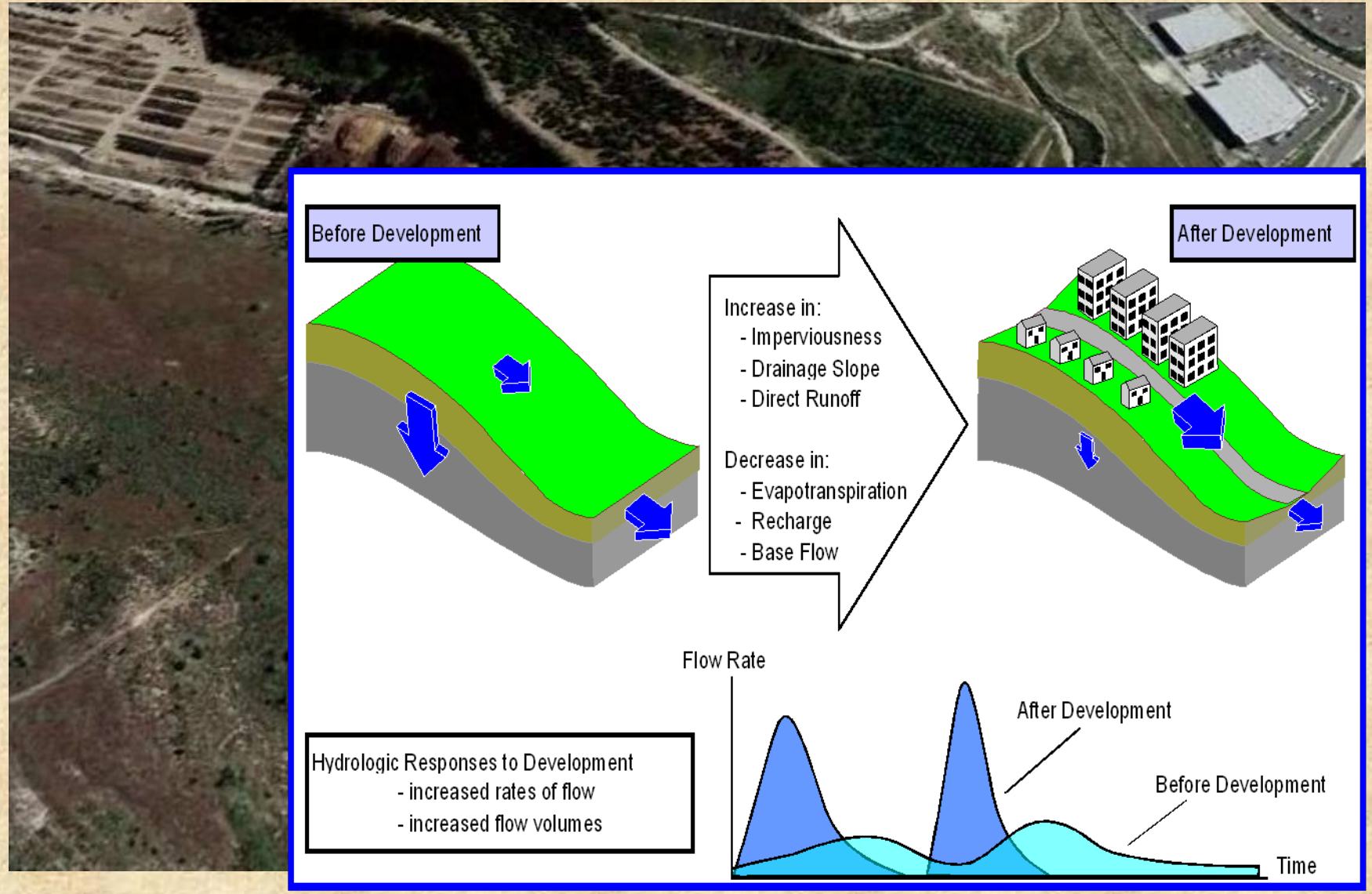
Developing Tools for Hydromodification Management and Assessment

Hydromodification: Channel Erosion

Hydromodification: Channel Erosion



Challenges in Managing Hydromodification

- Change can occur rapidly
- Streams respond differently
- May be dealing with legacy effects
- Responses are difficult to predict

