Hydrobiology

THE FIRST FIVE MINUTES - THE IMPORTANCE OF TIMELY MONITORING OF UNEXPECTED PHYSICAL IMPACTS TO RIVERS

Andy Markham

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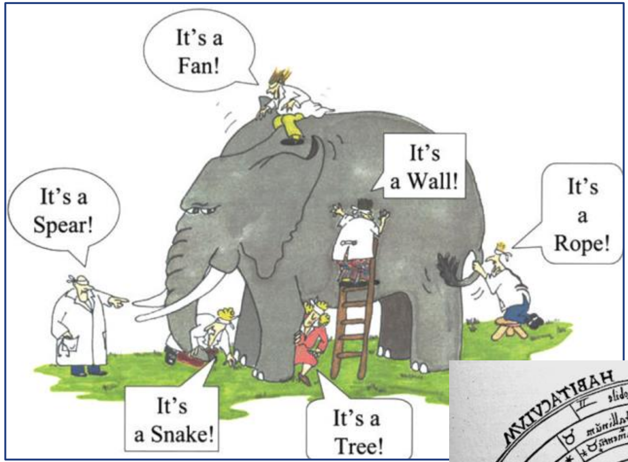
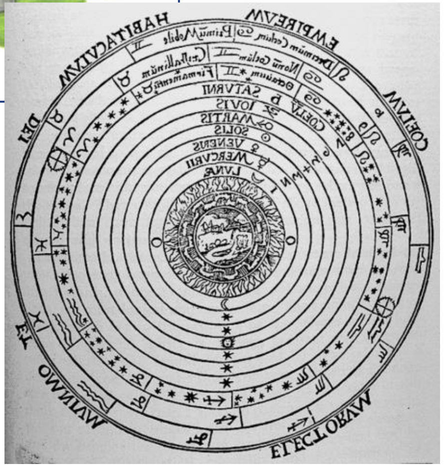
THE IMPORTANCE OF DATA - BAD IS WORSE THAN NONE AT ALL





- Wrong Answer
- Need to Backtrack/Correct
- Opportunity Cost in Lost Time and Resources
- Incorrect Management Response

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THE IMPORTANCE OF DATA - GOOD IS BETTER THAN NONE

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IMPACTS

- Physical impacts (sediments and morphological change)
- Water quality impact
- Ecosystem impacts
- Livelihoods
- Human health

USACE – Mt St Helens Long Term Sediment Management Plan

SEDIMENT IMPACTS ON RIVERS - CASE HISTORY

Type	Examples
Volcanic Eruptions	• **Mt Pinatubo (Gran and Montgomery 2005, Hayes et al. 2002)** • **Chaiten Volcano, Chile (Major et al. 2016)** • **Mount St. Helens (Collins and Dunne 1986, Lehre et al. 1983, Major 2000, Major 2004)**
Landslides	• **Nakagawa river, Japan (Koi et al. 2008);**
Mining (Continuous Impact)	• **Ok Tedi, PNG (Parker 1996, Pickup 2001 & 2008)** • **Porgera, PNG (Swanson et al. 2008)**
Mining (Dam or Structural Failure)	• **Marcopper, Philippines** • **Mount Polley, Canada (Byrne et al. 2015, Cuervo & Burge, 2017, Nikl et al. 2016.** • **Novat Rosu, Romania (Bird et al 2008)** • **Los Frailes, Spain (Macklin et al 1999, Benito et al. 2001, Macklin et al 2006)**
Other Dam Failures	• **Condit Dam, Washington US (Wilcox et al 2014)** • **Barlin Dam, Taiwan (Tullos and Wang 2013)**
Engineered Dam Removals	• **Glines Canyon and Elwha Dam, Washington US (Warrick 2012, Warrick et al 2015, East et al. 2015)** • **Matilija Dam, California, US (Cui et al. 2016)**
General Studies & Review of Legacy Sediments	• **General Studies/Reviews of 'Legacy Sediment' including:** • **James (2013),** • **Sims & Rutherfurd (2017)**

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MANAGEMENT CONSIDERATIONS

- Most change happens quickly
- Impact and recovery needs to be understood
- Baseline condition
- Information dissemination

Marcopper tailings spill, Boac River, Philippines, 1996

PEOPLE WANT TO KNOW (IMMEDIATELY)..

- Is the water safe to drink/use?
- Why did all the fish die? (did all the fish die?)
- Health - Will we get itchy skin if we touch the water?
- Why is the water that colour?
- When will it be back to normal?
- What's this toxic sludge?

