



Gully annealing by aeolian sediment: Field and remote-sensing investigation in Glen, Marble, and Grand Canyons

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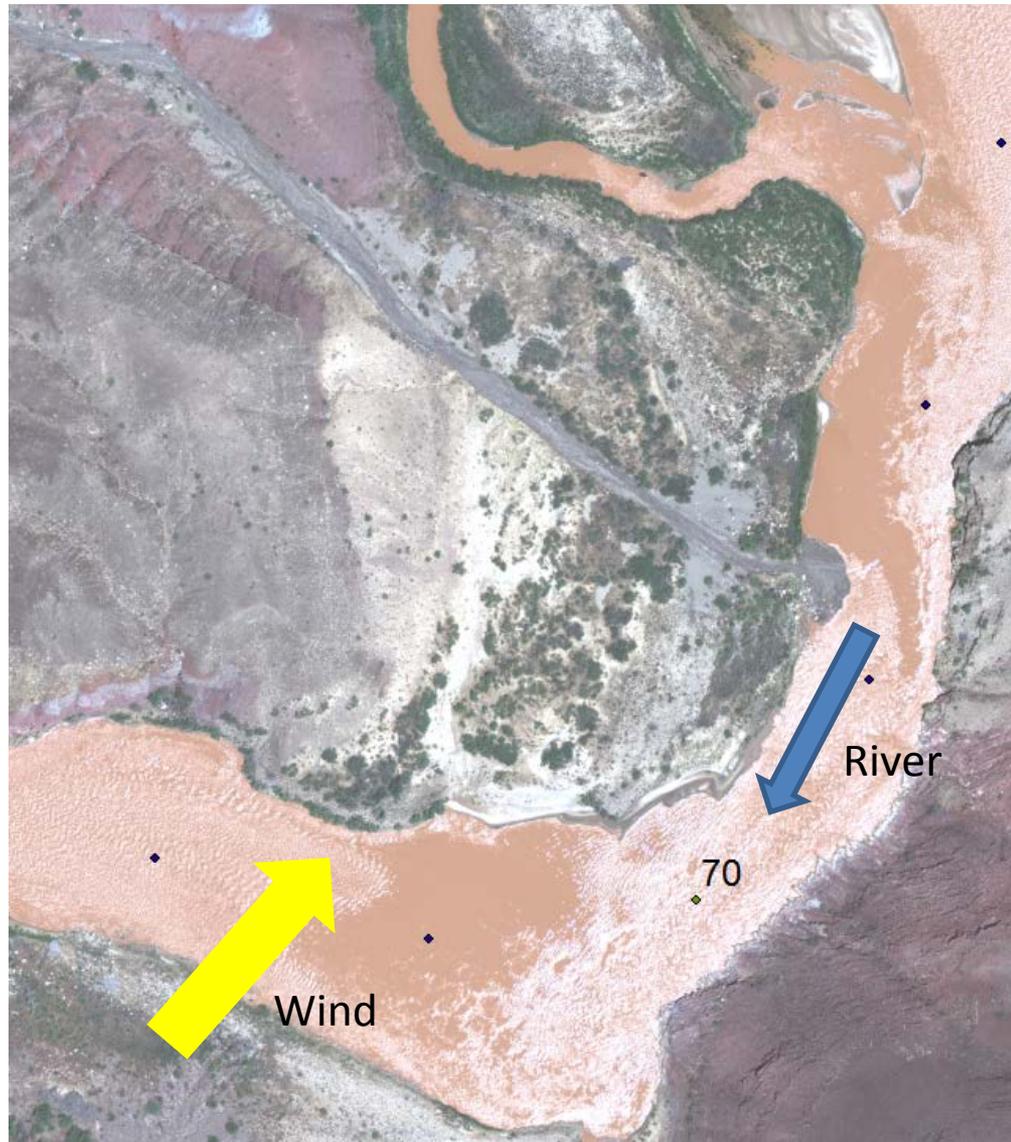
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U.S. Geological Survey

