Climate Change Research Program QUARTERLY PROGRESS REPORT	**2019** QTR 2-4

Progress Report # 1   **For the reporting period:** May 2019   **to** December 2019

Grantee Institution: University of California, Irvine   **Agreement #** CCR20021

Research Grant Title Innovation Center for Advancing Ecosystem Climate Solutions

Signature Line (authorized representative): *Erika Blossom*

RESEARCH GRANT PROGRESS SUMMARY

Provide information for each task in the research grant's scope of work, noting zero if work has not been started on a specific task:

TASK # OR DESCRIPTION	DESCRIPTION	PERCENT OF WORK COMPLETED FOR THIS PERIOD	PERCENT OF WORK COMPLETED TO DATE	REIMBURSEMENT AMOUNT CHARGED FOR THIS PERIOD	REIMBURSEMENT AMOUNT CHARGED TO DATE
1.1	Collect and homogenize data layers	30%	30%	$136,052.50	$136,052.50
1.2	Test, improve, and update data layers	5%	5%	$27,400.00	$27,400.00
2.1	Prepare data analysis	20%	20%	$39,889.92	$39,889.92
2.2	Analyze historical and current data	5%	5%	$19,000.00	$19,000.00
2.3	Extend data analysis via data science and machine learning	0	0	0	0
3.1	Actively engage stakeholders	7%	7%	$26,244.11	$26,244.11
3.2	Produce decision-making tools	0	0	0	0
3.3	Communication	5%	5%	$7,000.00	$7,000.00
4.1	Develop valuation framework	3%	3%	$2,000.00	$2,000.00
4.2	Develop and implement valuation tools	0	0	0	0
4.3	Develop financing strategies	0	0	0	0

PROVIDE A SUMMARY STATEMENT DESCRIBING THE MILESTONES (INCLUDE GO/NO GO MILESTONES), ACCOMPLISHMENTS, SUCCESSES, BARRIERS, AND OBSTACLES THAT HAVE OCCURRED WITHIN THE CURRENT REPORTING PERIOD:

Upon notification of the award, the project's Executive Committee, comprised of Mike Goulden, Roger Bales, Yufang Jin, Toby O'Geen, and John Battles met to initially plan for the project. After this, a full team kickoff meeting was held on May 29 and 30, 2019, at UC Berkeley, and engaged 17 PI's and project staff.

There were some difficulties and time lags in hiring a project coordinator, project specialists, and postdocs, so the initial work on the project did not really begin until the end of the summer. However, outreach meetings, calls, and presentations occurred from early summer through December, and are outlined in question #3, below. Once the Project Coordinator, Raiven Greenberg, was hired on at UCI in November, active communication and coordination commenced, and movement began on organizing and working toward deliverables for Tasks 1, 2 and 3. The fist team calls were hosted, and sub-project team calls will be implemented on a bi-weekly basis going forward to maintain active communication and discuss the details of sub-tasks.

Per Tasks 1.1 and 1.2, a Shared Data Drive was created, and the UC Project Specialist, Mahnoor Khan, worked to collect and aggregate existing geospatial data layers for different components of carbon, water, dieback, and fire layers. PI's and graduate students contributed to this collection of data layers as well, though we have realized that it will take a coordinated effort to homogenize and refine these layers. There are also a few issues that were found with the data that was collected, which are further described in question #7, below.

Per Task 2.1, we began homogenizing data layers of past forest management and disturbance, and have developed several strategies to further refine several layers. For Task 2.2 we began to explore the management layers through several preliminary analyses, which are further detailed in additional sections, below.

Task 3.1, actively engaging stakeholders, got off to a great start. Numerous meetings and calls were hosted (detailed in question #3, below). Per Task 3.3, the Project Coordinator started to build the project website, which will go live in late January and Roger Bales, Co-Director of the Center, and one of the leads on Task 3, also contributed to producing a video, "Beyond the Brink: California's Watersheds". This video was a collaboration with The Chronicles Group, and features Roger, and Co-PI's Martha Conklin and Leroy Westerling. In it they discuss the issues plaguing California's forests and watersheds, and start to hint that there are some scientific and management solutions to these problems. Creating a follow-up video more focused on the solutions is one of our goals, and will likely be achieved in Year 2 of the project.