Dee River, Mt Morgan Historic Mine

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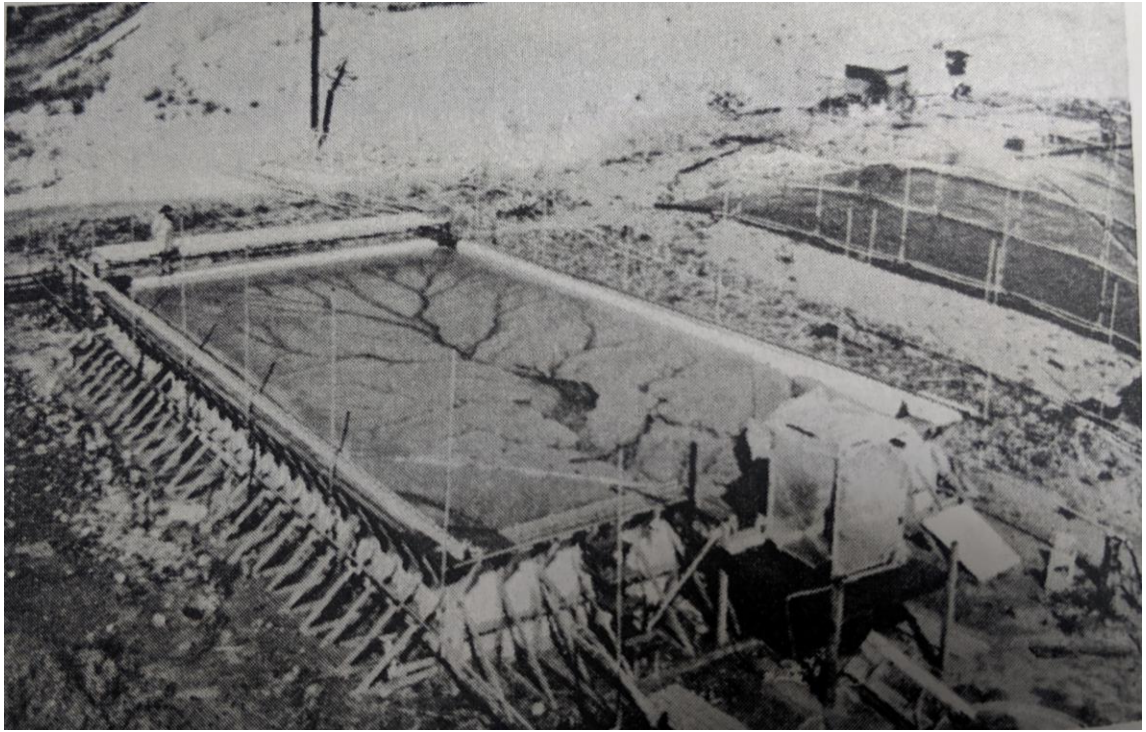
WHAT DO WE KNOW ABOUT LANDSCAPE RECOVERY FROM IMPACT

- Landscape Evolution Models (Siberia, Caesar)
- Davisian Cycle of Erosion (WM Davis)
- Stan Schumm…



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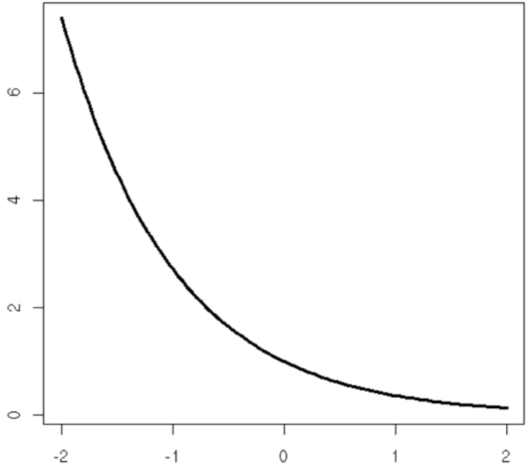
THE RATE LAW

William Graf (1977)
Negative Exponential Recovery

The rate law and the half-life concepts indicate that following disruptions, geomorphic systems approach new steady states very rapidly at first, but that adjustment becomes progressively slower.