Fluvial-aeolian-hillslope (upland) interactions



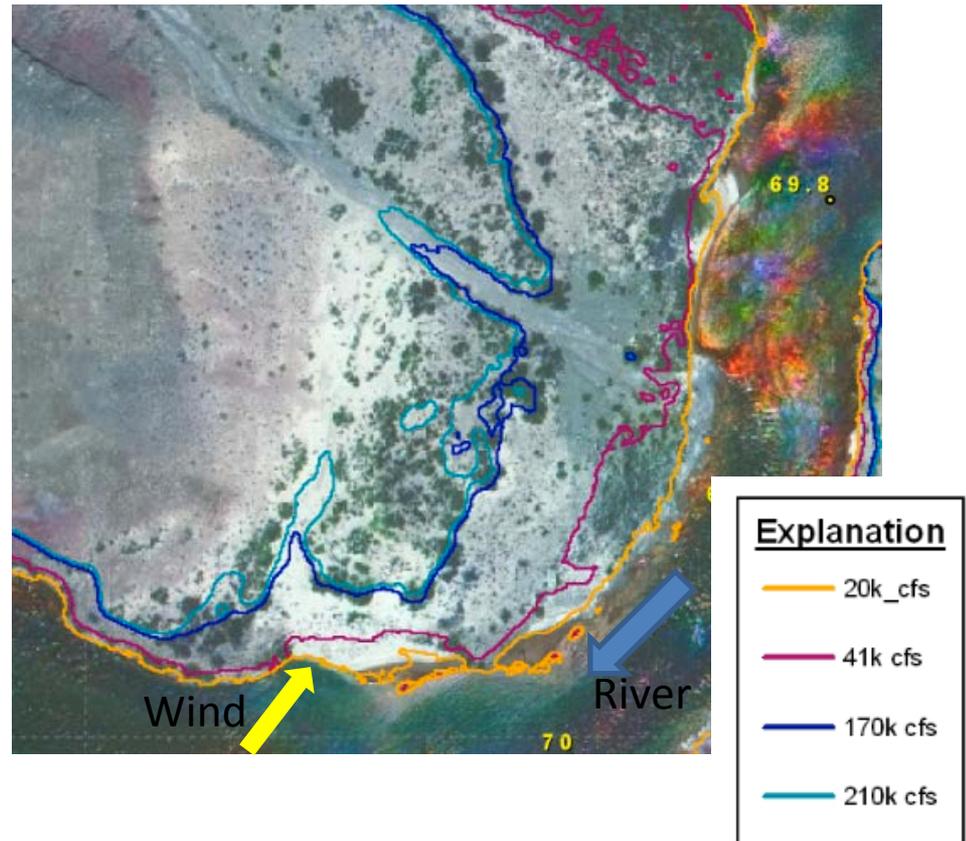
What happens to upland landscapes = what happens to archaeological sites



- Many archaeological sites are susceptible to gully incision
- Some archaeologically significant locations have very little active aeolian sand area, which might increase susceptibility to gully erosion

Aeolian sand in upland landscapes

- Possible that some yet-undocumented archaeological sites are within river-corridor dune fields
- Archaeological sites within dune fields might be less susceptible to gully development
- River corridor dune fields largely originated from 'extreme' floods
 - HFE deposits often smaller, far away, blocked by riparian vegetation
 - So, less connectivity between fluvial and upland landscapes today than in past



Comparing active vs. inactive aeolian sand

“Active” aeolian sand has wind-rippled surfaces, slip faces at angle of repose (Lancaster, 1994)



“Inactive” aeolian sand: biocrusted without ripples (Draut, 2012)