For Task 4, several planning telcons were held with Benis Egoh, Catherine Keske, and Roger Bales. In December, postdoc recruitment was initiated to support this portion of the project. Postdocs should be hired in Q1 of 2020, and work on Task 4 will begin at that point.

ACHIEVING PROGRAM GOALS

1. Briefly discuss any successes the research has achieved in furthering the Climate Change Research Program's <u>Program Goals</u>:

> Graduate students and postdocs at UCD have started their work on Task 1.1 and 2.2. One graduate student, Yuhan Huang, has started to work on mapping aboveground biomass using a machine learning approach driven by remote sensing and other geospatial data. Another student, Andy Wong, has been working on optimizing the evapotranspiration (ET) estimation with Landsat and MODIS satellite data over the Sierra Nevada region. Postdoctoral researcher, Margarita Huesca, has been

working on tree mortality detection using the AVIRIS hyperspectral remote sensing data, with an ultimate goal to and understand the temporal evolution and spatial patterns of tree mortality in California.

At Stanford, postdoctoral researcher, Kyle Hemes, has specifically started to look at second order carbon cycle impacts.

At SDSU, Walter Oechel has measured carbon sequestration and water use for different stand ages of chaparral at the SDSU Sky Oaks Biological Field Station in southern California; SDSU has developed an initial GIS of stand ages and biomass for California. The effect of drought on carbon sequestration in California has been analyzed for the last 5 years to begin to understand how increasing drought could affect the carbon sequestration potential, and water use, of chaparral in different aged stands. Soil respiration rates have been determined as affected by rainfall, overstory species, and canopy cover.

2. Describe any successes made in advancing the objectives of the applicable research focus area (i.e., carbon dioxide removal, methane reduction, or heating, cooling, and thermal storage):

The work at SDSU will help map and predict the future carbon dioxide removal potential of chaparral based on stand age, management strategy, and climate.

At UCD, Yuhan has compiled the available Lidar data for the Sierra Nevada, and explored various approaches to derive AGB from the lidar data. This Lidar-based AGB will be used to train and test the machine learning approach for mapping AGB with Landsat, other satellite data, climate, and topographical data. Andy is in the process of finalizing and evaluating ET optimization and automating the ET method to produce historical monthly ET maps since 2002.

Regular monitoring of forest water stress and tree mortality are critical for understanding the drivers for tree mortality and for improved forest management strategies. Dr. Huesca at UCD has investigated the capability of the imaging hyperspectral data in detecting dead trees. Random Forest regression model was able to map the tree mortality along Sierra Nevada reasonably well, with a r^2 of 0.82. The most important predictors include metrics related to chlorophyll absorption, water content and dry matter content, and aspect. Our next step will be to develop a Landsat-based algorithm to map annual tree mortality since 1984.

3. Summarize efforts taken during this report period to conduct Meaningful Engagement:

Mike Goulden attended the Multi-stakeholder Forum on Fires and Water, hosted by California Environmental Dialogue, at Scripps institute of Oceanography on July 31, 2019 and met several southern California utility company representatives, whom we will engage in the needs assessment.

Mike, Roger Bales, and Toby O'Geen attended the Climate Change Research Symposium 2019: Engagement in Research in Sacramento. Through a variety of breakout sessions in this event, they engaged and listened to many perspectives that differed from those we typically hear when engaging our traditional stakeholders. They were also able to discuss our project with multiple interest groups.

Additionally, Toby introduced and solicited collaborations with the UCANR's Cooperative Extension's Forestry Workgroup. This group of academics performs research and outreach on forest management, fire and forest health and trains the trainers and policy makers throughout California.

Toby also gave a presentation about carbon sequestration in rangelands at a workshop: Farming in the New Normal in Vacaville hosted by UCCE and USDA-NRCS. Here, he highlighted research that

demonstrates how soil organic carbon stocks in rangeland soils is correlated to wet years but not dry years. Evidence suggesting that the below ground carbons stock may be vulnerable to droughts in the future if they become longer and hotter as predicted by climate change experts.

Roger also met with Placer County Water Authority & Yuba Water, as well as Tahoe Central Sierra Initiative colleagues. Mike Goulden also had a call with Nic Enstice of the TCSI in September to learn more about how we can engage with and support their work.

