Determining Erosion Hazard in the Arcata Community Forest Based on Slope and Creek Proximity

Abstract

The Arcata Community Forest is a public park that accommodates multiple recreational and commercial uses including: sustainable logging, hiking, mountain biking, and horseback riding. These groups use the same roads and trails in the forest, which leads to trail degradation and contribute to soil erosion. The purpose of this report is to identify hazardous areas along the Community Forest trail system for soil erosion; our criteria for high risk include any trail that intersects a stream, or has slopes ≥15%. We proposed that straw wattles or other erosion control methods be implicated to prevent damage to local waterways.

Introduction

The purpose of this project is to protect aquatic ecosystems by properly maintaining the erosion of trail systems around the Community Forest that have steep slopes or cross streams. Suspended solids are both the visible and microscopic solid matter in waterways (Brady et al.). While a certain level of suspended solids is natural and healthy for any stream, lake, or river; too much can lead to ecological disasters such as the burial of anadromous fish spawning beds, or the process of eutrophication which depletes oxygen in the aquatic ecosystem (Brady et al.). Soil is usually covered by a combination of litter, living plants, decaying organic matter, or rock: when it lacks sufficient cover, then erosion will likely increase drastically (Brady et al). There are three primary features tied to the mechanisms of water-driven erosion: sheet, rill, and gully erosion (Brady et al.). Gully erosion, which resemble formations such as the Grand Canyon but can be a on scale as small as a few inches deep; can look the most devastating in respect to erosion but is in fact has less impact than sheet or rill erosion (Brady et al.). Sheet and rill erosion are caused by water impacting, and/or moving as a solid mass over exposed soil and contribute the most solids to local waterways. (Brady et al.).

Multi use trails have become increasingly popular in the community, hikers, equestrians, and mountain cyclists have used the same trails. All three activities contribute towards trail widening, leading to vegetation loss, soil exposure, and trail degradation (Pickering et al., 2009), but have their own kinds of impacts on the trail. The horses weigh around 4380 g/cm whereas a hiker has about 416 g/cm squared, meaning that the weight of the horse is the main reason why they cause more destruction (Liddle, 1997).