Objectives for landscape scale analysis

Are gullies less prevalent and/or annealed (healed) in places like this? →

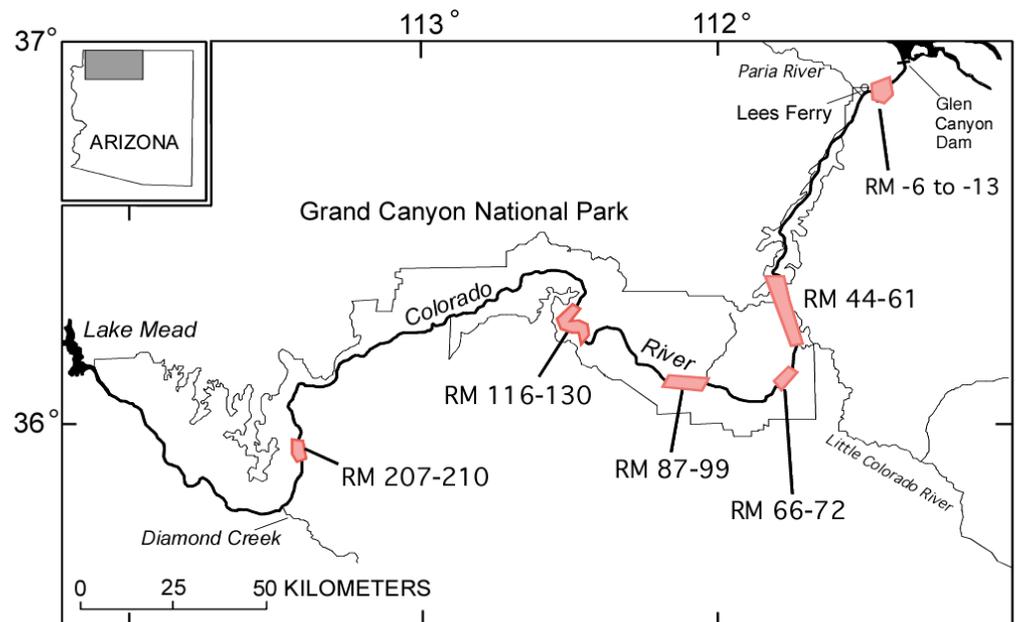