Stanford postdoc, Kyle Hemes, attended the CALAND training, offered by CNRA and Sacramento State, and interacted with agency (CNRA, CARB, BLM) users and LBNL model developers. The tool includes fire and fuel-related management with a carbon stock and flow model for natural and working land management through the century. Kyle also traveled to UC Irvine in November to present initial ideas from the Stanford Field Lab, mostly around Task 2, at a CECS project team meeting. He also met one-on-one with many project collaborators.

Walter Oechel at SDSU has begun to engage those interested in conversion of biomass to energy and/or hydrogen and sequestration of production CO_2, namely Roger Aines at Lawrence Livermore National Labs (who is also working with the following on pyrolysis, CO_2 capture, and gasification), Professor Asfaw Beyene, Director, Center for Renewable Energy and Energy Efficiency at SDSU, and Professor Temesgen Garoma, Professor of Environmental Engineering at SDSU. Additional engagement is planned with land managers, especially USFS and CDF.

Mike and John Battles participated in the Statewide Forest Science Research Coordination Meeting on November 15, 2019 in Sacramento. Mike and Roger had a follow-up call with Pat Manley at USFS and Kristen Wilson at The Nature Conservancy and have since shared shapefiles and data layers.

John also discussed project goals with members of California Forest Management Task Force during their December 9, 2019 meeting.

John and Roger engaged with policy makers as part of the "Forests in Flux: How Science Can Inform Policy" event, hosted by the California Natural Resource Agency, on December 11.

CURRENT STATUS OF THE RESEARCH

4. Summarize the efforts taken during this report period to accomplish the task objectives for each project in the grant:

A shared Google Drive was created to start collecting and homogenizing data layers as per Task 1 of the project initiative, with numerous PI's, graduate students, and project specialists contributing to identifying and vetting these layers.

For Task 2, Kyle Hemes and Chris Field (both at Stanford) began work on three research projects: 1. A conceptual piece, with Mike Goulden, on multi-use management and co-benefit tradeoffs managing CA's forests; 2. Exploring synergies with 'natural climate solution' co-benefit questions at a variety of scales, with CA as a prime case study; 3. Data analysis project looking at the biogeochemical (carbon cycle) dynamics following major California wildfires using remotely sensed indices and products.

At UCD, progress was made on Task 2 via a data analysis project looking at potential biophysical feedbacks (LST, VPD, soil moisture) after major CA wildfires using Landsat LST, and in the future, impacts on forest regeneration.

> Details of work on Task 3 are summarized in our answer to question #3, above.
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> For Task 4, two postdoc recruitments were initiated in December to support this portion of the project. Postdocs should be hired in Q1 of 2020, and work on task 4 will begin at that point.

5. Summarize by task any deliverable or outcome completed during the current reporting period:

> We have made decent progress in producing Version 1 C, H_2O, dieback, fire layers, per Task 1.1, but they are not yet complete. We have created a shared database including several key layers such as carbon biomass, fire severity, and a few management history sub-layers. We categorized data into "measures of ecosystem response" and "predictors of the effects of management".

6. If applicable, what short-term value, interim findings or success stories can you produce as a result of your work?

> One notable success is that the film, "Beyond the Brink: California's Watersheds" was deemed an official selection of the Wild & Scenic Film Festival, hosted by the South Yuba River Citizen's League. It will be presented at the festival on the evening of Friday, January 17, as well as the morning of Saturday, January 18. It was also picked up by KVIE (PBS Norcal) and will be shown on January 23 at 7pm, 25th at 4pm, 26th at 7:30pm, and 27th at 6:30pm. This is just the beginning for this video and for others that will be produced by the Center.
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> In addition, Yufang Jin presented at the American Geophysical Union's 2019 meeting in San Francisco. She, along with other project colleagues, including Dr. Margarita Huesca, presented "Tree mortality detection and assessment using AVIRIS imaging spectroscopy data in the Sierra Nevada Mountains", sharing their project findings thus far.
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> In the realm of furthering our research, we have determined, by comparing multiple carbon biomass data layers, that the GNN LandTrendr approach used by Oregon State University's LEMMA team was superior (most complete and accurate) and deemed it the preferred dataset for use in the project moving forward for the carbon biomass data category.
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> Additionally, short-term value has come through promoting collaborations between institutions and research groups through the Center. We have also learned from and interacted with State Agencies through multiple meetings, and have several others upcoming in Q1, 2020.

