Post-Wildfire Geomorphic Stream Response Since 1996 in Twelve New Mexican Watersheds

Aljaz Praznik, 3208 Loma Vista, 87106 Albuquerque, New Mexico

Kyle Shour, Virginia dr., Albuquerque, New Mexico

Submission ID is 221

Abstract

The severity, size, and frequency of wildfires has increased dramatically in New Mexico and across the American West over the past several decades. The severe nature of these fires has resulted in catastrophic consequences for downstream communities and ecosystems. Therefore, it is important to understand the geomorphic response of stream's burned watersheds decadal timescale to allow for design of resilient infrastructure and sustainable stream and riparian ecological restoration.

Introduction

In this research, we examined the geomorphic response of several streams in New Mexico after a wildfire, by analyzing changes in morphometric parameters using historical aerial photography sequences and by field reconnaissance on first through fourth order streams.

We visited four sites in New Mexico that were burned by a wildfire between 1996 and 2013 and performed a reconnaissance on each location. The drainage area varied from 1.2 to 13.4 square miles. Stream channels at these sites were largely ephemeral, but a few were perennial. We observed signs of post-fire erosion and sedimentation, bed sorting, vegetation establishment and other indicators of watershed recovery focusing on identifying recent and on-going geomorphic activity in low and higher-order channels.

We conducted GIS analysis using available historical aerial photography sequences at 12 sites to digitalize active channel area and channel centerline from second order headwater streams to fourth order channels near canyon mouths. Streams were divided into reaches by confluence locations. Changes in reach-averaged active channel area and sinuosity were evaluated.

We will present the results of the changes in morphometric parameters through time as well conceptual models that have been developed by combining the morphometric parameter analysis with field observations.

Other major headings

Field Visits

Geomorphic field reconnaissance was performed at three burned watersheds over the course of four days with the goals of evaluating:

- Post-wildfire depositional and erosional processes, emphasizing the most recently active processes to begin to understand which processes occur at which durations post-wildfire. This includes aggradation, degradation, lateral erosion, widening, gully evolution, and fan building.
- Post-wildfire bed material sorting. This includes determining when gradations at the surface and sub-surface start to differ and inception of riffles, steps, and pools.
- When riparian and upland vegetation re-establishes and how vegetation species differ from pre- to post-wildfire.
- The suitability of a site for additional detailed data collection to support future studies.
- Active channel width at a few locations to help quantify uncertainty in the associated morphometric parameter analysis results.

Silver

The Silver Fire burned the west slope of the Black Mountains in the Gila National Forest in 2013. Two streams were visited on July 28, 2018. For much of the visited watershed, the effects of the burn did not seem severe. Limited gullying and debris flow scars were observed. Oak and pines species both had several trees that survived the fire and stands of even age pioneer species (e.g., aspen and locust) were few.

The lessons learned from this field visit are:

- Burn severity and slope play an important role in the magnitude of geomorphic response. This may be important 5-years after the wildfire.
- Geologic controls play affect the type, magnitude, and location of the geomorphic response on both lower and higher order channels.

Pinatosa

The Pinatosa burn scar is located in the Gallinas Mountains southwest of Cordova, New Mexico in the Cibola National Forest. The burn occurred in 1996. The site was visited on July 28, 2018 (Figure 2). Based on the surrounding, unburned watershed, the canopy cover was ponderosa and mixed pinyon-juniper. Much of the canopy was destroyed by the fire. While the predominate vegetation cover was grass and forbs, trees have grown to as much as 10 feet tall. Trees are primarily New Mexico Locust and juniper.

The primary lessons learned from this site were:

- The material deposited by the fire is largely stable. Perhaps only being mobilized in an infrequent, large magnitude flood.
- Watershed vegetation re-establishment is on-going after 22 years; riparian vegetation is not expected to establish because of the ephemeral nature of the flow.
- Bed material sorting did not occur because of the ephemeral nature of the flow. This may prolong the fluvial geomorphic response relative to a perennial or intermittent flow stream.

Las Conchas - Cochiti Canyon

The Las Conchas Fire burned the Cochiti Canyon watershed on the east slope of the Jemez Mountains in 2011. This site was visited on August 6 and 16, 2018. The first visit was used to gain an overview of watershed and select tributaries along the north side of the main canyon. The second visit was used to observe the main channel and tributary confluences.