Are gullies more prevalent in places like this? →

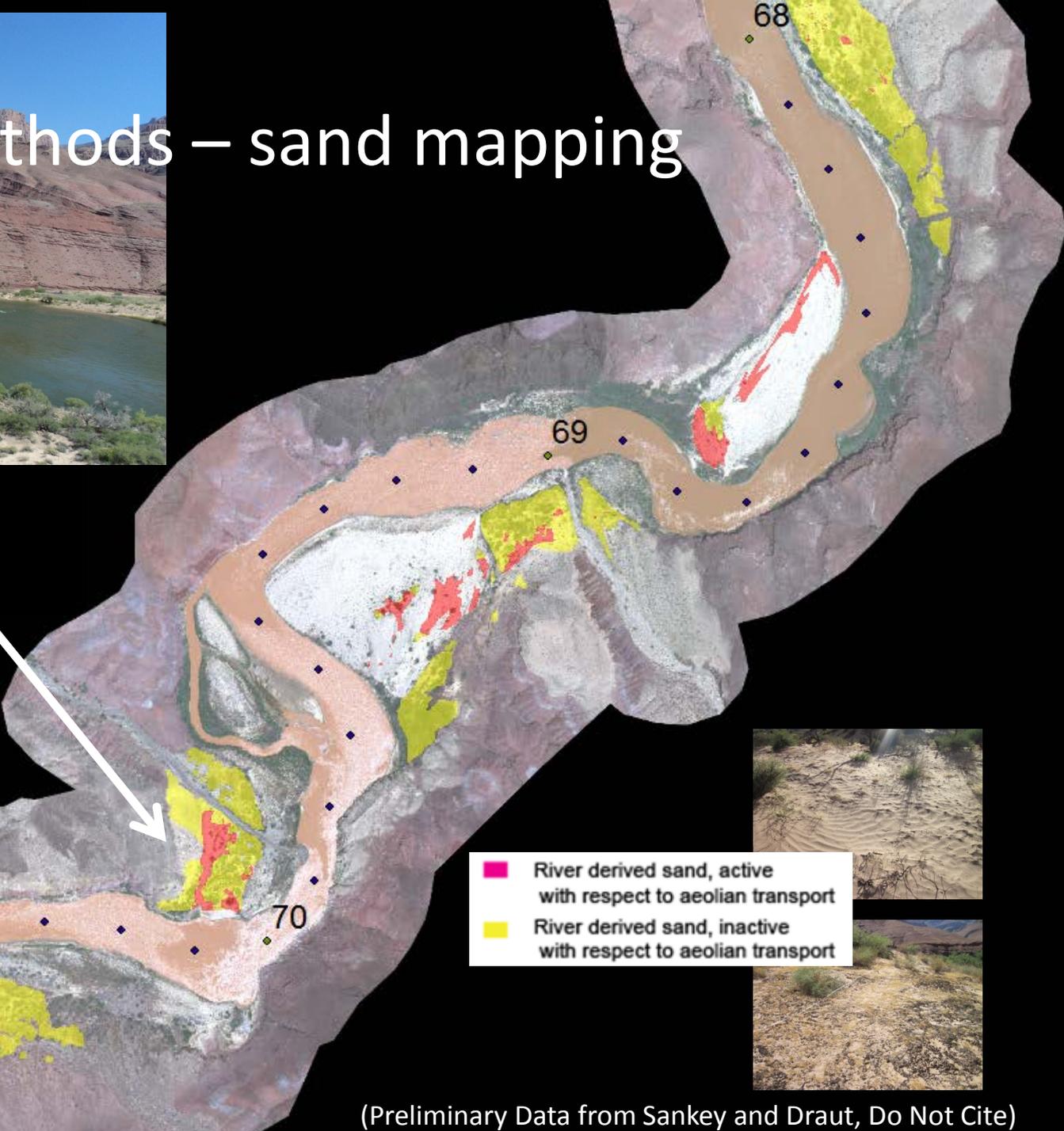
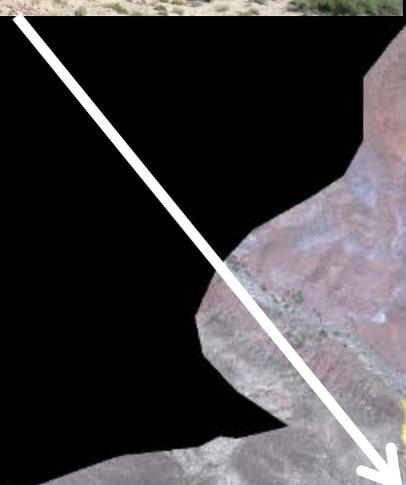