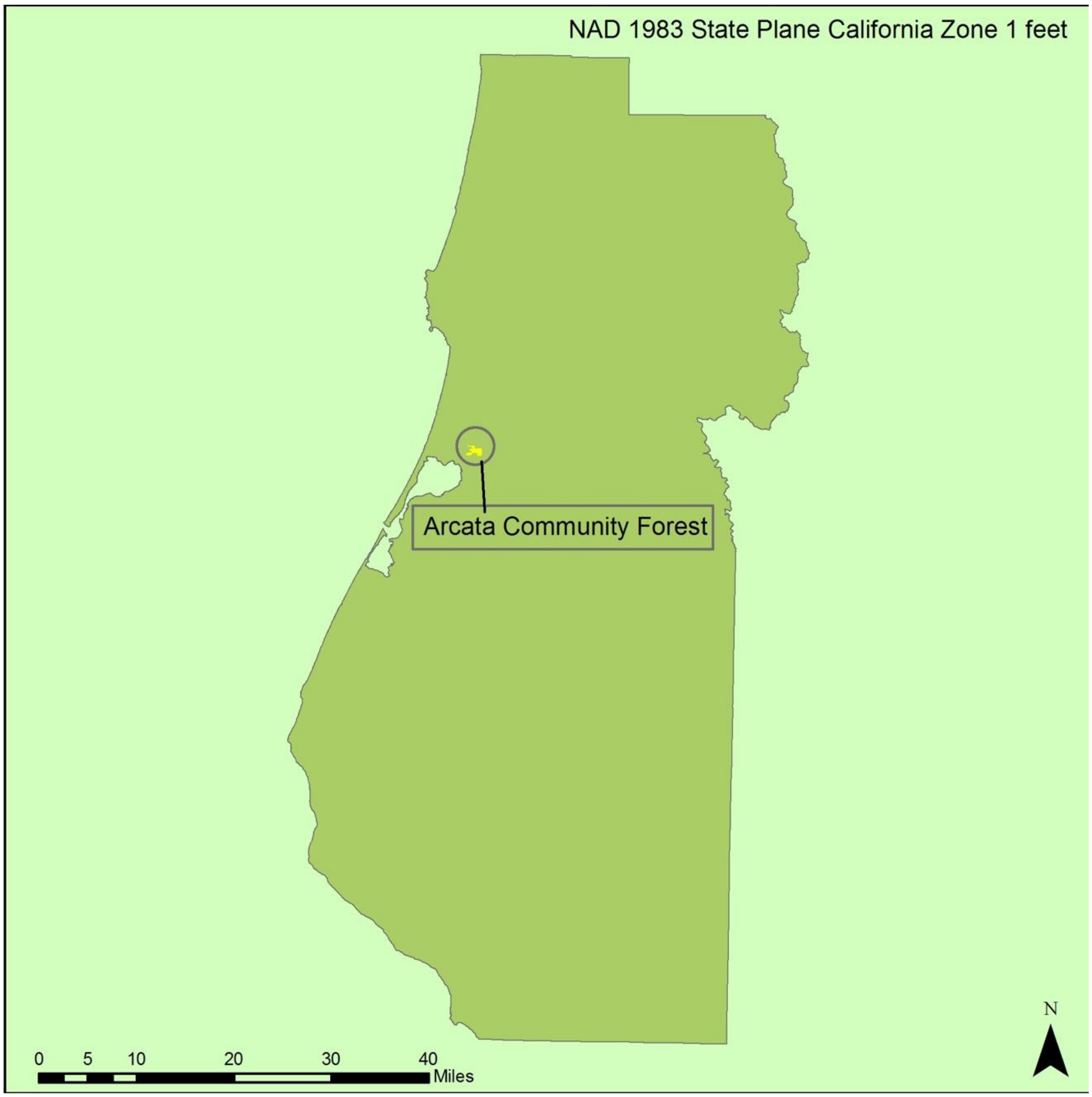

Figure 1: Locator map showing where the Arcata Community Forest is located in respect to Humboldt County.