Most stormwater permits require management of hydromodification effects

Current Study: Tool Development

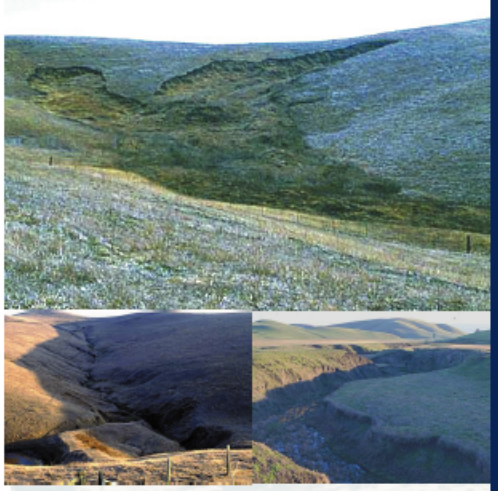
1. Which streams are at the greatest risk of effects of hydromodification? ➡ *Screening Tool*

2. What are the anticipated effects in terms of increased erosion, sedimentation, or habitat loss, associated with increases in impervious cover? ➡ *Modeling Tools*

3. What are some potential management measures that could be implemented to offset hydromodification effects? ➡ *Management Tools*

TR #607 – Tech Foundation

HYDROMODIFICATION SCREENING TOOLS:
TECHNICAL BASIS FOR DEVELOPMENT OF A FIELD SCREENING TOOL FOR ASSESSING CHANNEL SUSCEPTIBILITY TO HYROMODIFICATION



Brian P. Bledsoe
Robert J. Hawley
Eric D. Stein
Derek B. Booth

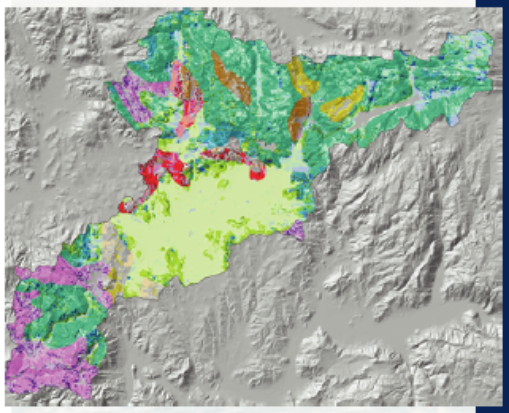
Southern California Coastal Water Research Project
Technical Report 607 - July 2010

HYDROMODIFICATION SCREENING TOOLS:
FIELD MANUAL FOR
ASSESSING CHANNEL SUSCEPTIBILITY

Southern California Coastal Water Research Project
Technical Report 606 - March 2010

TR #606 – Field Manual

HYDROMODIFICATION SCREENING TOOLS:
GIS-BASED CATCHMENT ANALYSES
OF POTENTIAL CHANGES IN
RUNOFF AND SEDIMENT DISCHARGE



Southern California Coastal Water Research
Technical Report 605 - March 2010

TR #605 – GIS Tool

Current Study: Tool Development

1. Which streams are at the greatest risk of effects of hydromodification? ➡ *Screening Tool*

2. What are the anticipated effects in terms of increased erosion, sedimentation, or habitat loss, associated with increases in impervious cover? ➡ *Modeling Tools*

3. What are some potential management measures that could be implemented to offset hydromodification effects? ➡ *Management Tools*

