Environmental Geology Seminar – OSU – April 22, 2003 – Jack Schmidt, Utah State

Flood Restoration on the Colorado River

Flood Analysis – ancient and modern
River Restoration – restoring flows to past levels
Dams – alteration of natural fluvial process
Restoration Criteria
(1) Size of sand bars (surface area, volume, location, thickness)
(2) Fish Populations (type, numbers)
Story – controlled floods / dam releases as a river restoration tool

Colorado River – landuse
Much of river diverted for use by LA, Phoenix, Las Vegas
75% of native fish are unique and endemic (locally specialized)

River Continuum: Polluted/Dewatered ---------- Wild

Reversal and Restoration: using controlled flows to stimulate restoration of habitat and fish populations

Lower Colorado River
Late 1800's steamboats navigated the river far up stream into Arizona and Nevada
River was channelized and levied for use and flood control
First Dam: Laguna Dam built in 1908

History of Reservoir storage: reservoirs increased steadily from 1920's through year 2000, with significant jump in dam building in the 1960's

Current ratio: Reservoir Storage / Mean Annual Flow = x6
(i.e. the flood flow, discharge, and sediment flux are totally controlled)

Upper Basin –
1930's dam building phase, then post 1965 another building phase

River Dynamics
Hydraulic geometry – shape of channel controlled by water and sediment flux
Dams – alteration of channel characteristics
Dams – control of water and sediment flux (act as sediment traps)

Sediment deficiencies immediately downstream from dams
Transport capacity > sediment supply

Farther downstream from dams – side tributaries provide suspended sediment and gravel bedload via debris flows, and debris fans

Transport rate < sediment supply

Grand Canyon downstream of Glen Canyon Dam = total sediment deficit

Debris Fans – emanate from side tributaries, supply coarse cobble to large boulder sediment to main stem of river

Creates rapids and provides coarse boulders that are immoveable due to dam-controlled discharges.

Grand Canyon – surplus of boulders in debris fans, deficit of sand / suspended load

Eddy bars – on lee side of fans, reverse circulation downstream creates quiet water areas that result ins sand deposition and development of eddy bars.

Action of Dams on River

Decrease peak flows on river
Decrease variability of discharge on river
Decrease fine sediment load due to dam-sediment trap
Decreased load, decreases in-channel bars
Post-dam construction, excess energy and < sediment supply result in channel erosion and vertical incision

River Restoration Issues and Processes:

Controlled floods used to mobilize sediment and re-build eddy bars
Over time – riparian vegetation stabilizes bars

Grand Canyon Data Collection: GIS, gaging stations, survey transects, photo analysis

1996 experiment

7 days of steady discharge at 45,000 cfs
the only sediment in transport was from sand on bars
fine suspended load decreased during flood Q as sediment was depleted
fine sed. Load coarsened during flood process

Grand Canyon –

System has very little sediment available for transport, quickly mobilized
Downstream of glen canyon dam, sed. Supply increases as tributaries increase

Different stretches of river respond differently to flood discharge (varying sed. Load along length of river)

Moral of Story:

Do no see any long term sediment storage on bars as result of controlled floods
Sediment supply is limited in Grand Canyon
Channel segments vary in response to controlled floods
Discharge is a driving variable, sand bar size in a response
Sediment load was not controlled as a variable (how to recharge system with sediment?)
Controlled floods = loss of economic dollars due to loss of hydro power

What is the social cost and benefit of geomorphic restoration? What is gained economically or politically?