Methods

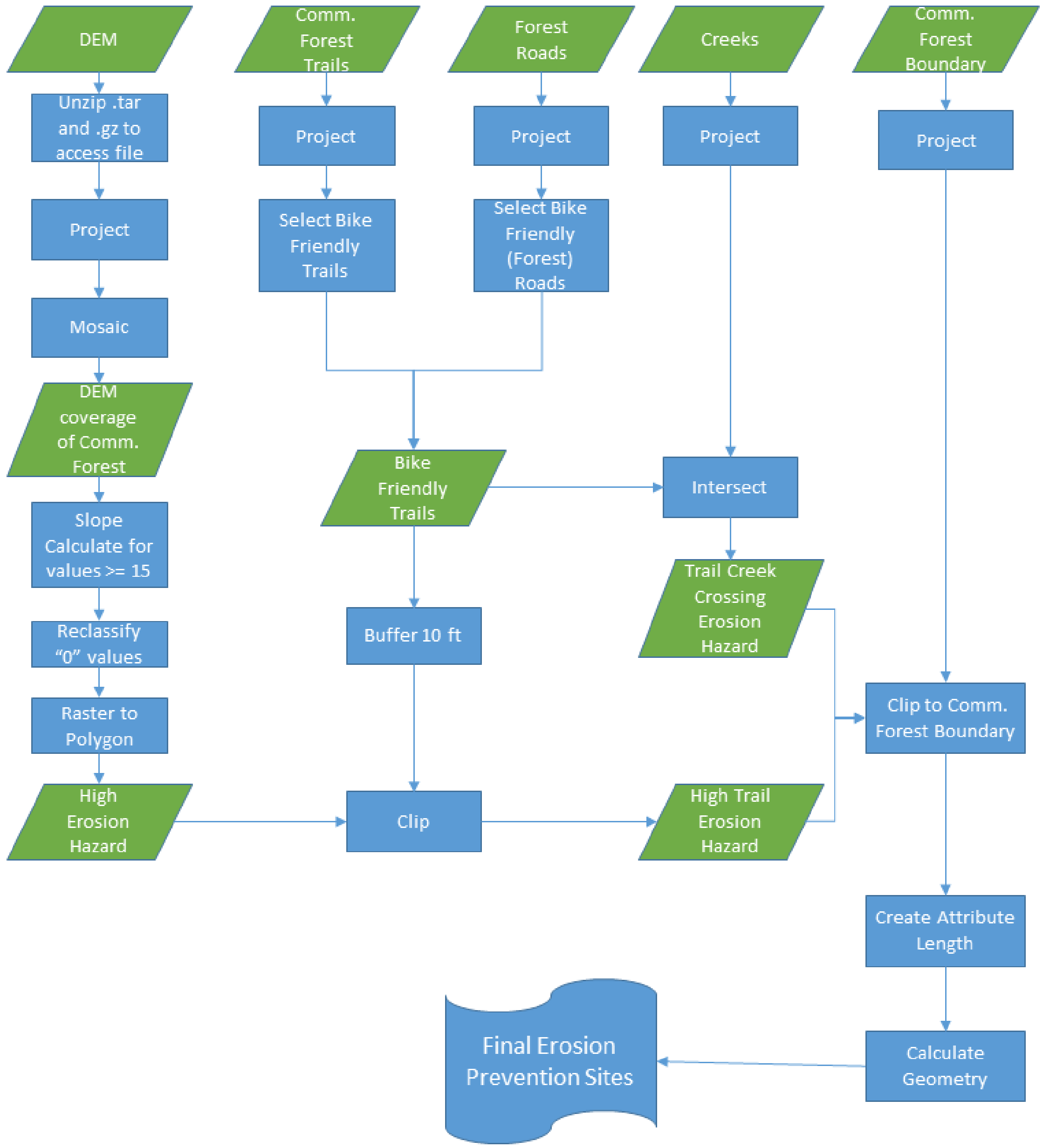

Figure 2: The processes used to derive the site selection with the highest risk of erosion based on both slope, and stream proximity.

We used ESRI ArcMap software to model for erosion, analyze site attributes, and create the maps in this report. Collaboration was made possible by Google Docs, final word processing was done with Microsoft Word, the flowchart was made using Microsoft Powerpoint. We were very fortunate to find all the files that were needed for site analysis from Humboldt County GIS, the files such as streams and roads had attribute tables filled with data such as name, length, watershed, and much more than we needed. The digital elevation model was borrowed from Lab 10 and had resolution detailed enough for analysis and production of the hillshade that we added a custom color gradient to. We chose to work in NAD_1983_StatePlane_California_I_FIPS_0401_Feet because the City of Arcata GIS already used that projection, we would like to submit our findings to the City, and we wanted to make data sharing as streamlined as possible.

Results and Discussion

We identified five locations within the Community Forest that met our criteria for high erosion hazard based on slope, and 12 sites either crossed or were within ten feet of a creek (see tables 1 and 2 for complete site lists and descriptions). In order to mitigate soil erosion into waterways, we recommend the installation of straw wattles on the downslope of each site. Straw wattles are tubes of straw or coconut husk that are commonly used as primary sediment and erosion control measures. They function for 12 to 24 months and should be staked and trenched in (see figure four) (CASQA). There are several advantages to using straw wattles over other erosion control methods such as jute mats, or fencing. Wattles are relatively small with a diameter of 9-20 inches, and do not obstruct trail use; they do not disturb the view of the trail or surrounding area; they can be sourced locally; and they are biodegradable (CASQA). We determined the cost per foot of the straw wattle using an average the $25-$30 per 25 feet range from the California Storm-water Quality Associations, which gave us an average cost of $1.10 per foot of straw wattle (CASQA). The total cost of materials (not including transportation or personnel costs) for all sites is $1581.98. We can manage the cost of installation by recruiting the Humboldt State Cycling Club members as volunteers for trail maintenance crews. More analysis on soil type, nutrient content, and exposed trail surface are needed to quantify the total amount of soil loss to erosion; but the model could be compared to sediments recovered by the straw wattles for future site monitoring.

Table 1: Trail erosion proximity to creeks.

Trail	Watershed	Length (Feet)	Straw Wattle $
Janes Creek Road 1	South Fork Janes Creek	1.7	1.87
Comm. Forest Loop Road	Jolly Giant Creek	22.5	24.75
Janes Creek Road 2	South Fork Janes Creek	20.2	22.22
Upper Janes Creek Trail1	South Fork Janes Creek	20.6	22.66
Lower Janes Creek Trail 1	South Fork Janes Creek	20.5	22.55
Ridge Road 1	South Fork Janes Creek	20.1	22.11
Powerline Trail	Jolly Giant Creek	24.2	26.62
Fickle Hill Grade	Jolly Giant Creek	21.1	23.21
Vista Trail	South Fork Janes Creek	31.4	34.54
Ridge Road 2	South Fork Janes Creek	21.1	23.21
Lower Janes Creek trail 2	South Fork Janes Creek	25.1	27.61
Ridge Road 3	South Fork Janes Creek	21.2	23.32
Lower Janes Creek 3	South Fork Janes Creek	24.1	26.51
Jolly Giant Road	Jolly Giant Creek	93.5	102.85

Table 2: Erosion hazard based on slope greater that 15%

Trail	Watershed	Length (Feet)	Jute Mats
Redwood Park Trails	Campbell Creek	171.5	188.65