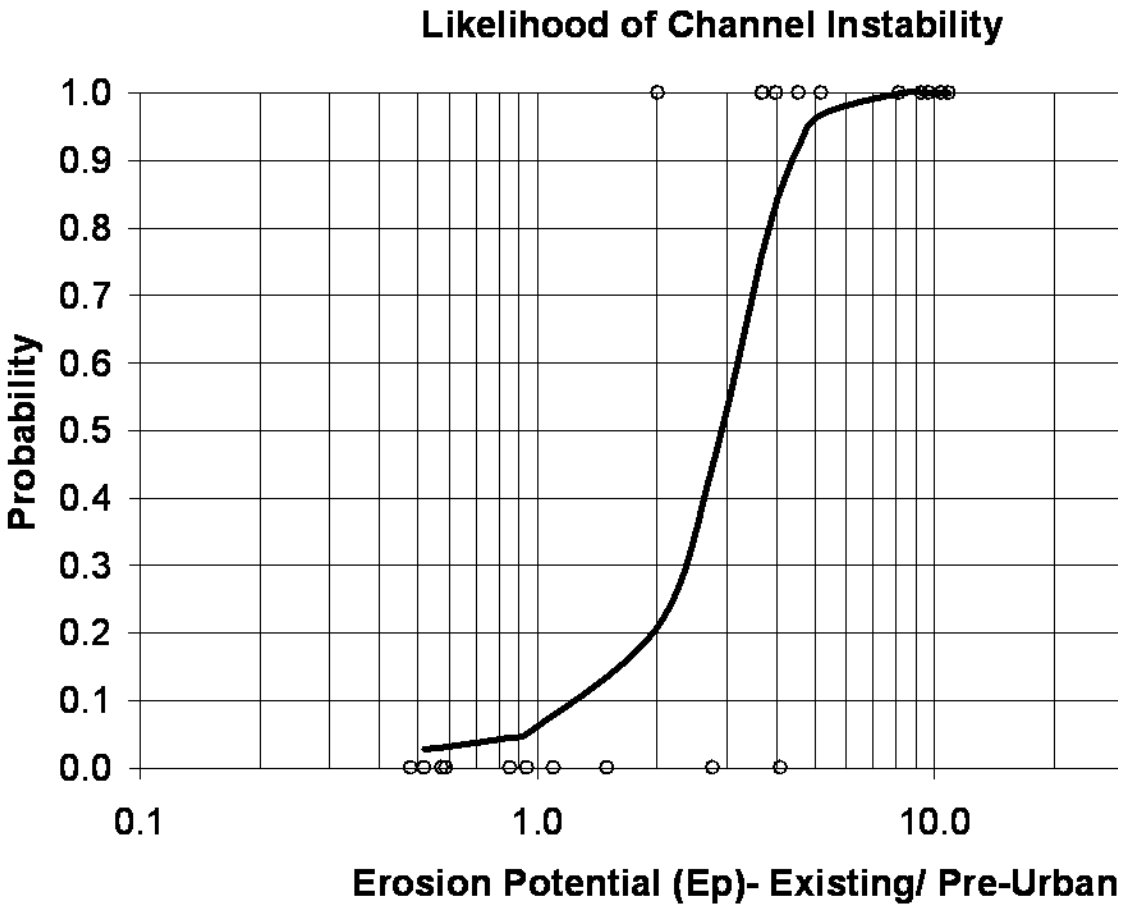
Model Options

- Deterministic Models-
  - ✓ Mobile Boundary Models
  - ✓ Sediment Imbalance/Load Ratio
- Probability/Stochastic Models
  - ✓ Logistic regression
- Pseudo Deterministic Models
  - ✓ Regime Diagrams
- Iterative Solution Models
  - ✓ Artificial Neural Networks

Deterministic Models

- For example:
  - ✓ HEC-RAS
  - ✓ FLUVIAL-12
- Don’t typically perform well in S. CA Streams
  - ✓ Difficulty predicting flow and sediment & split flow
  - ✓ Geologic heterogeneity
  - ✓ Widening / bank failure processes
  - ✓ Extremely data intensive to calibrate
- High cost/effort → high uncertainty in output

Logistic Analysis of Channel Stability



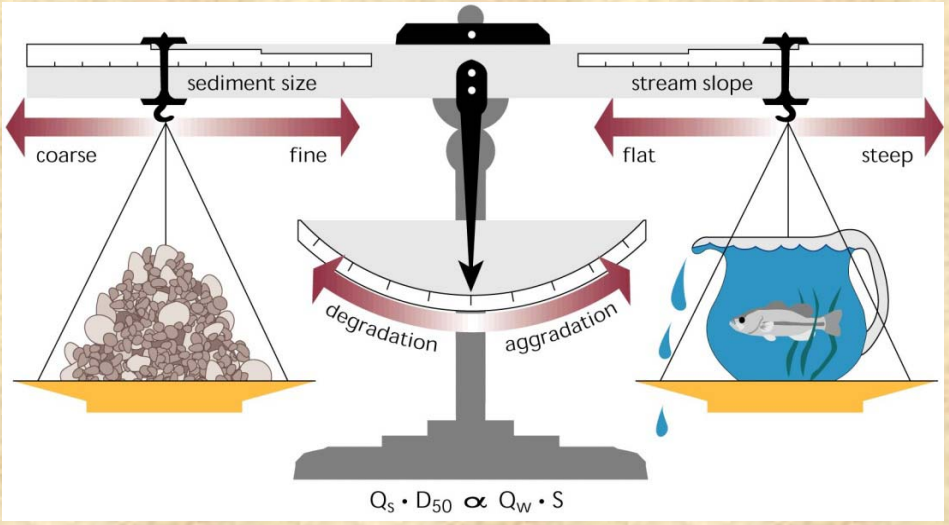
- Can be derived empirically or using models
- Good for evaluating binary /threshold response
- Less applicable for gradient of responses

