Climate Change Research Program	**2022**
QUARTERLY PROGRESS REPORT	**QTR 1**

Progress Report #   10   **For the reporting period:**   January 1, 2022   **to**   March 31, 2022

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

Research Grant Title   Innovation Center for Advancing Ecosystem Climate Solutions

Signature Line (authorized representative): _____

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	5%	90%	$5,000.00	$302,786.23
1.2	Test, improve, and update data layers	5%	90%	$8,000.00	$334,623.72
2.1	Prepare data analysis	5%	85%	$12,000.00	$259,546.77
2.2	Analyze historical and current data	10%	80%	$15,000.00	$268,035.26
2.3	Extend data analysis via data science and machine learning	15%	65%	$5,000.00	$80,059.07
3.1	Actively engage stakeholders	5%	85%	$30,000.00	$405,244.11
3.2	Produce decision-making tools	10%	85%	$47,000.00	$502,000.00
3.3	Communication	5%	85%	$9,203.52	$154,203.52
4.1	Develop valuation framework	5%	90%	$5,000.00	$140,000.00
4.2	Develop and implement valuation tools	15%	65%	$30,000.00	$173,388.13
4.3	Develop financing strategies	15%	55%	$7,000.00	$78,676.19

> **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:**

In Q1 2022, the CECS team made significant progress on our Natural Climate Solutions (NCS) Toolbox, the main technology deliverable of our project. In addition to adding significant functionality and several new layers to the Data Atlas tool (which can be found online at https://cecs.ess.uci.edu/data-atlas/), we also created a more solidified version of the Data Bridge tool, and worked to get all components of the NCS Toolbox up onto the cloud-based virtual desktop platform, Apporto. Moving the tools, and in particular, the Data Bridge, onto a cloud-based platform means that the process for accessing CECS data and tools will be much more streamlined for users. This functionality will ultimately let us share the tool much more widely, as well as rapidly update it and push updates out to users in near real time.

In the weeks before the move to Apporto, CECS team members held numerous meetings with stakeholders, and strengthened relationships with Pyregence, Accel, and Blue Forest, as well as hosted a multi-day tool audit with representatives from CNRA, CAL FIRE, CARB, and the Governor's Wildfire and Forest Resilience Task Force. This audit had twofold benefits: 1) We were able to showcase the great work that the team has completed so far, and to show our data and tools can be useful to advancing the climate and land management goals of the state, and 2) We received valuable insights from our knowledgeable panelists, who provided us with feedback on both the content and functionality of the tools that we are now incorporating into improved versions of all tools, which should be available for public release in Q2.

One additional development of note is that our analysis of ecosystem services was deepened this quarter, and that we have started to develop a mock-up of an ecosystem services valuation tool, which will be expanded upon and hopefully added to the larger NCS Toolbox in Q2.

Dozens of papers on CECS research are in the works, and 13 papers were either submitted, under review, or published during this reporting period.

ACHIEVING PROGRAM GOALS

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

> Our main focus in Q1 was refining the Data Bridge tool, the final unifying piece of our Natural Climate Solutions (NCS) Toolbox. We made great strides in operationalizing the NCS Toolbox and have started to move it to a virtual desktop platform, Apporto, that we should be able to share with stakeholders starting in early Q2. A particular improvement was developing the capacity to prioritize potential treatment areas based on a list of key variables that users can weight according to their perceived importance or what they are trying to manage for. Explanation of further improvements to our NCS Toolbox can be found in section 4 of this report.
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> Additionally, at San Diego State University (SDSU) research in Q1 examined carbon flux in chaparral, which informs California's plan of integrating land use, conservation, and management into its climate change programs. Specifically, students analyzed the net ecosystem exchange of carbon and microsite level soil respiration. The effects of extreme weather events, such as drought and fire, and stand age on CO_2 flux were also studied. All three study areas allow for a better understanding of how extreme weather events fueled by climate change influence the carbon source-sink relationship of chaparral

ecosystems. This furthers CCRP's goal of developing resources that build resilience in vulnerable ecosystems while advancing climate change solutions.

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

The expectation is that using the NCS Toolbox would allow for more informed decision making, which would in turn further sequester carbon throughout the state. However, we need people to start using the tools to show this, and have only just begun this process. More direct examples should come from engaging stakeholder groups in utilizing our tools in Q2.

