Investigation and Status of Continuous Turbidity Monitoring at TMI Sites in Tennessee Streams

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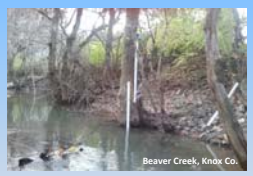

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Introduction

Siltation in Tennessee Streams

a) The occurrence of suspended sediments in excess
b) Silt is one of the most frequently cited pollutants in Tennessee, impacting almost 6,000 miles of streams and rivers (2010, TDEC).
c) Once cited and placed on the 303d list for impairment steps must then be taken to develop sediment TMDLs
d) Simple toxic threshold likely does not capture elastic nature of invertebrate communities

Introduction

Linking biological impairment to Siltation

a) Turbidity as a surrogate measure for Total Suspended Sediments (TSS)
b) Concentration-duration-frequency (CDF) curves for characterization of episodic suspended sediment transport
c) Tennessee Macroinvertebrate Index (TMI) scores & Habitat Assessements

Project Objectives

- Relate dose response for concentration thresholds from CDF curves to available TDEC sampling efforts
  a) TMI scores
  b) Taxa families (Intolerant vs. Tolerant)
  c) Habitat Assessments
- Identify a parameter that best categorizes variance in basin specific duration characteristics

Sites

- Monitoring seven TMI sites near Knoxville in Ridge and Valley Ecoregion (ER 67)
- Will include USGS historical real-time turbidity data from Nashville area in Interior Plateau Ecoregion (ER 71)
- Limited Sites available where turbidity data, suspended solids, and TDEC sampling occur
- Data Collection Period 12-20-11 to 6-19-12

ER 67 Sites

Global Waters Stage-Turbidity Data Loggers:

- Fourth Creek
- Hinds Creek
- Buffalo Creek
- Bullrun Creek
- Beaver Creek

ER 67 Sites

YSI Sondes
- Clear Creek
- Little Turkey Creek

TMI Sites

- Fourth Creek = 16
- Beaver Creek = 20
- Little Turkey Creek = 28
- Locke Branch = 30
- Hinds Creek = 30
- Bullrun Creek = 30
- Buffalo Creek = 34
- Clear Creek = 34
- Harpeth = 34
- Copperas = 40

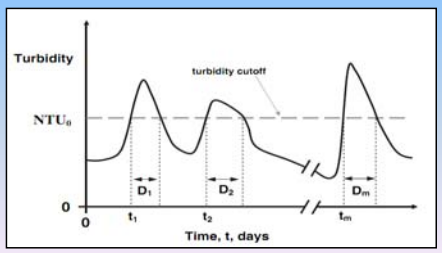
TMI Range: 0 - 42: 0 bad / 42 good

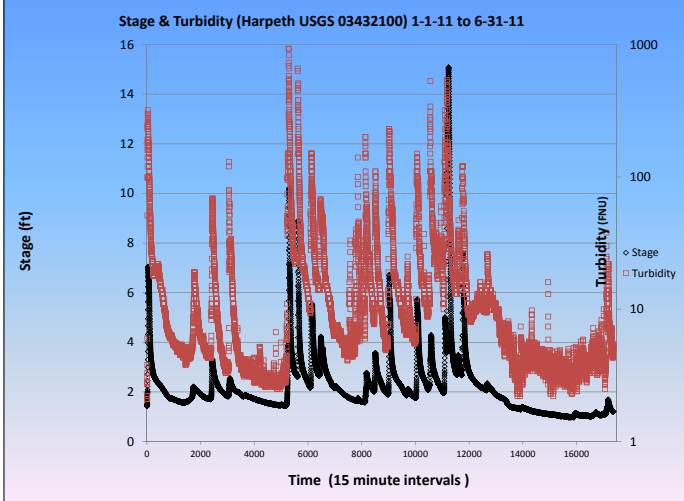
Technical Field Challenges

- Optical fouling
- Equipment malfunction due to weather exposure
- Continuous maintenance spread out over a geographic area
- Access during high stage events

Development of CDF Curves

Poisson Arrival Approach
- Episodic turbidity spikes during storm flows
- Can be considered random and similar to a Poisson process
- Substantial theoretical development (Cramer and Leadbetter, 1967; Todorovic, 1978)





Development of CDF Curves

$$P(m) = \lambda^m e^{-\lambda}/m!$$

Poisson Probability Distribution
- P(m) = probability of m occurrences
- m = # of occurrences in time interval
- λ = mean # of occurrences in the time interval

$$P(D \geq d) = e^{-d/\mu}$$

Exponential Distribution describes the duration of the event (Anderson *et al.*, 1993)

$P(D \geq d)$ is the probability that a specific events duration (D) exceeds the duration of interest (d) and μ represents the mean duration.

$$N_d = N_T \cdot e^{-d/\mu}$$

Transformation of the above equation gives us the theoretical expected # of events when fitted for a given threshold.