Model Options

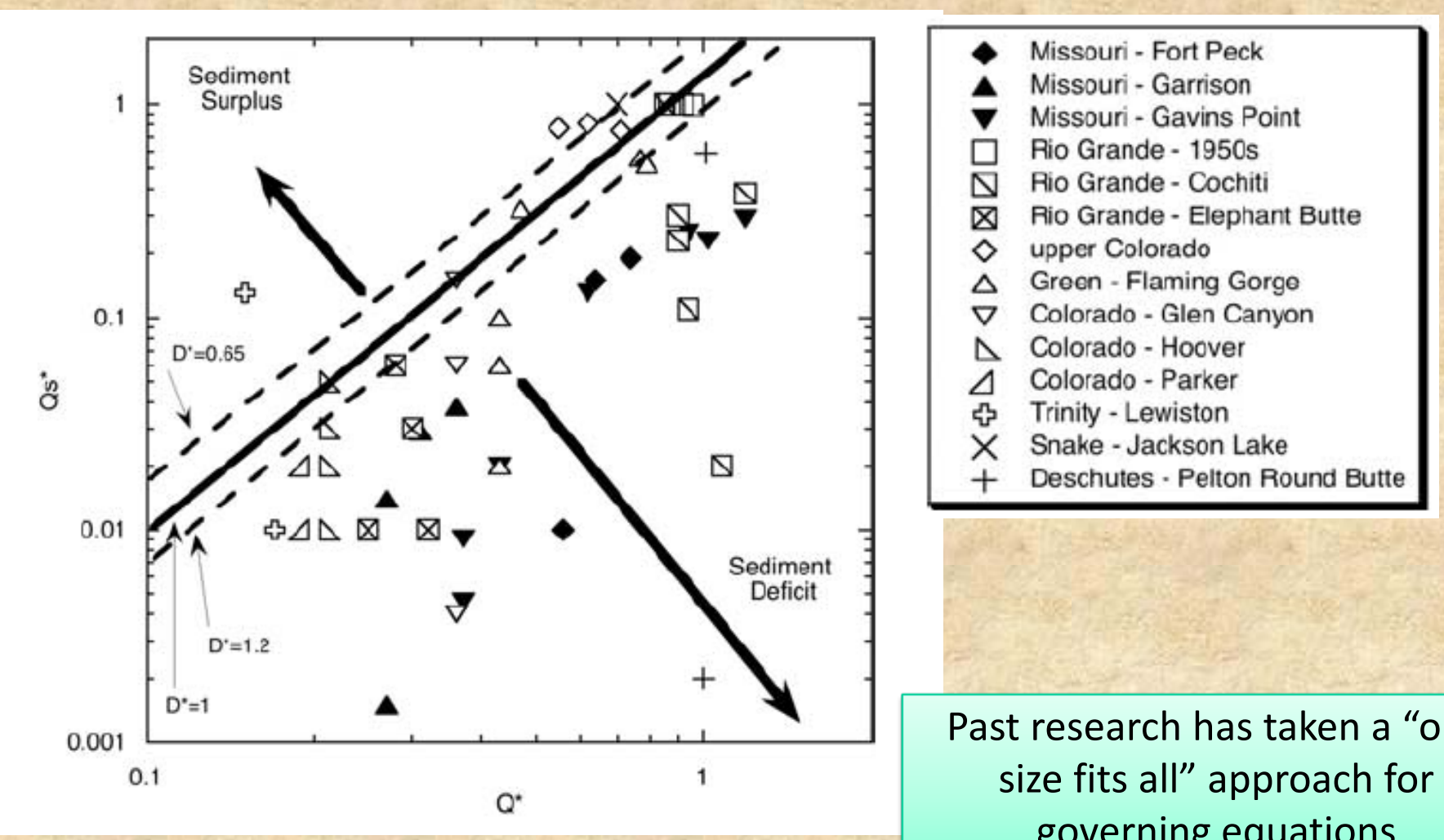
- Deterministic Models-
  - ✓ Mobile Boundary Models
  - ✓ Sediment Imbalance/Load Ratio
- Probability/Stochastic Models
  - ✓ Logistic regression
- Pseudo Deterministic Models
  - ✓ Regime Diagrams
- Iterative/Statistical Solution Models
  - ✓ Artificial Neural Networks