Throughout the reach observed, the active channel width increased post-wildfire and channel aggraded, even above the pre-wildfire floodplain (Figure 9). Imbricated bars formed. As bed material supply decreased, a low flow channel incised into the post-wildfire deposits. In erosional reaches as the bed continued to adjust, meander development occurred, and pool, riffle, and step formation initiated. This has led to formation of a new floodplain surface, which is now well vegetated with locust, elder, oak, willow, roses, sedges, grasses, and forbs. The banks to the new floodplains are low. In depositional reaches, the active channel narrowing is less pronounced, and several bar surfaces exist. Some step and riffle formation were observed.

Computer Analyses

We conducted GIS analysis using available historical aerial photography sequences at 12 sites to digitalize active channel area and channel centerline from second order headwater streams to fourth order channels near canyon mouths. Streams were divided into reaches by confluence locations. Changes in reach-averaged active channel area and sinuosity were evaluated.

We compared pre and post fire active channel lengths within different stream orders.

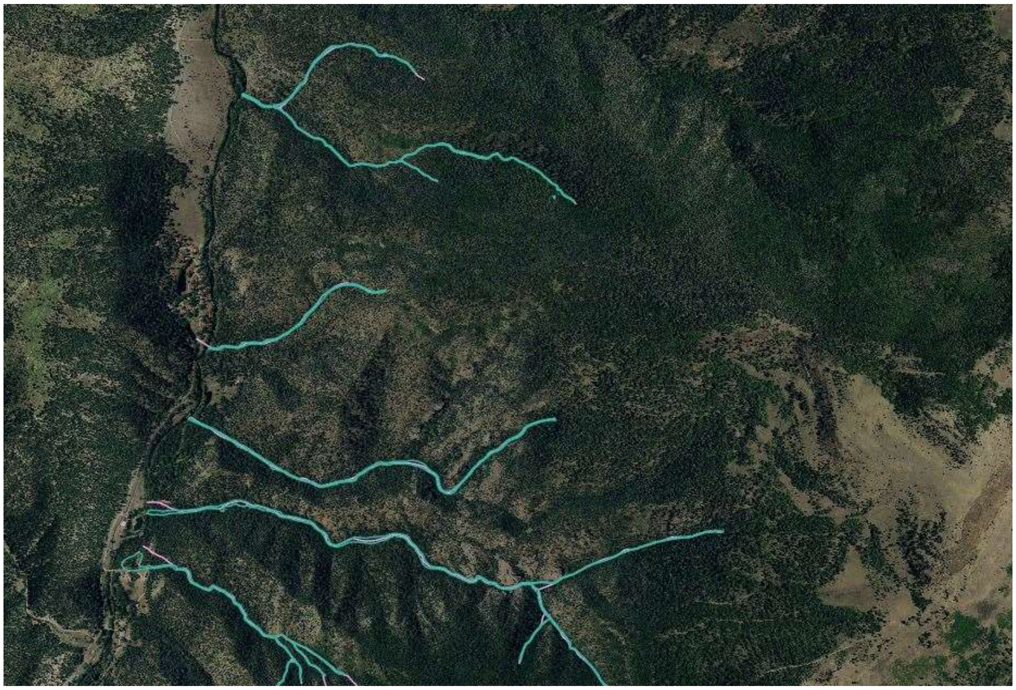

Image 1; Aerial photo of the area before the Tres Lagunas fire, the blue lines show river streams

Image 2; Burning scar after the Tres Lagunas fire, the blue lines show different stream orders

Improving Resiliency and Sustainability of Watershed Resources and Infrastructure

- Climate Variability and Sediment
- Dam Removal or Rehabilitation
- Fluvial Geomorphology
- Gully Erosion
- Hydraulic and Sediment Transport Modeling
- Infrastructure in the Stream Environment
- Physical Sediment Load Measurements
- Regional Sediment Management
- Remote Sensing and Monitoring
- Reservoir Sedimentation and Sustainability
- Sediment Impacts on Wildlife and Habitat
- Sediment Properties
- Sediment Surrogate Measurements
- Sediment Yield and Fingerprinting
- Stream Restoration