# Gully erosion of cultural sites in Grand Canyon

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I. Erosion control: Are checkdams working?

*Results:*

a) small data set indicates checkdams do work to reduce erosion
b) damaged structures are associated with steep gradients and high erosion
c) woody debris checkdams appear to work better than rock linings

*Recommendations:*

a) enlarge dataset
b) continue erosion control, especially woody debris structures
c) undertake necessary maintenance

II. Monitoring: Will photogrammetry remote sensing work?

*Results:*

a) individual photogrammetric datasets had a vertical accuracy of 6-10 cm depending upon level of interpolation
b) combined successive datasets had an accuracy of ~20 cm at best
c) error can be minimized with numerical guides, but vegetation, shadows, weather, and photographic quality and cost are other problems

*Recommendations:*

a) photogrammetry at this scale is not yet appropriate for monitoring moderate to small-scale gullies
b) with more detailed photography and future technology, it probably will be

III. Geomorphology: Why is it happening?

*Results:*

a) erosion is happening by the processes of infiltration-excess overland flow, minor piping, and knickpoint retreat
b) eolian processes, biotic crust, and unexpected infiltration characteristics play a role in erosion
b) erosion corresponds particularly well to high gradients
c) an initial slope-area-based numerical model indicates gully erosion can likely be predicted based on up-catchment geomorphic properties

*Recommendations:*

a) complete geomorphic studies, including empirically relating precipitation to erosion
b) undertake the next step in predictive modeling of gully erosion
c) study and understand eolian system
d) baselevel hypothesis can be tested

Additional benefits:

1) training students
2) significant contributions to topical science