California Trail	Janes Creek	445	485.50
Fickle Hill Grade	Jolly Giant Creek	60	66.00
Comm. Forest Loop road	Jolly Giant Creek	342	376.20
Janes Creek Road	South Fork Janes Creek	56	61.60

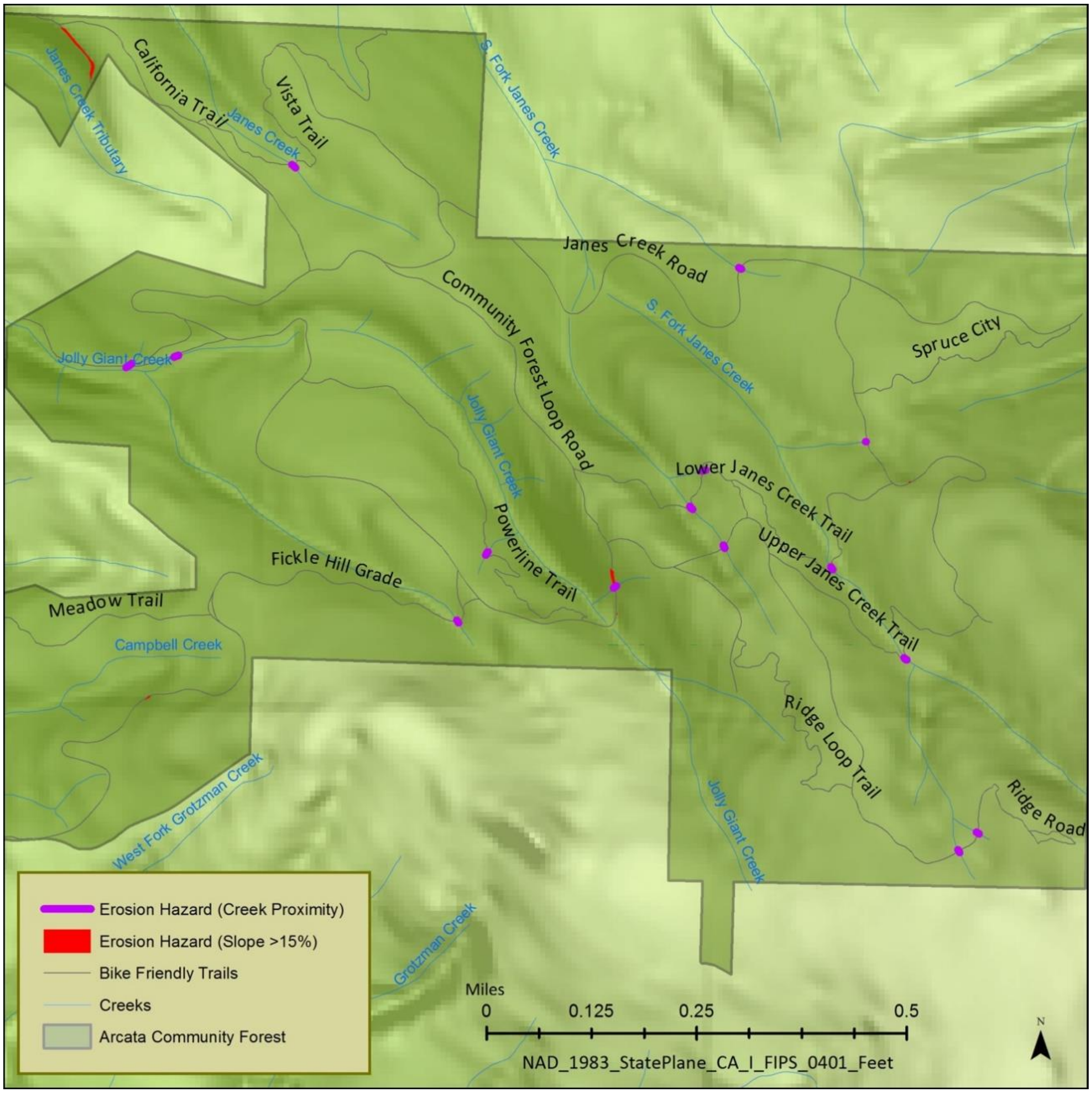

Figure 3 A Site map showing where the steepest slopes are in the community forest. These spots are at the highest risk of erosion for all three activities. We chose these spots because they in an area where streams and trails cross each other, which is where the most erosion will occur.

