BURN SEVERITY AND ITS IMPACT ON SOIL PROPERTIES: 2016 ERSKINE FIRE IN THE SOUTHERN SIERRA NEVADA

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09/18/2017

Purpose/Statement of Interest

Wildfires are one of the most dominant natural and human-caused agents of landscape change. Furthermore, their after effects, particularly slope failure and debris flow, continue to alter the landscape years after the fire has passed. In fact, wildfires and consequential debris flow and slope failure events cost human lives and cause billions of dollars in damage annually. The 2016 Erskine Fire near Lake Isabella caused two fatalities and damaged 285 structures. Even more, climatic trends for southern California project that wildfires and consequential slope failure events may increase in frequency in the coming years, further disrupting communities, economic productivity, and safety. Thus, in attempt to reveal the 2016 Erskine fire's potential to alter the landscape, the physical properties of unburned soils and soils of low, moderate, and high burn severities will be explored. Employing liquid limit, plastic limit, and shear strength tests will elucidate the effects burn severity has on the physical properties of soil within the 2016 Erskine fire perimeter. The goal of this project is to explore the correlation between burn severity and soil properties and how this influences slope failure and debris flow.

Significance

Natural hazards, such as wildfires, cause billions of dollars in damage and thousands of human casualties worldwide (Galve, Jorge Pedro et al., 2016; Nadim et al., 2006). The 2016 Erskine fire occurred during June and July of 2016 and ultimately burned 48,020 acres, destroyed 285 homes, and took two human lives (inciweb.nwcg.gov). Nonetheless, the 2016 Erskine fire contributes to worldwide cumulative damage assessments. Within another recently burned region of the Sierra Nevada, massive debris flows occurred and caused temporary closure of Highway 395 and damaged more than twenty structures, including residences (Wagner et al., 2012). Recent studies have shown a trend of longer fire seasons, and climate models indicate wildfires will continue to be more frequent (Yoon, et al., 2015). Increases in wildfire-induced slope failure and debris flow events are likely to result from intensifying fire seasons.

In this study, soil characteristics conducive to slope failure within the Erskine fire perimeter will be explored. The results will elucidate the influence fire intensity has on soil properties and may aid to enact measures that can help mitigate the damage when the next slope failure event occur. Completion of this research project could also help establish California State University, Bakersfield as a leading contributor to original research in the San Joaquin Valley.

Background

A Mediterranean-like climate with hot, dry summers dominates the study area within the Erskine Fire perimeter of California. This region’s climate is categorized as a Csa climate, according to the Köppen-Geiger Climate Classification system (Kottek, 2006). The weather has cyclic variations, with periods of drought followed by wet seasons, which increases the likelihood of slope failure events within recently burned areas (Abatzoglou, 2009; Crozier, 2010). Heavy rainfall events in mountainous regions

can trigger flash floods, and thus enhance slope failure and debris flow probability (Crozier, 2010). Coupling recently burned landscapes and steeply dipping mountain slopes with flash flood events generates a high likelihood for slope failure (González-Ollauri and S. B. Mickovski, 2015; Lu, 2014). The study area within the 2016 Erskine fire perimeter is such a place bounded by recently burned, steeply dipping, and sparsely vegetated hill slopes, which pose a high potential for slope failure or debris flow events.

Moreover, soil is one significant agent influencing slope failure and debris flow. Soil can be loosely defined as the unconsolidated material that overlies bedrock and is composed of organic matter, as well as sand-, silt-, and clay-sized grains. In this study, I plan to perform geotechnical analyses on the soil affected by the fire. These tests will reveal the impact fire intensity has on soil's physical properties. Atterberg limits and shear strength of the soil samples will be investigated on CSUB's campus using recently acquired soil testing laboratory equipment.

I anticipate that increases in the soil's burn severity will cause decreases in liquid limit, plastic limit, and shear strength of the soil. I hypothesize that slope failure is more likely to occur in areas that experienced high fire intensities. The final results of this study are also slated to be presented at conferences.

References

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1. Description of the mentoring process between you and the student, including how you plan to develop the student's strengths and remediate any weaknesses.

Mr. Sade Haake has consistently ranked as a top-10 student in the several classes he has taken of mine and is currently working on his thesis as a master's student in the Department of Geological Sciences. He is also well informed about fundamental geology concepts and their relationship to our proposed project. In previous projects with Sade, he demonstrated that he can apply his knowledge to help solve real-world problems through the application of science. Thus, Sade is an excellent student who can help me achieve the goals of the proposed project.