3. Summarize efforts taken during this report period to conduct <u>Meaningful Engagement</u>:

One of the larger components of CECS outreach and engagement in Q1 centered around an "audit" of the CECS NCS Toolbox with a group of State agency representatives. The panel, convened by Loretta Moreno of the California Natural Resources agency, was comprised of the following individuals: Alan Talhelm (CARB), Lara Kueppers (Governor's Wildfire and Forest Resilience Task Force), Jamie Lydersen (CAL FIRE), Dana Dysthe (CAL FIRE), and Brett Agler (CAL FIRE). For the audit, we hosted a series of three 2-hour calls with the panel between January 18 and January 25.

The overarching goal of this audit was to introduce panelists to the NCS Toolbox, show test cases for both the AB 2551 area and the state level, and show the capabilities for CECS tools to answer the most pressing land management questions on the minds of managers in California. On the first call we acquainted people with some of the technical and scientific underpinnings and perceived uses of the NCS Toolbox. We also ensured everyone was set up with the software on their machines and could run a test example. On the second call, we walked through examples highlighting pre-treatment planning, pre-treatment prioritization, pre-treatment evaluation, and post-treatment monitoring capabilities. We also showed participants how to visualize spatial data outputs in ArcGIS Online alongside our pre-loaded starter kit layers. Our third call focused more on feedback from the panelists to help CECS improve our tools in future iterations, and also allowed time for us to answer some of the panelist's more specific technical and scientific questions. Overall, the audit was a success and not only allowed us to showcase the work that CECS has done so far and how it fits into the landscape of decision support tools in California, but also provided us with ideas for how to continue to build upon our work and make the NCS Toolbox even more useful for managers and practitioners throughout the state.

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We also continued to strengthen ties with several specific collaborators this quarter, including ACCEL, Pyregence, and Blue Forest Conservation. CECS Director, Mike Goulden, and UC Berkeley Professor, John Battles, have been deeply involved in discussions with the USFS Pacific Southwest Research Station team building the ACCEL tool, and have had several calls this quarter to learn more about the synergies between the two efforts, and how we can move forward together. In the same vein, Mike and John, along with UC Irvine Professor, Jim Randerson, met at least four times this quarter with the Pyregence team on how we can coordinate our efforts in decision support tools, especially regarding the impacts of wildfires. Meetings with Pyregence and the ACCEL team will continue on at least a biweekly basis in Q2, as we further explore what combined efforts from our three times might look like, and what we can collectively achieve for the State.

Meanwhile, CECS Co-Director, Roger Bales, hosted biweekly meetings (at least 8 meetings throughout the quarter) with the nonprofit group, Blue Forest Conservation, continuing our conversations from

previous quarters, and looping in more members of the CECS team. CECS researchers presented research findings to Blue Forest, chatted about the use of CECS data on potential upcoming projects, as well as potential additional collaboration opportunities (such as their wildfire smoke and public health project with the California Council on Science and Technology), and funding prospects.

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We continued to host additional introductory and follow-up calls with a variety of different agencies, nonprofits, and other research groups, further detailed below:

On January 26, Mike, CECS Project Coordinator, Raiven Greenberg, and UC Irvine Postdoctoral Researcher, Jon Wang had a follow-up call with Kendall DeLyser of American Forests and Nadia Tase of CAL FIRE's FRAP Division to discuss the expected effects of management on flame length data and how they might be able to use it for their analyses.

On February 28, Mike, Roger, and Stakeholder Engagement Coordinator, Meghan Cook, had a follow up call with Andrew Schwarz and Cassandra Evenson of DWR to discuss CECS data in regard to runoff and fire probability. We will follow up with them once the 2020-2021 data update is complete.

Roger and UC Merced PhD student Han Guo met with a UC Davis team about CA forests & water, eventually resulting in a proposal to CAL FIRE to use CECS products for part of their proposed project on bioenergy (working with Caspar Donnison, Gail Taylor, and Malcolm North). Roger had two separate meetings with Yuba Water regarding water benefits of forest management, based on CECS data. As a precursor to a larger upcoming meeting, Roger also met with a subset of the French Meadows partnership in mid-March to give them a preview of CECS products.

At San Diego State University (SDSU), undergraduate researcher, Ben Hall, made efforts to engage with experts from SDSU, UC Davis, and the USDA-Forest Service to develop his project focusing on the potential of harvesting chaparral in San Diego County.

Mike and Raiven met with more than 15 members of the British Columbia based Pacific Institute for Climate Solutions team to introduce them to CECS and our tools, and to learn about their work on fires and climate in the Pacific Northwest, as well as how we may be able to integrate our efforts.