EXAMPLE OF SEDIMENT IMPACT - SAMARCO IRON ORE MINE, BRAZIL

WHAT HAPPENED

5th November 2015

Catastrophic Collapse of Fundao Tailings Dam

19 Fatalities

32 mm^3 of tailings lost

26.5 mm^3 trapped in Candonga Hydroelectric Reservoir

5.5 mm^3 transported and deposited along 630 km to mouth of Doce

Mudflow equivalent to 10,000 yr flood event at upstream peak

Triggering mechanisms included adverse geotechnical conditions in the slimes and sands zones as the dam height increased, minor earthquake activity.

UPSTREAM REACHES

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BENTO RODRIGUEZ

BENTO RODRIGUEZ - BARRA LONGA

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BARRA LONGA

CANDONGA

BEYOND

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THE PLUME (NOV 24)

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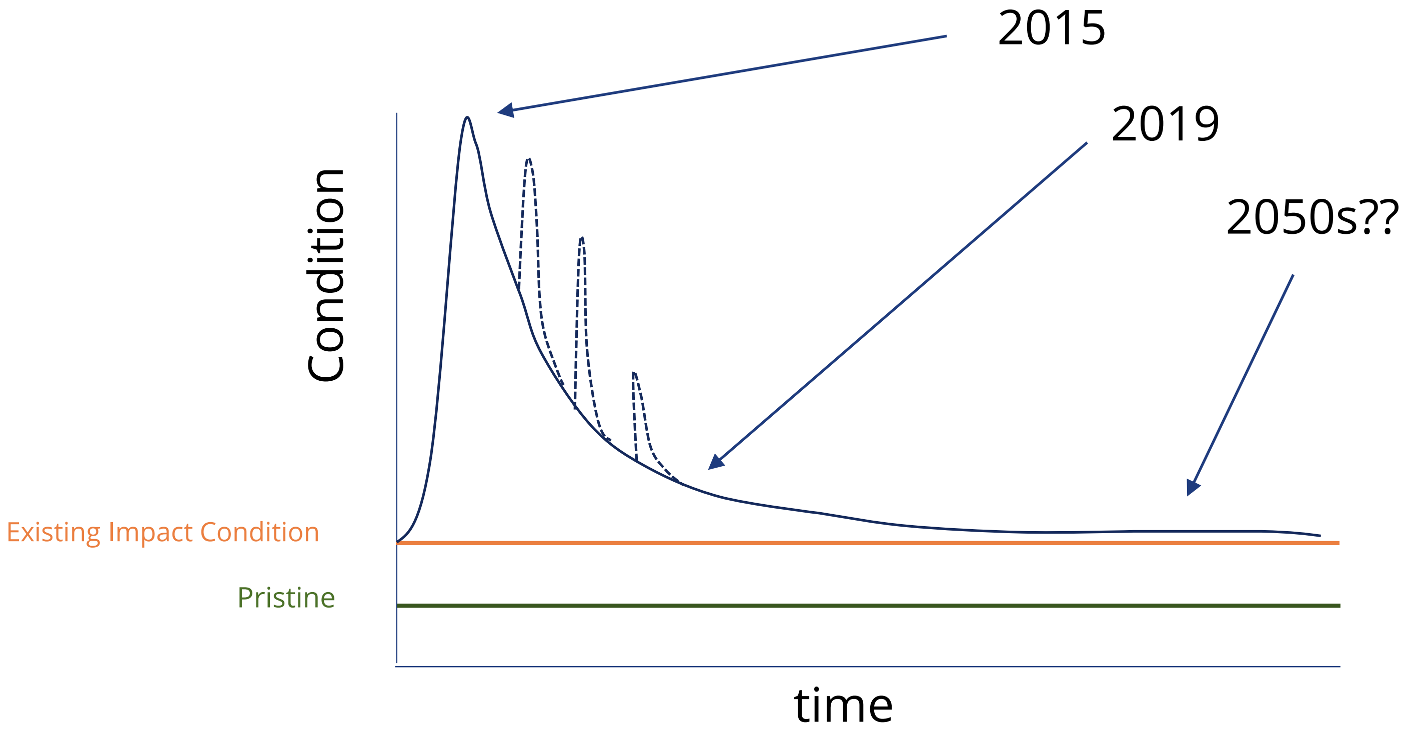
SIMPLE CONCEPTUAL MODEL