Hypotheses

- (1) Gullies are more evident in areas where sediment is inactive with respect to aeolian transport than in areas with active aeolian transport;
- (2) Gullies terminate more commonly in active aeolian sand than in inactive sand;
- (3) The historical (remotely sensed image) record contains evidence of gullies that have annealed over time and so are less evident today than in the past.



Methods – sand mapping



- River derived sand, active with respect to aeolian transport
- River derived sand, inactive with respect to aeolian transport



Methods – gully delineation

- Goal
 - Identify flow paths with concave across-slope shape

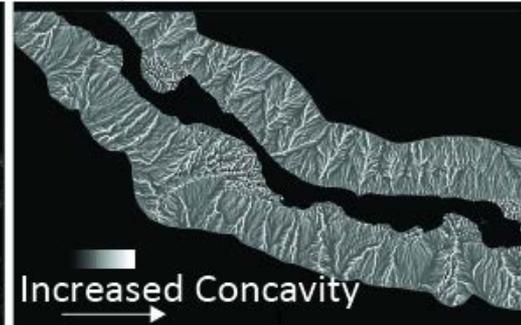


Gully delineation

DEM

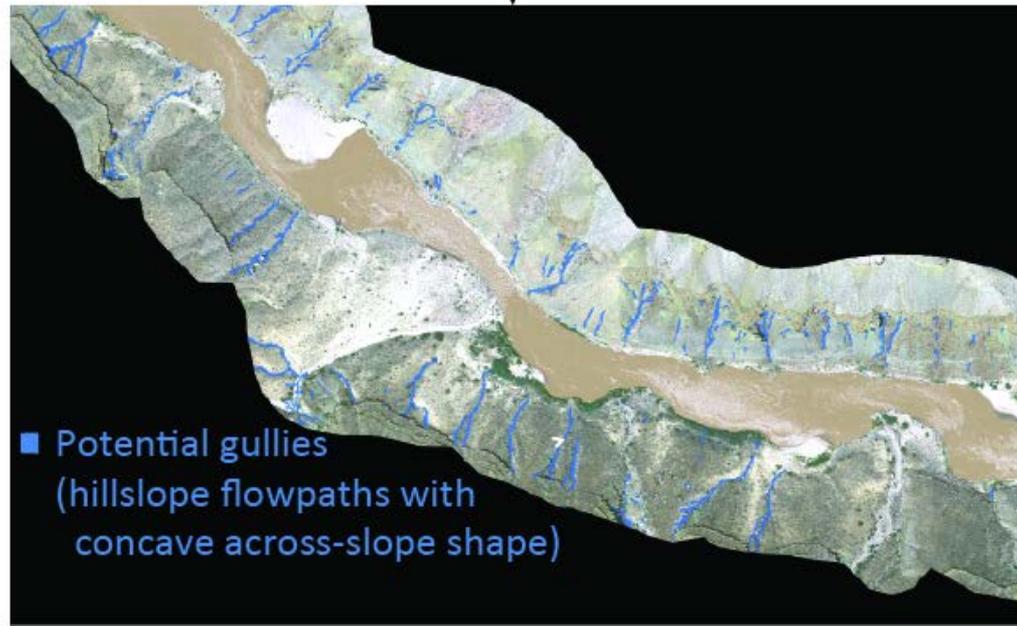


Flow Accumulation



Topographic Plan Convexity

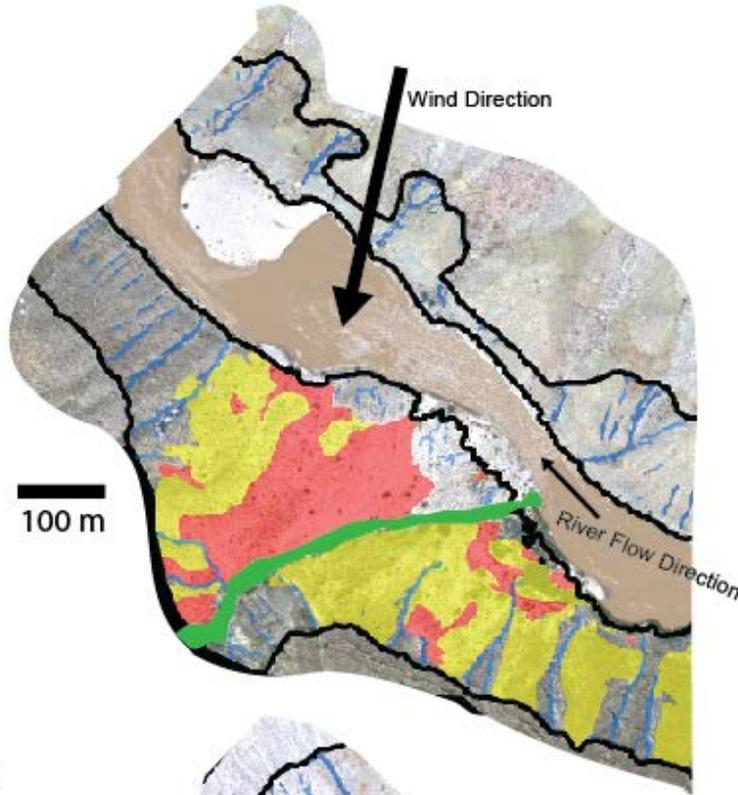
Final Gully Map



(Preliminary Data from Sankey and Draut, Do Not Cite)