Mike, Roger, and Raiven also met with Sierra Nevada Research Institute Executive Director, Molly Stephens, and National Parks Service Physical Scientist, Andi Heard. We showed Andi how CECS tools could help with NPS with determining prioritization and planning for on-ground work, and conducing post-fire analysis. We will follow up in Q2 once the CECS data have been updated for the 2020 and 2021 fires years.

On March 30, Mike Goulden presented to the CA Climate Hub and USFS Region 5 during their Climate Literacy & Decision-Support Tools Workshop - Part 2. Mike presented on the CECS Data Atlas and Data Bridge tools to a group of target users of our tools- managers and those working closer to what is happening on the ground. The University of Washington presented on their RxGaming and LicoSim tools, and Mike thought about how we might integrate these tools into CECS' work as well.

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To further share the work of CECS beyond academia and agencies, several team members undertook special efforts to speak about CECS data, engagement, and tools through both in-person speaking engagements with students, and via film recordings meant to be shared with the public.

For this, Raiven Greenberg presented to the UC Irvine Campus as a Living Lab Course, speaking to a class of undergraduate students who are sustainability interns on campus at UCI, and who are taking a course to complement their experiential learning. Raiven presented on her career path and how she came to join CECS, and then shared about the importance of stakeholder engagement and how we've done that at CECS, as well as explained some of the data and showed example uses of the Data Atlas. This is all in hopes of engaging the younger generation in thinking about stakeholder-centered science and climate solutions.

In addition, Roger Bales was interviewed for the PBS program "American Grown: My Job Depends on Ag", for their episode entitled "Burn Scars", where they explore how wildfires and forest health affect groundwater recharge throughout the state. You can view the episode [here](#).

On March 18, Roger hosted rough cut of the film "California's Watershed: Healing", which is partially funded by CECS, and which prominently features several CECS researchers, alongside several State and federal officials. The screening was hosted at UC Berkeley, and also shown virtually. In-person attendees included Roger's class at UC Berkeley, as well as some of CECS' partners, like Blue Forest. John Battles also attended and assisted with soliciting feedback. Meghan Cook assisted with the film screening by surveying attendees and synthesizing feedback for film editor, Jim Thebaut of the Chronicles Group. This feedback process is to ensure that the film is as relatable and as informative as possible for our stakeholders, while still being engaging and fun to watch.

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:

Task 1

To better support integrating the forest sector into climate mitigation strategies, UC Merced postdoctoral researcher, Jian Lin, conducted a comprehensive literature review to identify original studies which examined the relationship between forest management and carbon outcomes, and then employed meta-analysis to quantify climate benefits or losses from implementing individual management practices. Jian differentiated the impacts of forest management on carbon outcomes by activity types, carbon pools, and study regions, and quantified the magnitudes and ranges of the carbon pools for different forest activity types. Preliminary findings are found in section 6 of this report.

Meanwhile, efforts on studying carbon fluxes in chaparral continued by Walter Oechel's lab at SDSU. There, PhD candidate Andrea Fenner analyzed field data to determine the effects of fire on carbon flux in chaparral ecosystems. She also used ArcGIS to model vegetation health and burn severity in chaparral ecosystems. MS candidate, Jessica Montes, conducted a time series analysis of her soil respiration data to understand the hourly and daily trends of soil respiration after rainfall events during dry and wet seasons. The SDSU team maintained three eddy covariance towers to support their continuing carbon flux measurements.

Task 2

UC Irvine PhD candidate, Carl Norlen, has been updating analysis on how wildfire recovery changes forest drought response. He is working on a manuscript draft and aiming to have the first draft complete in Q2, and submitted in Q3. He also began working on a project using the NCS Toolbox to study how fuels impact wildfire risk in California, and is comparing field data sets from the Irvine Ranch Conservancy and Center for Environmental Biology data with data from CECS.

At UC Davis, Professor Yufang Jin has been working with PhD candidate, Yuhan Huang, to refine the daily fire rate of spread study, which was done by Erica Scaduto (a former MS student), for all large fires from 2012 to 2020, using a machine learning approach.

In another take on machine learning, UCI PhD student, Ved Bhoot, continued to work this quarter on pixel-scale recovery analysis. He produced R code to extract out data to train a model and conduct exploratory analysis on recovery patterns throughout California from 1986-2019, and has R scripts prepared to produce a pixel scale analysis. Ved also produced a CA ownership raster, patched together state-wide mosaics of PRISM precipitation and temperature, and produced rasters of years since fire as stand age. He is close to being ready to train a random forest model, but will first produce state-wide products for burn severity as dNBR. He is currently using FRAP polygons but will likely switch to Jon Wang's disturbance history layers for better quality pixels. The final table that he is producing will use around 1% of the pixels from the burn perimeters which should produce a table with ~2-4 million rows of data ready for analysis.