Regime Diagrams Overview

- Simple models to predict channel response to changing flow and sediment supply
- Graphical representation of concepts of Lane's balance
- Based on empirical relationships, validated with local data



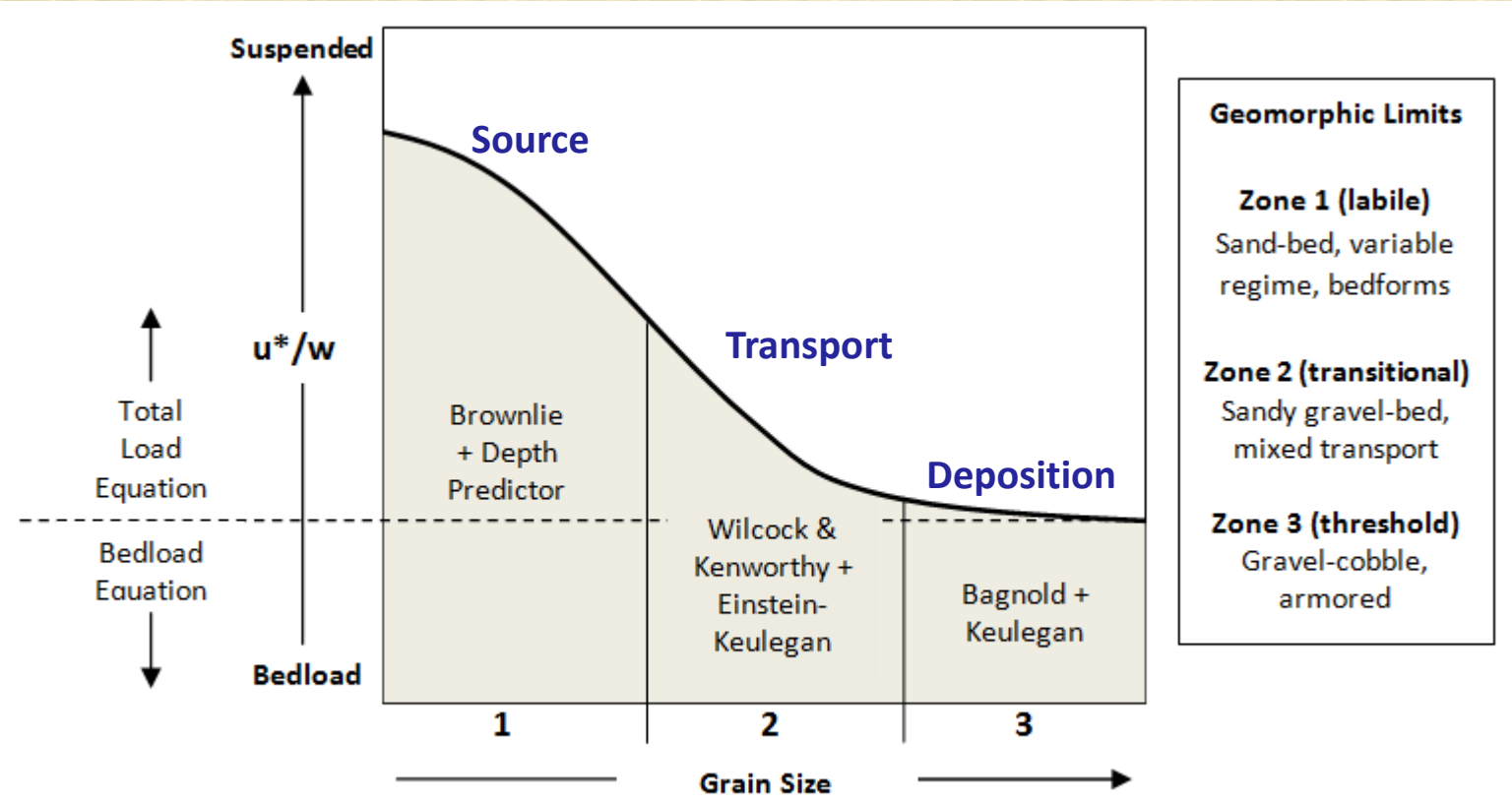
Sample Regime Diagram



Past research has taken a "one size fits all" approach for governing equations

Schmidt and Wilcock 2008

Relationships Vary by Stream Type



Hydraulic Geometries

h, flow depth
w, channel width
$f(Q_{eff.})$

Topography and Material

S_o, channel slope
S_v, valley slope
D_s, grain size

Physical Parameters

g, gravity
ν, kinematic viscosity
G, specific gravity

Model Equations

$$q^* = f(D_s, S)$$
$$q_b^* = f(D_s, S, Q, w)$$
$$D^* = D_s$$
$$P^* = f(Q, S_v)$$