Even master's students have some aspects of the learning process that need improvement, such as how to better make a reasonable observation, how to better generate a scientific hypothesis, how to better use different approaches to find solutions, and how to better interpret the result(s). An old Chinese philosopher, Confucius, said the following: "I see, I forget. I hear, I remember. I do, I understand." By giving Sade the opportunity to do research under my guidance, not only do I believe I can help him grow as a student, I also believe this project can inspire his natural curiosity and further cultivate his problem-solving abilities. I will facilitate the success of the project and a positive learning experience, and an important aspect of my mentoring process is allowing Sade to take an initiative in advancing the progress of our project. Thus, I will play a role of an advisor. Through the continuous feedback between Sade and myself, I will evaluate every step of progress he has made and everything he needs to further improve and to guide him on the right track. Moreover, at the onset of our project, I will help him set up a correct and efficient strategy to finish our proposed project. Sade, at this point, has not yet mastered his understanding related to this project, even though he continues to grow as a student. However, by giving Sade reading assignments of appropriate textbooks and related peer-reviewed journals, my mentoring experience will help him further expand the breadth of his knowledge and equip him with the knowledge necessary to successfully complete the project.

In this project, Sade will collect soil samples from proposed field locations and conduct geomechanical laboratory experiments to reveal the soil's physical properties as a function of fire intensity. At the onset of the project, Sade will not only advance hands-on experience, but he will also learn new analytical laboratory skills. This kind of practice will further strengthen his knowledge so that he can continue to pursue his higher education.

2. Explain how the student's proposed project fits in with your area of research, scholarship, and/or creative activity. Also, explain how this project will enhance your ability to publish and/or write grants for extramural funding in your area.

Erskine wildfire sparked Sade's proposal to research slope stability following a wildfire. He sought my help because of my experience with sedimentary processes and geotechnical analysis as related to slope failure. My expertise lies in sedimentology, and studying the mechanisms responsible for slope failure allows me to expand my research field to include the roles wildfire and soil sediments have in triggering natural hazards in Kern County. This is also one important component and target of NSF CREST Phase II. I

have conducted several studies involving climate in the San Joaquin Valley, and now Sade's project will allow me to expand my research focus to include wildfire's impact to a changing climate. The results of this project will open a new avenue for Sade and myself to generate grant proposals and help CSUB advance its academic goals. The results of this research are scheduled to be presented at two national conferences during the fall 2017 semester.

3. Describe the steps you will take to prepare your student for the REQUIRED written and oral presentation in 2018.

Good writing and oral presentation abilities are prerequisite for a great scientist. A clear project outline can facilitate good writing. I will first help Sade build up the backbone of the report and set up a schedule for finishing this project with him. Then, every successive part of the project Sade writes can be inserted into the backbone of the project once he finishes and summarizes that step's work. In the scientific field, publication of research data usually follows quite strict styles, so having Sade read some relative research papers will be helpful for him to become accustom to using appropriate scientific terms to describe data. After he finishes his studying and writing, editing is another important step for him to improve his writing. Through several rounds of editing and presentation practice between Sade and myself, I think Sade will be prepared very well for scholarly scientific writing, as well as advance himself towards his goal of being a scientist.

Delivering an oral presentation is like telling a story; it first needs clear context that can engage the audience. At the beginning of the presentation, Sade needs to build rapport with his audience. To prepare Sade with this presentation, I will guide him to build a good outline and rapport. Then, I will create chances for him to practice speaking and revise his presentation by considering other people's feedback. Premier presentation opportunities for Sade are the GSA and AGU 2017 fall meetings to be held in Seattle and New Orleans, where he plans to present and explain his research to geoscientists from across the globe.

Initiative Outcome Proposal

As indicated by the Initiative Requirements, I, the student, will maintain regular contact with the Graduate Student Center and participate in relevant workshops. I will ensure that the Graduate Student Center has my correct contact information, so I can be notified when events are planned. Second, I will provide a written and oral summary of my project, so I can share the research findings with our community. In fact, I plan to present my research this year at national conferences. Third, I will also record and document meetings with my mentor, which will help me monitor my progress with the project. Lastly, I will notify my mentor in advance, so he can plan to participate in a one-hour workshop.