Task 3

Major overhaul and updates have been made to the NCS Toolbox in Q1, our largest push yet to get these tools ready for public use.

For the Data Atlas in particular, which is publicly available at https://cecs.ess.uci.edu/data-atlas/, UC Davis Web Programmer, Mike Walkinshaw, added informative "tool tips" for each of the data layers. Users can hover over a "?" icon next to the layer name in the table of contents to display a brief description of the layer, and (in some cases) how it was derived. Mike also added a feature to allow users to make "point queries" on the map. Users can click the map to identify the specific data layer values at that location, whether they are viewing a single layer or comparing layers (in which case the values for both layers are shown). The point query feature is not relevant for the RGB "overview" layers. In the version of the tool that is still under development, Mike also added an experimental feature that allows users to add shapefiles from their own computer to be displayed on the map. This can be useful for visualizing a user's area of interest within the context of our data layers. It could also serve as a means of displaying summaries and analyses from the Data Bridge tool. This feature is currently only available in the development version of the Data Atlas, but will likely be released on the public version sometime in Q2.

Our other push was to start to prepare the Data Bridge for public use, and to set things up to better complement data analysis, letting users more easily get an answer to the problem they are trying to solve. As part of this, UC Berkeley Research Tech, Elliot Kuskulis, developed a starter kit of map packages for ArcGIS Pro and ArcMap by compiling and organizing publicly available data layers to be used in conjunction with the CECS DataBridge to support environmental planning in California. He also helped with testing for multiple versions of the DataBridge by replicating examples and documenting issues during the process, assisting us in troubleshooting and allowing Mike Goulden to make the necessary changes to the underlying source code. Mike also coordinated with the cloud-based virtual desktop service, Apporto, to start to set up the NCS Toolbox for public access.

To support these new tool updates and additions, Meghan Cook, developed talking points to promote CECS' data and tools. She also continued to develop data and tool documentation, including metadata and detailed descriptions for original CECS data layers, and user guide for CECS tools. These will be added to the NCS Toolbox in Q2. Meghan also edited and updated the CECS website to reflect current research, accomplishments, and products, and wrote and posted blog articles to the CECS website to promote published papers from CECS researchers, including this blog about Aurora Gutierrez's recent research on temperature and burn probability in the Sierra Nevada. Meghan also co-managed the CECS Twitter account and wrote and sent a quarterly newsletter to stakeholders. The most recent newsletter can be viewed here. In addition to all of the written communications listed above, Meghan also worked with Elliot to draft a script for a CECS DataBridge tutorial video and record a test version of this video.

To assist with the need for additional communications surrounding CECS' research and tool updates, we decided to host a cohort of Science Communications Interns for a third summer, and put up the job posting in late February. We received 18 applicants for three spots, and began selecting candidates to interview. Interviews and selection will happen in Q2, and interns will begin their 8-week internship starting on June 21.

Task 4

Great strides have been made in Q1 by CECS researchers who are focused on ecosystem services and valuation.

UC Irvine Postdoctoral Researcher, Charity Nyelele, submitted a manuscript on how machine learning offers new opportunities for mapping currently understudied cultural ecosystem services including recreation. She also worked towards completing the first draft of a paper on the economic valuation of recreational ecosystem services in the Tahoe Central Sierra Initiative (TCSI) area. She contributed to revisions made on the multi-benefit paper led by Blue Forest that was resubmitted for journal review. Alongside UC Irvine Assistant Professor, Benis Egoh, Charity also submitted an abstract for the "Rewilding and restoration of degraded ecosystems" session of the International Society for Ecology 2022 Congress in Geneva, Switzerland.

During this period, UC Merced PhD candidate, Han Guo, finished a manuscript regarding valuing the benefits of forest restoration on enhancing water supply and hydropower. By using a scalable top-down approach to tracking annual evapotranspiration, coupled with hydropower simulation models that include energy-price information and marginal prices for water sales to value water-related services, he showed that water and hydropower benefits can offset the cost of restoration, especially in the face of climate change. Aside from the water-related benefits, Han is also working on valuing the benefits of forest restoration on mitigating the severity of wildfires, mainly for avoided costs on building assets loss, deterioration of air quality, soil erosion, carbon loss. The methods combine prediction of burn probability and flame length. He continued to work toward valuing the benefits of forest restoration, aiming to increase the resilience and sustainability of forest within California to facilitate associated projects for mitigating wildfire severity.