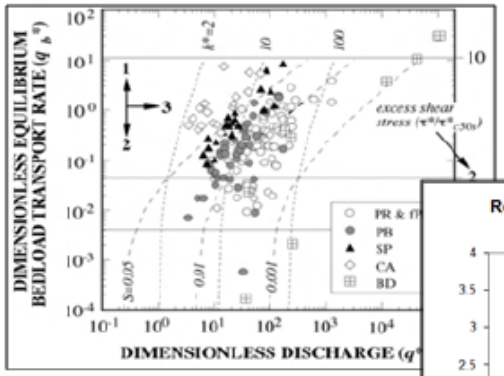
Flow Resistance

- Brownlie 1981
- Limerinos 1970
- Jarret 1987
- Snyder et al.

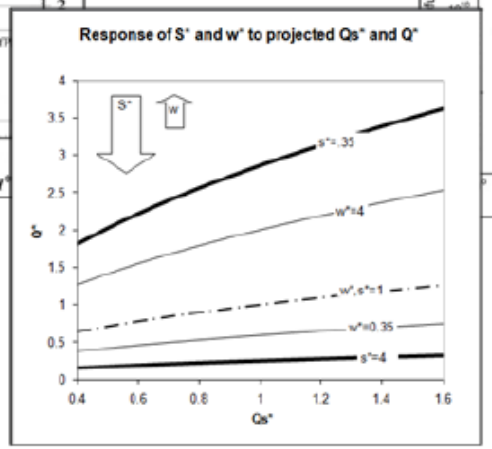
Sediment transport

- Yang 1996
- Brownlie 1981
- Bagnold 1980
- Schoklisch 1962