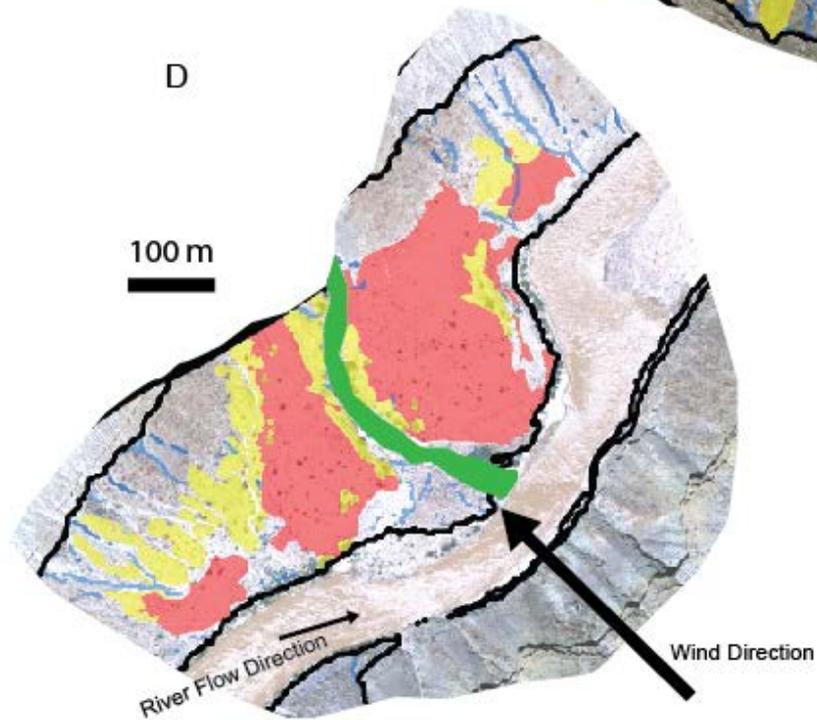
Forster

C



Fossil

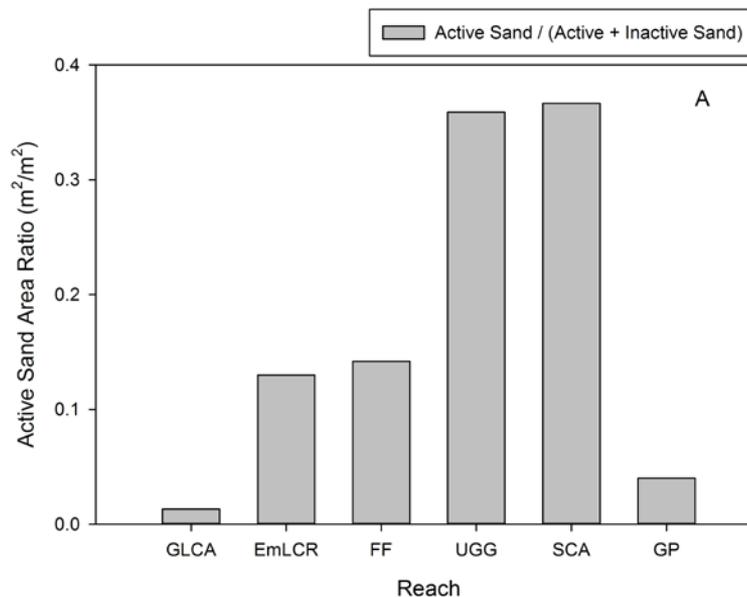
D



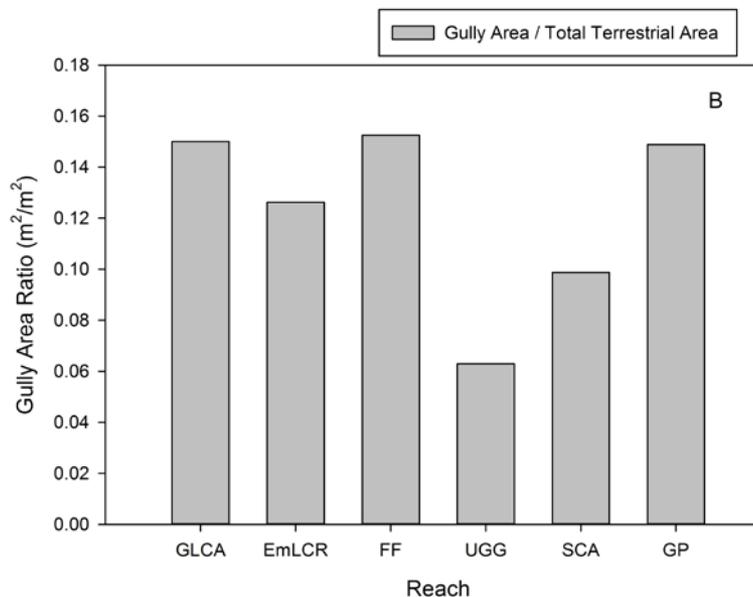
- Terrestrial Area
- River derived sand, active with respect to aeolian transport
- River derived sand, inactive with respect to aeolian transport
- Gullies
- Tributary
- ★ Example locations of gullies that terminate in aeolian sand

Results

How does the proportion of active vs. inactive aeolian sand vary by reach?