In Q1, UC Merced Postdoctoral Researcher, Min Gon Chung revised his manuscript, "Economic impacts of management activities and carbon sequestration and water production in dry forests." He also continued to update a web-based tool that estimates carbon and water values for 20 years after forest management practices in the TCSI. Min also valued raster files regarding the expected effect of management on water supply. For runoff valuation, he used three different options: unit prices ($50/acre-foot, $200/ acre-foot, $500/ acre-foot), discount rates (0, 3, 5%), and duration of benefit (first

year, sum over 10 years, and sum over 20 years after treatment). This resulted in 675 water valuation layers, and will be adopted as a part of the Data Atlas later this summer.

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

The creation of NCS Toolbox on the cloud-based virtual desktop platform, Apporto, was a large outcome for CECS this quarter. Mike Goulden worked with Apporto tech support to get the CECS data and tools up onto this platform, and is currently iterating on updates, before sharing internally with the full CECS team in early Q2, and then sharing this publicly shortly thereafter. Moving the tools, and in particular, the Data Bridge, onto a cloud-based platform means that the process for accessing CECS data and tools will be much more streamlined for users. It will allow people to do quick data grabs and evaluations on a virtual desktop environment, without needing to have a certain amount of RAM of storage space on their computer. This functionality will ultimately let us share the tool much more widely, as well as rapidly update it and push updates out to users in near real time. This full working beta version of the NCS Toolbox was one of the "stretch" goals of the project, so we are incredibly happy to achieve this, and to still have several months left to continue to refine it.

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

NCS Toolbox Audit with State agencies

As mentioned in Section 3 of this report, our NCS Toolbox audit with State agency representatives was a success for two reasons: 1) We were able to showcase the great work that the team has completed so far, and to show our data and tools can be useful to advancing the climate and land management goals of the state, and 2) We received valuable insights from our knowledgeable panelists, who provided us with feedback on both the content and functionality of the tools that we are now incorporating into improved versions of all tools, which should be available for public release in Q2.

CECS Semi-Annual Meeting

In addition to our meaningful outreach with stakeholders and partners, we also took the opportunity to bring our internal CECS team together in a meaningful way this quarter with an "all-CECS" two-part Semi-Annual Meeting on March 28 and 31. This allowed researchers to share their research updates with the full team, discuss the progress on the NCS Toolbox, and to brainstorm about future directions that we can take to further build upon this work and create a positive impact. Team members left with a renewed sense of camaraderie going into the last leg of this project.

Research findings and applications:

Jian Lin found through his meta-analysis that for case studies that employed the field observation approach, all forest management activities caused a decline in live aboveground carbon, while the responses of dead aboveground carbon and forest floor carbon varied depending on activity types. For mineral soil carbon and soil respiration rate, thinning tended to increase their magnitudes while prescribed fire had the opposite effects. For case studies that employed the modeling approach, we see that continued business-as-usual or low scenarios will lead to the net carbon sources, indicated by statistically significant differences between mean/median points and the horizontal zero line. The increased magnitudes of carbon benefits were larger when changing from low to moderate scenarios than from moderate to aggressive scenarios, suggesting that moderate scenarios seem to be a realistic and efficient option by balancing carbon outcomes and the practical concerns.

Papers under review or published in Q1 (note that all publications to date can be found on the Publications page of the CECS website):