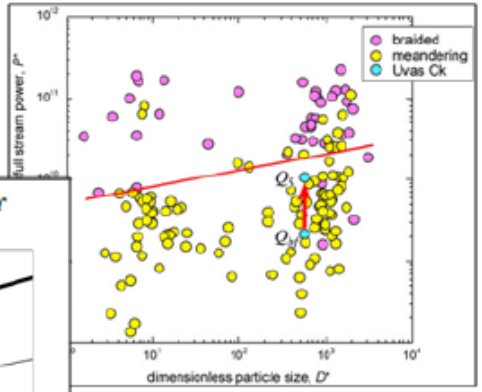
Absolute Channel Response



Relative Channel Response



Meandering-Braiding Thresholds



Study Sites

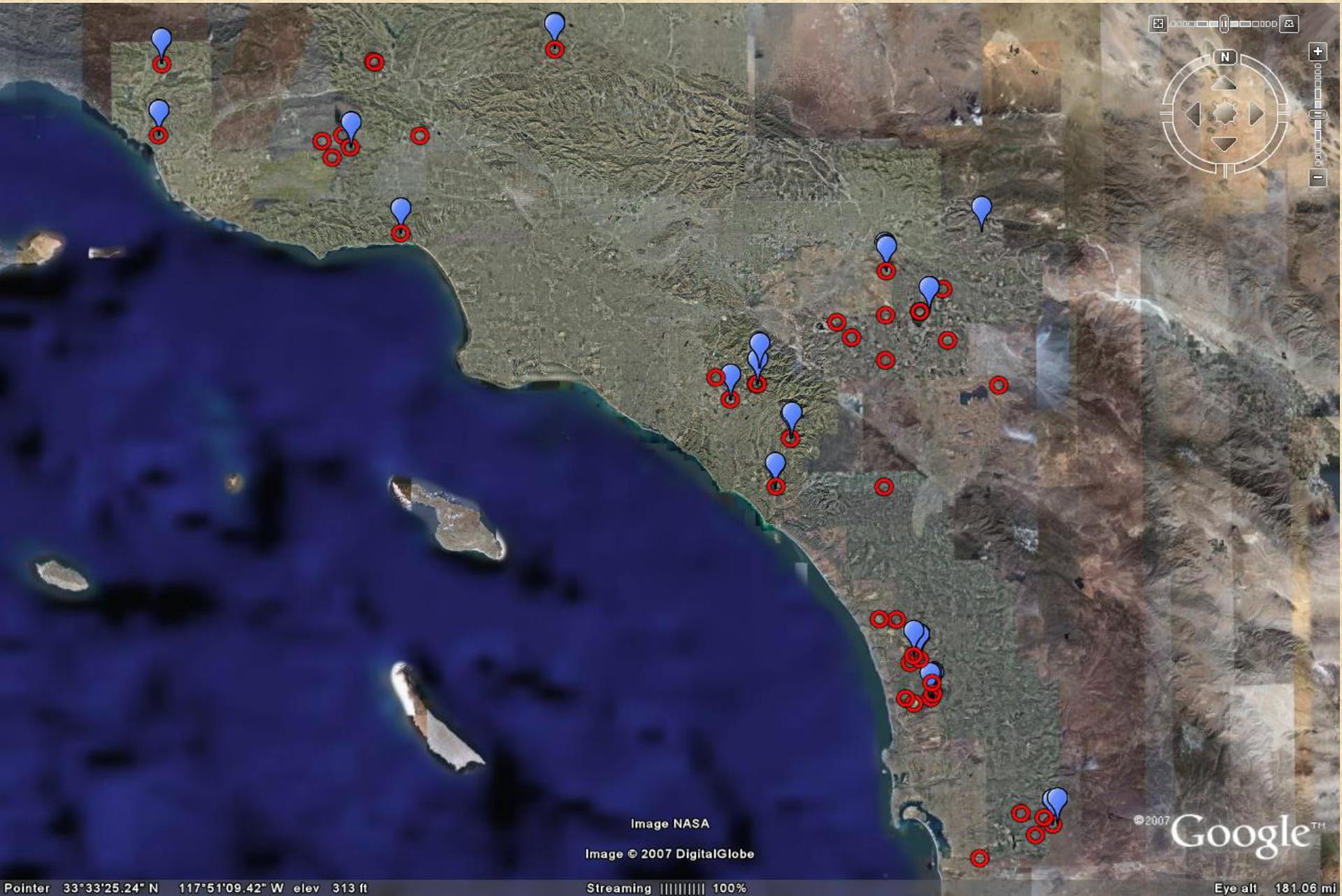
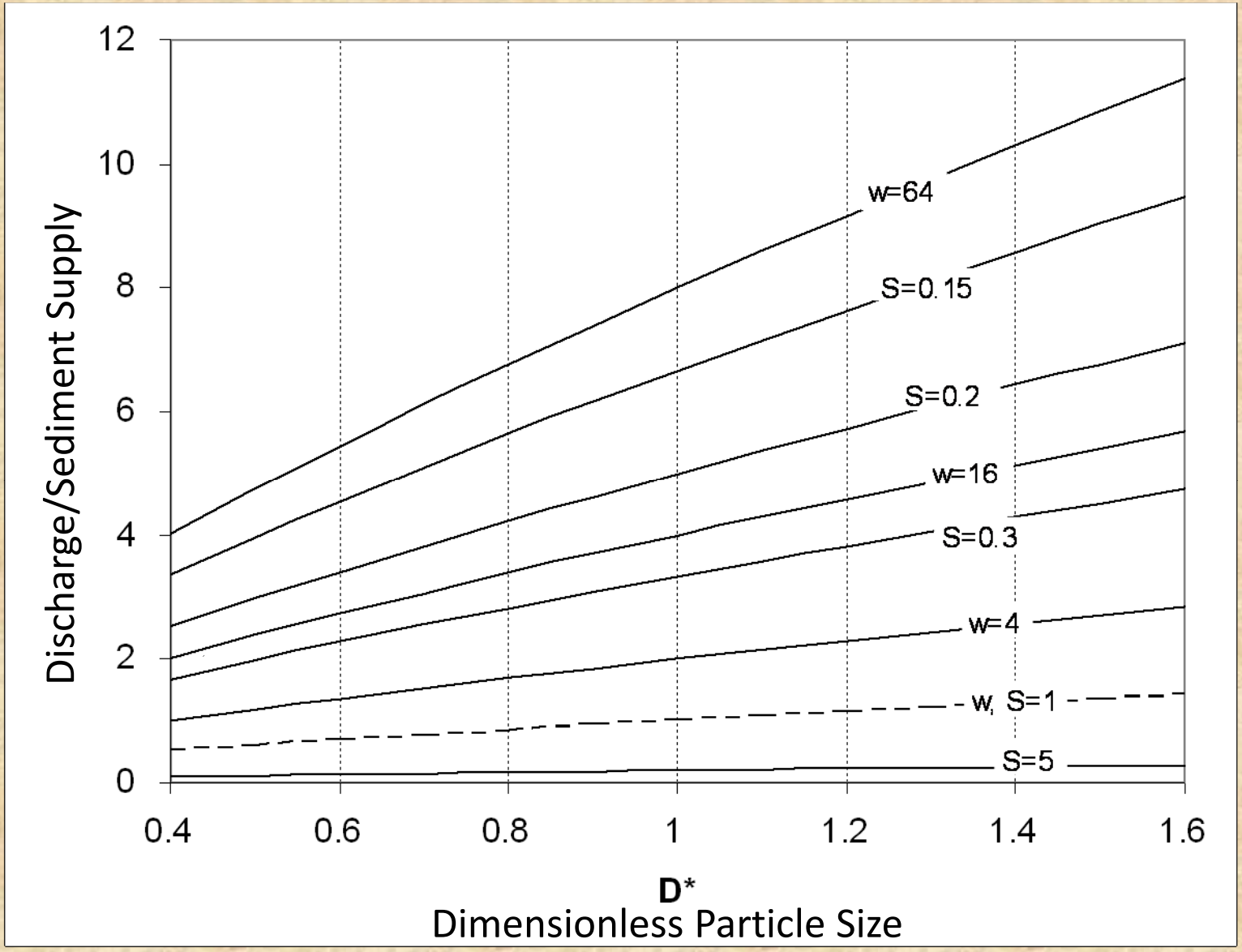