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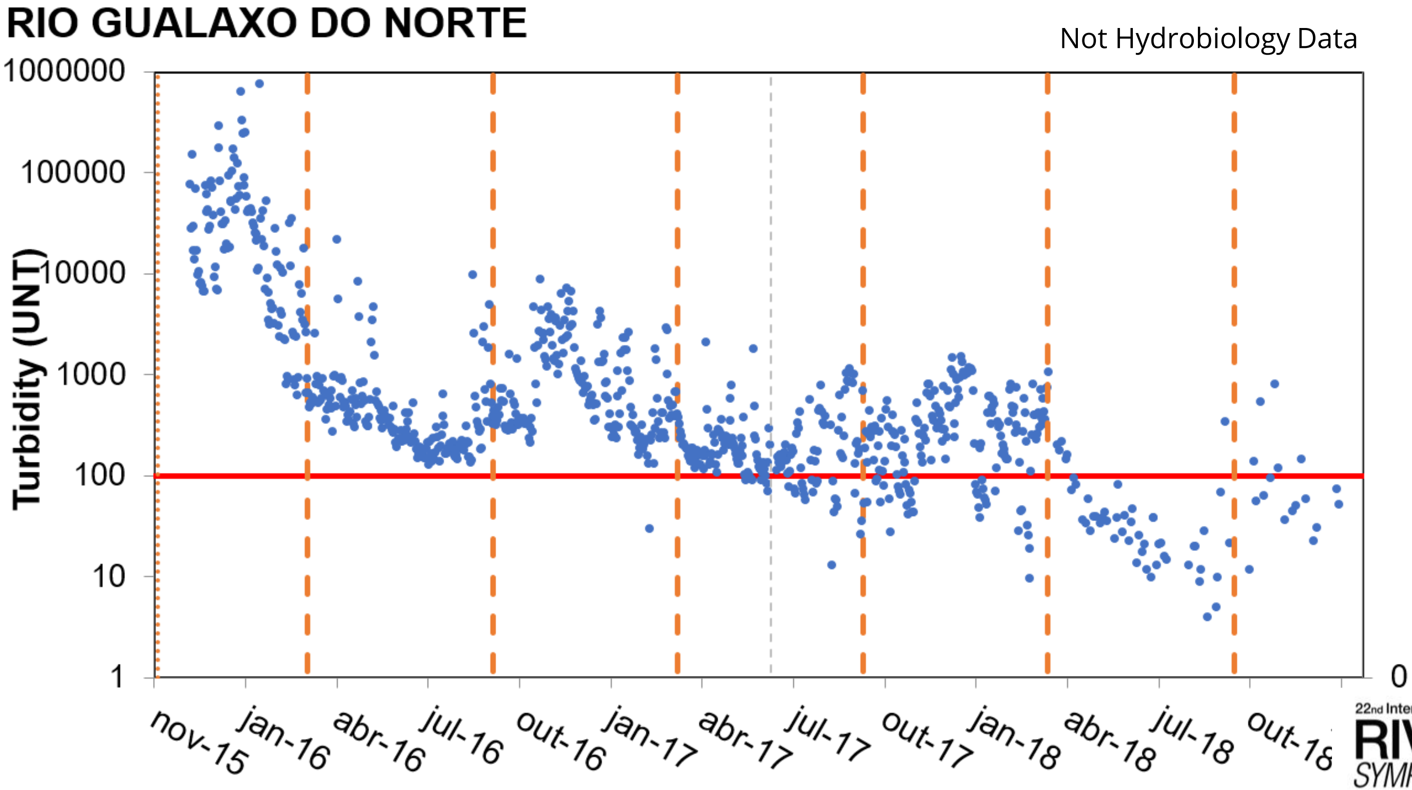
RESPONSE - DECAY LAW



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REMEDIATION - OCT16 TO FEB17




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SUMMARY

Problems	Areas for Improvement
Lack of Strategy – some industries/agencies better than others	Collaboration, commitment, preparedness. Governance & accountability
Lack of anticipation	Plan for the unexpected
Reliance on and misunderstanding of risk	Better understanding of risk
Lack of baseline leading to uncertainty over recovery targets	Baseline and ongoing monitoring
Lack of stakeholder information and engagement	Engagement with potentially impacted communities – Quick answers!
Lack of timely response leading to uncertainty over impacts	Plan for rapid mobilisation for impact monitoring

Hydrobiology

27 / 43 Lang Parade
Auchenflower 4066
QUEENSLAND

PO Box 2151
Toowong 4066
QUEENSLAND

+61 (0)7 3721 0100 P
info@hydrobiology.biz
www.hydrobiology.biz

BRISBANE | PERTH | SINGAPORE | PAPUA NEW GUINEA