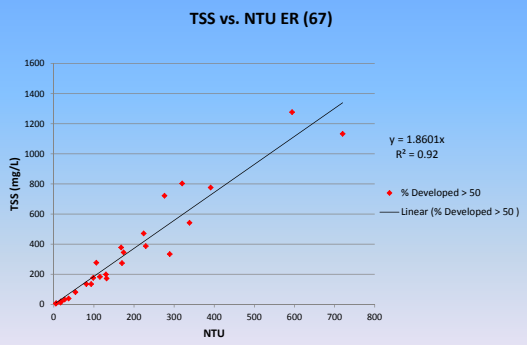
N_d = number of expected events
N_t = Total number of events
μ = mean duration of events

Construction of CDF Curves

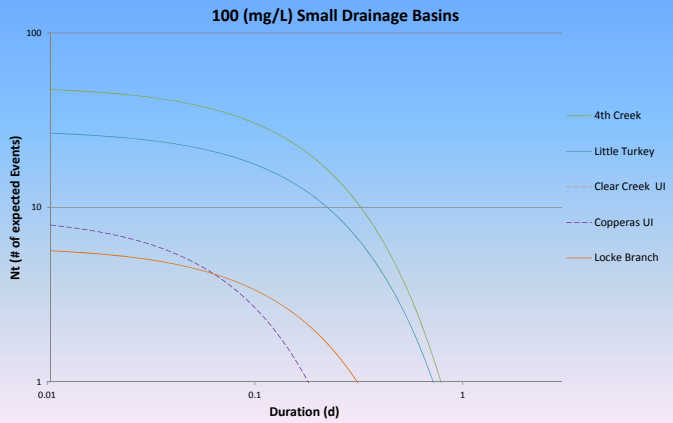
- First, a magnitude of interest (NTU_0, SSC_0, TSS_0) must be selected as a cutoff value.
- This allows the calculation of a given duration per event in excess of the level of interest.
- Next, data must be organized by number of events, ranked, and adjusted to common time period.
- Data can be fitted to explain the variance between variables.

	Duration of Event (days)					
Event No.	NTU ≥ 7	NTU ≥ 20	NTU ≥ 55	NTU ≥ 150	NTU ≥ 400	NTU ≥ 1,100
1	1.92	0.83	0.29	0.07	0.07	0.02
2	0.63	0.45	0.15	0.07	0.06	0.02
3	0.53	0.28	0.13	0.05	0.02	0.02
4	0.46	0.22	0.11	0.05	0.02	0.02
5	0.43	0.21	0.08	0.04	0.02	
6	0.41	0.21	0.08	0.04	0.02	
7	0.36	0.21	0.06	0.03		
8	0.35	0.19	0.06	0.03		
9	0.32	0.17	0.05	0.02		
10	0.32	0.16	0.05	0.02		
11	0.31	0.15	0.03	0.02		
12	0.27	0.13	0.03	0.02		
13	0.26	0.10	0.03	0.02		
14	0.26	0.10	0.02			
15	0.24	0.08	0.02			
16	0.21	0.06	0.02			
17	0.19	0.06	0.02			
18	0.19	0.06	0.02			
19	0.19	0.04				
↓	↓					
97	0.05					
Number of Events	97	31	18	13	6	4

Turbidity vs. TSS



Comparison CDF Curves



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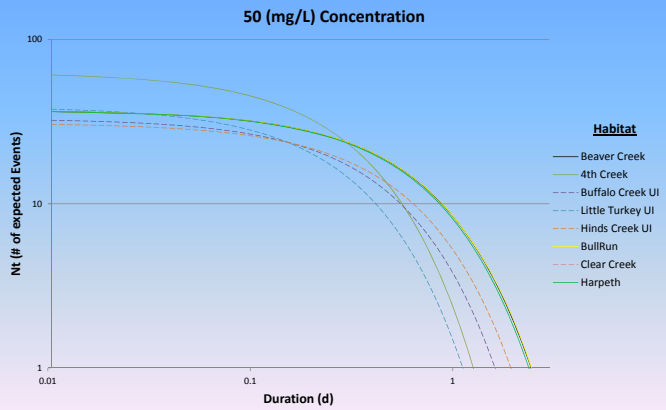

Conclusions

- Work-in-progress

- Final analysis correlating CDF curve metrics with TMI scores to be completed by December 2012.
- CDF analysis to characterize the episodic nature of suspended sediment transport appears promising.
- Questions…..