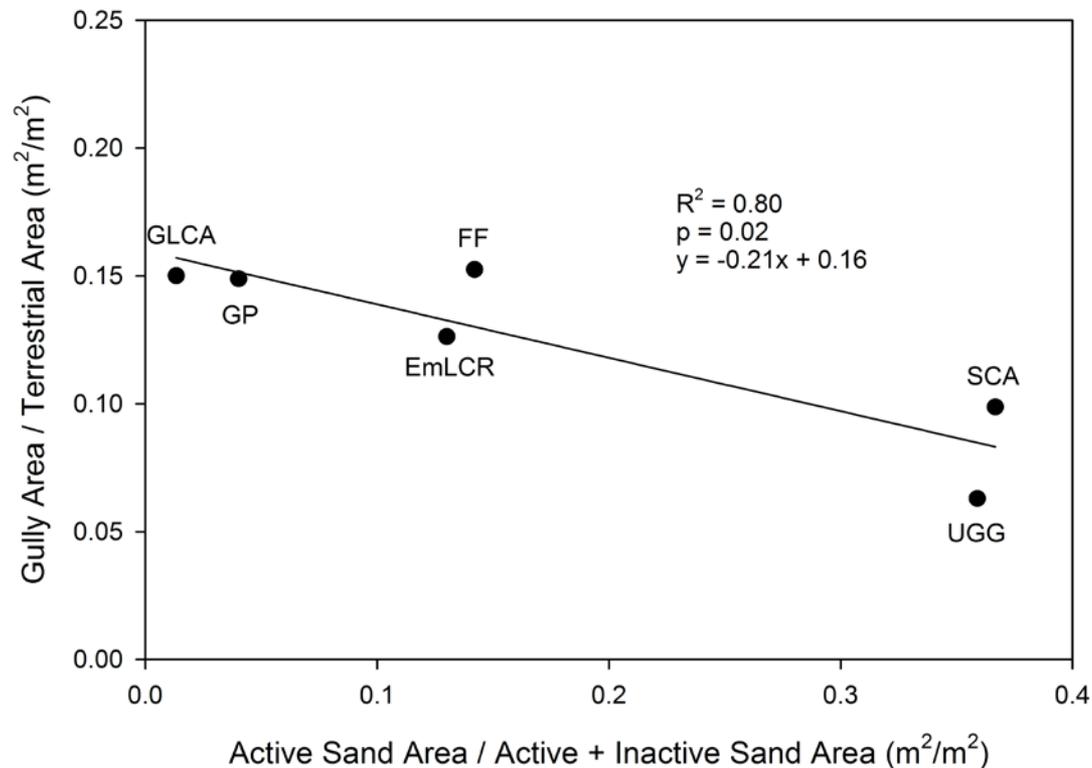
How does the proportion of area affected by gullies vary by reach?



(Preliminary Data from Sankey and Draut, Do Not Cite)

Results - hypothesis 1

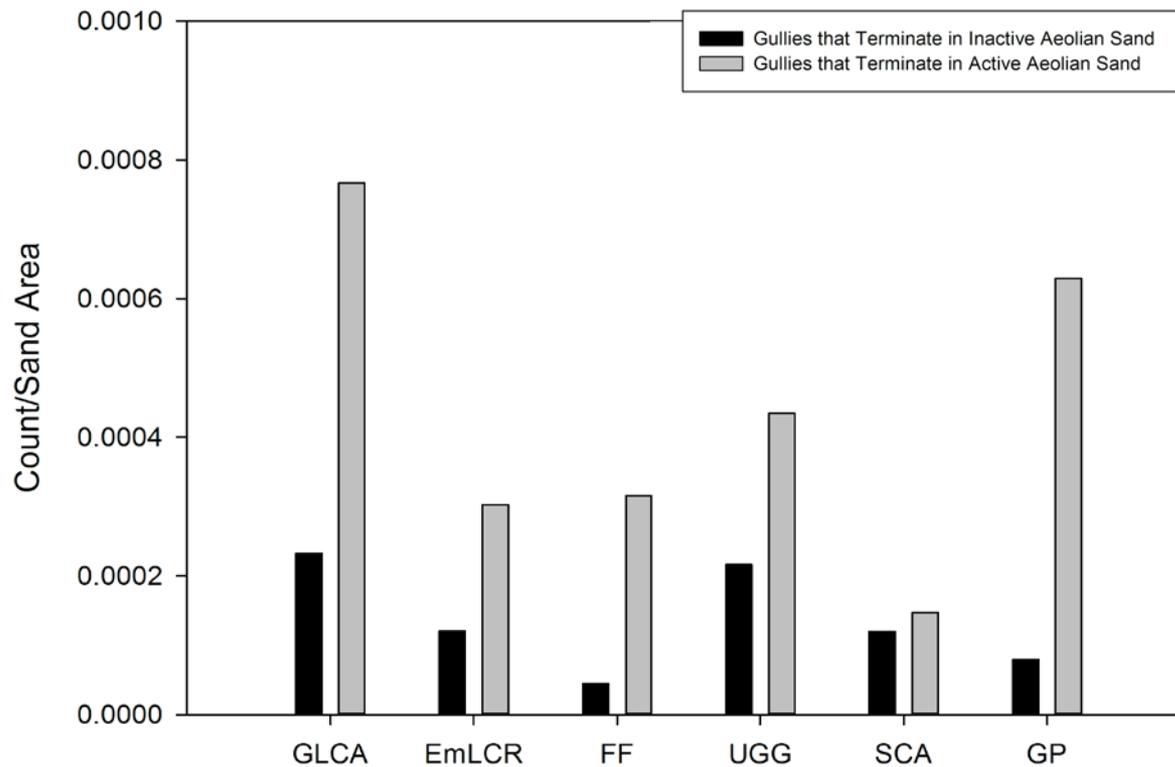
Are gullies more evident in areas where sediment is inactive with respect to aeolian transport than in areas with active aeolian transport?