7. Describe any challenges and/or opportunities encountered when accomplishing this portion of the Scope of Work:

> One of the largest challenges was getting staffing in place to support this project. Recruiting and hiring for the Project Specialist and Project Coordinator positions took longer than expected, and without these two key support staff members who help to centralize information and organize the team, it was difficult to get much done. It also took a bit longer than expected to get funding and subcontracts in place, which further delayed the project's kickoff.
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> We also encountered some challenges with the data layers as we started to accumulate them. While it is minor, several data layers need to be re-projected to 30m resolution and/or cropped to the CA state outline. In addition, some layers are in vector form while others are in raster form, so we need to decide which format to convert to and stick with for consistency throughout the project. The main challenge though is that many datasets were found to contain missing or incomplete information, namely in the management history layers such as "timber management" and "hazardous fuel

reduction" provided by the USFS. Moving forward we have to come up with a way to distinguish where and when each management type was completed in order to compile a more complete and accurate data layer representing management history in California; this actually represents a unique opportunity as well, one which we will take advantage of in Q1 2020. If we can accurately map when management actions took place, as well as which actions were preformed, this refined data layer could be of great use to State agencies, and to other projects/programs as well.

8. Is the research grant on budget and on schedule (Please refer to the Work Plan/Schedule for Implementation)? Please indicate here if a go/no-go milestone was reached this quarter, if it is behind schedule, and/or will not be met, and provide explanation. If other items are off budget and/or behind schedule, what issues need to be addressed and what steps are being taken to ensure that the grant is completed on time and on budget?

All project objectives will be met, but are 1-2 quarters behind on most fronts. If we can get the data layers for Task 1 compiled in an expedient manner, we may be able to ramp up on Task 2 more quickly, and make up some time. For Task 4 to begin we are just awaiting the hire of 2 postdocs. Advertisements for these positions are out now, and we project these 2 positions will be filled in March of 2020. Due to the project getting off to a late start, we are behind schedule on budget, and have spent less than what was allotted for the first 3 quarters of the project in almost every line item. Spending is projected to pick up slightly in Q1, but it is expected that a majority of the Year 1 budget will still be unexpended by the end of Q1 2020. Approval was given by Blake Deering to carry this unspent budget over into the same line items in the Year 2 budget.

ADMINISTRATIVE/FISCAL OVERVIEW

9. Provide a brief narrative explaining the grant's financial expenditures and budgeted amounts for this period that includes cash and/or in-kind items.

At UCI, budget was spent mainly on PI summer salary and salaries of the Project Specialist, and after November, the Project Coordinator. $188,336.35 has been spend across the last 3 quarters at UCI, with the vast majority of this being spend on personnel and fringe benefits. Personnel budget has been 62% spent, and it is projected that there will be an excess of funds from Year 1, even after the first quarter of 2020. These unspent Year 1 funds will be carried over in the same budget categories, and added to the Year 2 budget.

UCM has not yet invoiced for their work on this project, though work has been completed. Thus, we expect a slightly larger invoice from them in the beginning of Q1 2020. Their account administrator has been contacted and reminded that an invoice is needed for their work.

UCD spent $2,244.11 on PI salary in October. November and December invoices were not yet received at the time of this report. Therefore, UCD's charges in Q1 of 2020 will likely seem slightly inflated as well.

UCB spent $27,118.31 in Q3 of 2019, for one summer month of summer salary for PI John Battles and graduate student support.

SDSU has spent $5,136.33 thus far on PI salary. Less than 10% of Year 1 budget has been spent, and that it due to student salaries, technical salaries, and supplies being underspent. However, these categories are still needed for Year 2 and funds will be carried forward.

At Stanford $34,753.59 has been spent for PI effort and postdoctoral support of Kyle Hemes, who is actively engaged on the project. This spending is on track with the original budget.

Total project spending to date is at 20% of the budget allocated for Year 1.

10. Do you anticipate major modifications to the grant's budget or work plan in the next quarter?

We do not foresee any major modifications will be needed in Q1 2020, but may need to request a budget amendment in Q2 to redistribute some allocation of funding for a few postdoc/ support staff positions from other personnel categories/ from Year 1 budget carryover.

ADDITIONAL COMMENTS