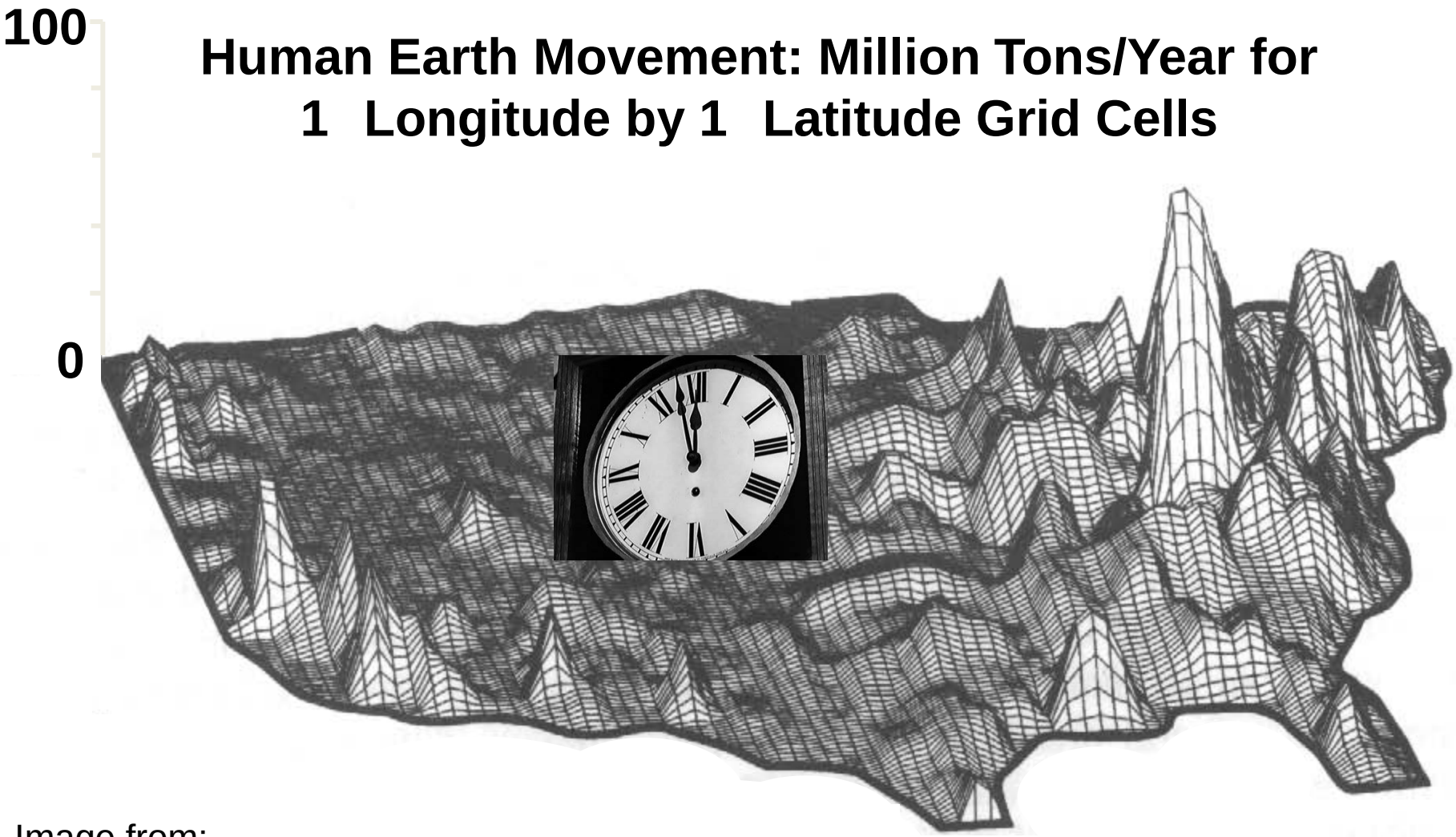


Image from:

Hooke, R. L., 1999, Spatial distribution of human geomorphic activity in the United States; comparison with rivers: Earth Surface Processes and Landforms, v. 24, p. 687-692.