(Preliminary Data
from Sankey and
Draut, Do Not Cite)

Results - hypothesis 2

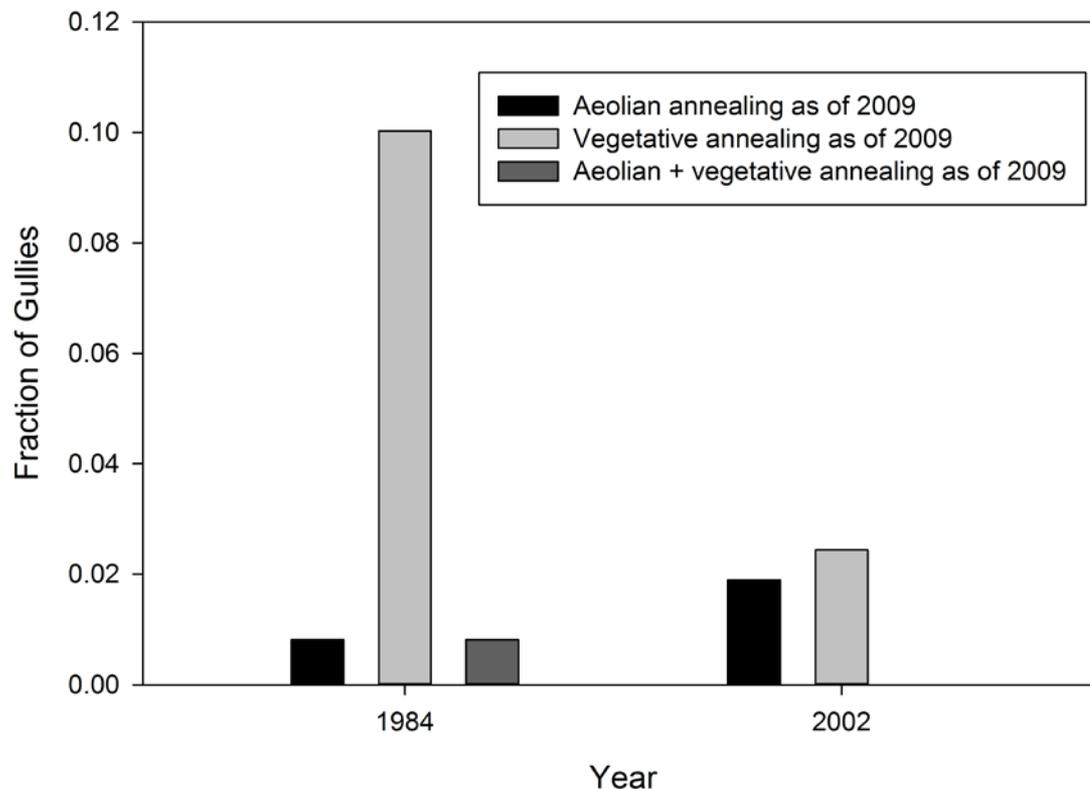
Do gullies terminate more commonly in active aeolian sand than in inactive sand?



(Preliminary Data
from Sankey and
Draut, Do Not Cite)

Results - hypothesis 3

Does the historical (remotely sensed image) record contain evidence of gullies that have annealed over time and so are less evident today than in the past?



(Preliminary Data
from Sankey and
Draut, Do Not Cite)

Future Questions

Connectivity along the river-hillslope continuum

To what extent will:

- decreased fluvial (HFE) deposition, and
- increased riparian vegetation growth (barriers),
inhibit aeolian sand supply inland?