Image NASA
Image © 2007 DigitalGlobe
©2007 Google™
Pointer 33°33'25.24" N 117°51'09.42" W elev 313 ft
Streaming 100%
Eye alt 181.06 mi

Calibrated Regime Diagrams

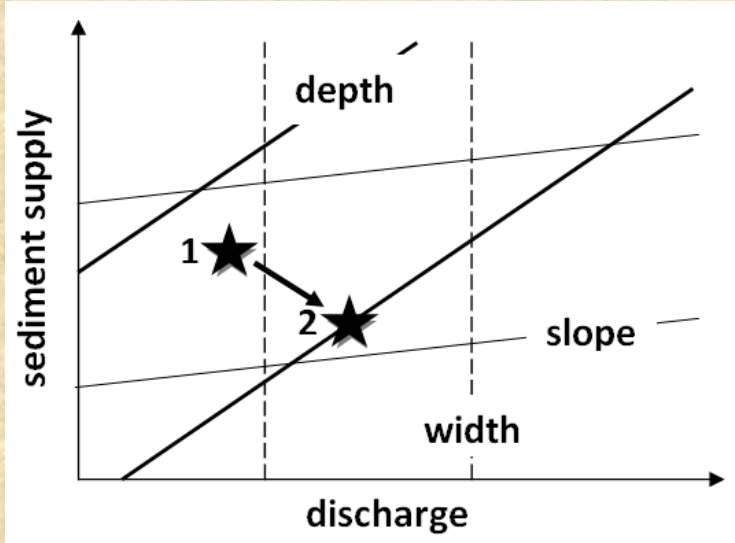


Expected Products

- 8-12 regime diagrams that examine:
  - ✓ Vertical vs. lateral channel response
  - ✓ Thresholds that result in change in planform
  - ✓ Sand bed, bedload transport, mixed channels
- Guidance on appropriate regime diagram based on channel type
- Regional relationship for stable channel slope
  - ✓ based on range of hydraulic parameters from reaches in S. California

Applications

- Use Regime Diagrams to assess expected general direction of change under proposed land use change
  - ✓ Channel deepening
  - ✓ Channel widening
  - ✓ Planform shift



- Initial guidance on potential management solutions
  - ✓ Flatter effect slope
  - ✓ Wider adjacent floodplain

QUESTIONS ?

Eric D. Stein
714-755-3233 erics@sccwrp.org