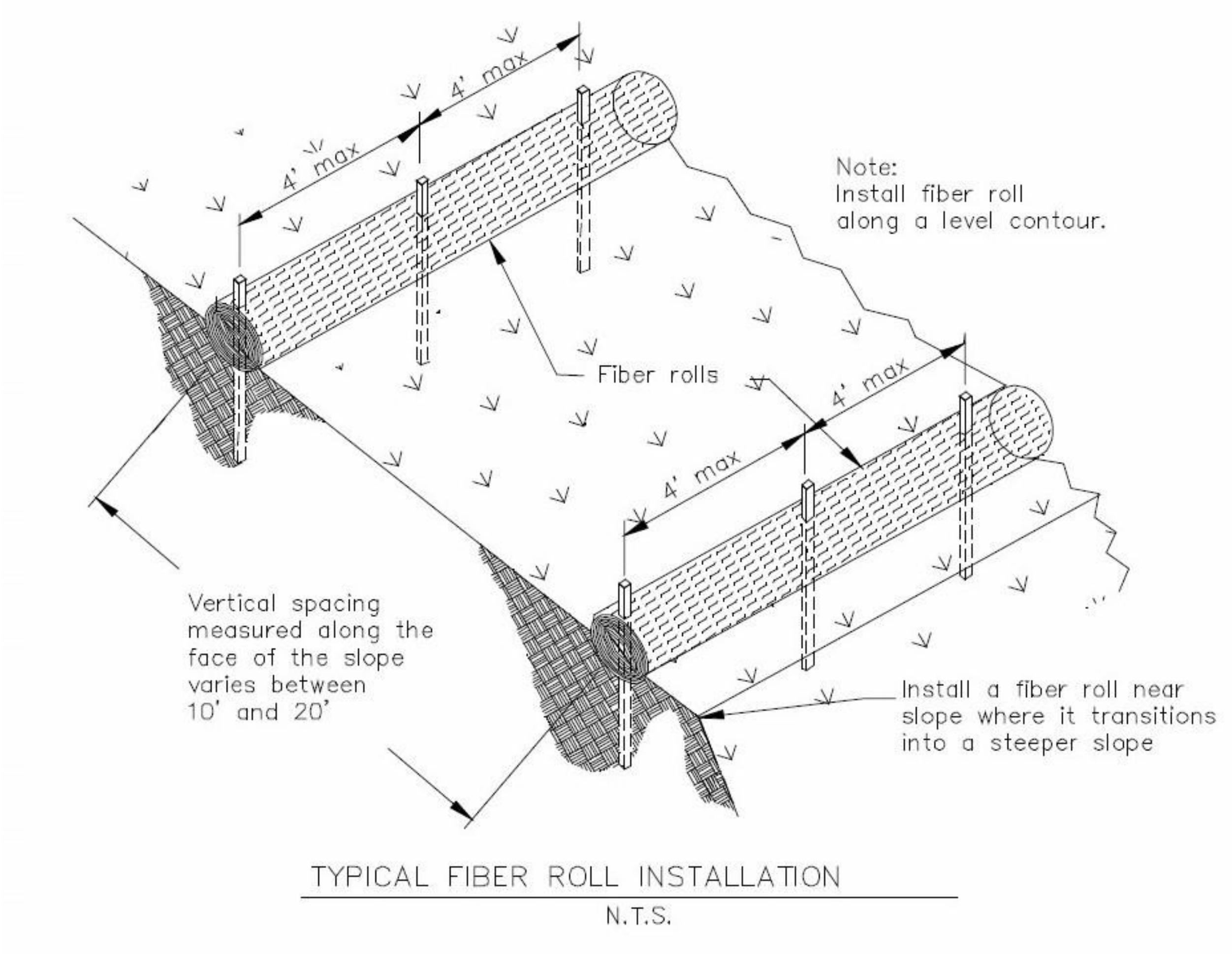

Figure 4: Straw wattle on a sloped grade. Notice the staking through the wattle.

Conclusion

Overall we were surprised at the relatively low number of sites in erosion hazard areas based on slope, because we ride our bikes throughout the forest nearly every day and believed the percent slope was greater than 15% along many of the trails. We were not surprised by the number of creeks encountered along the trails, as we are used to being soaked by Humboldt County's famous weather. The cost of materials for the erosion control method we suggest is low enough that the HSU Cycling Club could fundraise with, and volunteer for the City of Arcata to build public relations and protect native fish habitat. This project has created a baseline for future monitoring of soil erosion in the Community Forest, and can be easily modified to factor in other slope parameters.

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  http://www.cityofarcata.org/322/MapsGIS
  For: Creeks, Roads, Trails, Community Forest Boundary

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