From shrublands to avocados: Effects of land use and land cover change on soil carbon storage and fertility in Southern California

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EXECUTIVE SUMMARY

As the human population continues to grow so has the need to convert land for sustainable agriculture. As such, agriculture has become one of the biggest industries in California, largely supplying both citrus and avocado crops. The aim of this project was to begin quantifying how human activities such as land cover change and land use affect long-term ecosystem C and nutrient cycling. A comparison of avocado and orange groves and native coastal sage scrub (CSS) and chaparral shrublands located on the Santa Margarita Ecological Reserve (SMER) was performed to determine the affects of land cover change on soil carbon storage and fertility.
PROJECT OBJECTIVES

The initial project was aimed at comparing land cover change and land management for an avocado grove that had half the crop stumped, and the adjacent native CCS and chaparral at SMER. As an ecologist, I was interested in understanding how changing the land cover type affects the soil’s fertility in regards to growing sustainable agriculture. In addition to the land conversion, I was also interested in understanding how management of the crops affects the soil fertility. Coincidentally, the avocado farmer had to stump half of his crops due to limited resources and water availability. This sparked my interest in understanding how human activities might impact the terrestrial ecosystem and its ability to store C and cycle nutrients.

The project goal was to evaluate all three sites over the wet and dry seasons and compare the analysis on soil, tissue and litter pool samples between avocado, stumped avocado, and CSS stands. However, after visiting the research site and evaluating the stands, we realized that limited access to the stumped crops posed a problem for collecting samples regularly and the project goal had to be changed. To compensate for the stumped avocado groves, orange groves were used as a second crop to compare against the native CCS and chaparral and the avocado groves. The new project proposed that land cover change might affect soils differently depending on what type of crop is chosen to be grown on the land.

In the wet season, C storage and nutrient cycling are expected to perform at their highest and at their lowest, during the dry season. Thus we decided that collecting samples every month starting in November and ending in May would provide more quantitative data. However, after the collection and processing of the first set of samples, we realized that due to the large amount of samples we were collecting, we would not be able to process all the samples efficiently in the allotted project time. The project was then readjusted so that all samples would be during peak months of each season.

Due to the high volume of tissue and litter pool collected during the wet season, we were set behind a month, and during analysis we realized that the samples were processed incorrectly so the entire data had to be thrown out. This meant that the project had to be further readjusted, but because we were coming out of the wet season, we realized we were going to have to again change the project goal. With no data for the wet season and the dry season approaching, we decided to simply continue forward with the seasons we had available. The final goal was to collect tissue and litter pool at the end of the beginning of the dry season (May) and the peak of
the dry season (August) and to continue forward collecting the soil samples at the peak months of the season.

The original tasks included standard analysis of soil, tissue, and litter pool samples from each stand, and it was also proposed that the microbiology of the soil would be analyzed in hopes of providing more comprehensive research on soil fertility and C storage. Standard analysis of soil, tissue, and litter pool samples was kept as the main tasks despite the change in goals of the project, but the task of analyzing the microbiology of the soil was removed from the final report due to lack of available training and methods to collect successful data. The task was not replaced with another task due to the time limit of the project.

My interest in soils has stemmed from my experience working as an undergraduate in a soil lab at Cal State San Marcos. Being raised in the Central Valley of California under the influence of my grandfather (a tomato farmer), has fostered my interest in agriculture. This internship provided me with the perfect opportunity to combine both my experience and ecological skills with my passion for the environment and interest in agricultural development to produce useful research. I ultimately plan to obtain my PhD and hope to work for a government agency such as the USDA Forestry Service that will allow me to conduct research. As such, working with the WRI has brought me one step closer to reaching my career goal.
PROJECT APPROACH

Preparation

The first step in beginning this project was to become familiar with the research sites and collect information from the site managers and farmers on the management of the crops to gather a better understanding of what we might expect to see during the processing of our samples. The next step was meeting without our advisor, Dr. George Vourlitis, to develop the methods for collecting and processing samples. Because Dr. Vourlitis’ is directly related to our research proposal, his insight on collecting and processing data helped us develop methods to collect optimum data. Once the project was solidified, plots were selected and designated at each stand so that the first set of samples could be collected.

Sample Collection and Processing

After each set of samples were collected, the tasks were split up between both Zarela and I, and completed before the next set of samples were collected. This was to insure that
samples did not get lost, all the appropriate data was collected, and to reduce error or correct for error if needed. Dr. Vourlitis also provided us with training on the proper use of the laboratory equipment we needed to perform our analyses, before we began processing the samples.

Soil samples were collected in November and December, February and March, and May. Once samples were cleaned and roots were separated out, a standard soil analysis was conducted on each set of samples collected. This encompassed a soil moisture analysis, pH analysis, and a soil textural analysis. In addition to the above mentioned, dried soil was ground and ran through a CHN analyzer to identify the C and nutrient content of the samples. The approach for processing for soil samples remained the same throughout the entirety of the project, despite changes made in the overall project goal.

Tissue and litter pool samples were collected in May and August. Tissue was cleaned and separated to include stems and leaves as separate entities during processing. Litter pool was cleaned to remove additional components that might compromise the true litter pool quality. Once prepared for processing, tissue (stems and leaves) and litter pool samples were ground separately and ran through the CHN analyzer to identify the C and nutrient content of the samples.

Thorough methods for the standard analysis conducted on the soil, tissue, and litter can be found as presented by G.L. Vourlitis and J.S. Fernandez in the Journal of Arid Environments (2012).
PROJECT OUTCOMES

Soil Moisture

<table>
<thead>
<tr>
<th>Time (months)</th>
<th>Water Retention (%)</th>
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<tbody>
<tr>
<td>Nov</td>
<td>5.5000</td>
</tr>
<tr>
<td>Feb</td>
<td>6.0000</td>
</tr>
<tr>
<td>May</td>
<td>6.5000</td>
</tr>
</tbody>
</table>

Soil pH

<table>
<thead>
<tr>
<th>Time (months)</th>
<th>pH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nov</td>
<td>7.0000</td>
</tr>
<tr>
<td>Feb</td>
<td>7.5000</td>
</tr>
<tr>
<td>May</td>
<td>8.0000</td>
</tr>
</tbody>
</table>