1. Chen, B. and Y. Jin (2022). Spatial patterns and drivers for wildfire ignitions in California. Environmental Research Letters. *Environ. Res. Lett.,* 17**,** 055004.
2. Chen, Y., S. Hantson, N. Andela, S.R. Coffield, C.A. Graff, D.C. Morton, L.E. Ott, E. Foufoula-Georgiou, P. Smyth, M.L. Goulden, and J.T. Randerson. (2022, in revision) Tracking extremes in California wildfire spread using satellite active fire detections and an object-oriented classification approach. Scientific Data.
3. Coffield, S.R., C.D. Vo, J.A. Wang, M.L. Goulden, G. Badgley, D. Cullenward, J.J. Battles, W.R.L. Anderegg, and J.T. Randerson (in review). Using remote sensing to quantify the additional climate benefits of California forest carbon offset projects. Global Change Biology.
4. Eriksson, Max, Mohammad Safeeq, Tapan Pathak, Benis Egoh, Roger Bales (in review). Using stakeholder-based fuzzy cognitive mapping to assess management effects on wildfire-vulnerable forests. Restoration Ecology.
5. Guo, Weichao, Mohammad Safeeq, Hongyan Liu, Xiuchen Wu, Guotao Cui, Qin Ma, Michael L. Goulden, Mats Lindeskog, Roger C. Bales (2022). Mechanisms Controlling Carbon Sinks in Semi-Arid Mountain Ecosystems. Global Biogeochemical Cycles, Volume 36, Issue 3. doi: 10.1029/2021GB007186.
6. Hantson, S., N. Andela, M.L. Goulden, J.T. Randerson (2022, in revision). Human-ignited fires are faster, hotter and kill more trees in California forests. Nature Communications.
7. Hemes K.S., Norlen C.A., Wang J.A., Goulden M.L., Field C.B. (2022, in revision). "The magnitude and pace of photosynthetic recovery after wildfire in California ecosystems" PNAS
8. Norlen C.A., Golden M.L. (2022, in revision). Recent tree mortality inoculates semi-arid conifer forests against subsequent drought exposure. Communications Earth & Environment
9. Nyelele, C., Egoh, B.N., Keske, C. and Chung, M.G. (in review). Machine learning offers opportunities for reducing uncertainty in mapping understudied cultural ecosystem services.
10. Quesnel Seipp, Kimberly; Maurer, Tessa; Elias, Micah; Saksa, Phil; Keske, Catherine; Oleson, Kirsten; Egoh, Benis; Cleveland, Rachael; Nyelele, Charity; Wyrsch, Peter; Goncalves, Nicolas; Hemes, Kyle; Lewis, David; Guo, Han; Gon Chung, Min; Gritter, Abby; Conklin, Martha; Bales, Roger (in review). A multi-benefit framework for funding forest management in the Western USA.
11. Sam, J. A., Preisler H. K., Westerling A. L., Xu Q., Baldwin W. J. and Sleeter B. M. (in review). Estimation of Burn Severity Fractions in California. Environmental Research Letters.
12. Wang, J., J.T. Randerson, M.L. Goulden, C. Knight, and J.B. Battles (2022, in revision). Remote sensing reveals multi-decadal losses of tree cover in California driven by increasing fire disturbance and climate stress. AGU Advances.
13. Xu, Qingqing, Anthony LeRoy Westerling, Andrew Notohamiprodjo, Christine Wiedinmyer, Joshua J Picotte, Sean A. Parks, Matthew D. Hurteau, Miriam E Marlier, Crystal A. Kolden, Jonathan A. Sam, W. Jonathan Baldwin, Christiana Ade (in review). Wildfire Burn Severity and Emissions Inventory: An example implementation over California. Environmental Research Letters.

Conference Presentations:

Two SDSU students presented their work at the NOAA/EPP 10th Biennial Forum in Tallahassee, Florida. Andrea Fenner presented a research poster focusing on the effects of drought, fire, and stand age on CO2 flux in semi-arid chaparral ecosystems, while Jessica Montes presented a research poster focusing on soil respiration trends in chaparral.

UC Merced Project Scientist, Max Eriksson, presented on CECS stakeholder attitudes assessment workshops methods at the UC Merced Management of Complex Systems Seminar series.

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

> Setting up an online version of the Data Bridge has been rather challenging, but we have found a solution in using the virtual desktop platform, Apporto, and are in the process of getting it set up for internal testing before launching for external use in Q2.

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. <u>If other items are off budget and/or behind schedule</u>, what issues need to be addressed and what steps are being taken to ensure that the grant is completed on time and on budget?

> We are on budget, if not a little slow on spending in some instances. We may request another short no-cost extension after taking a more detailed look at our remaining budget and projected expenses.

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.

> UC Irvine spent $74,564.08 in Q1, mainly on salaries and benefits for the Project Coordinator, Postdoctoral Researchers, and graduate student assistance, in addition to administrative overhead.
>
> UC Davis spent $58,675.51 in Q1, primarily on our Programmer, PI effort, and overhead.
>
> UC Berkeley spent $7,193.15, on Research Tech salary and benefits.
>
> Stanford spent $17,183.74 on postdoc and PI salary and benefits, plus overhead.
>
> San Diego State University spent $15,587.04 on graduate student support, PI effort, and overhead.
>
> UC Merced did not submit an invoice this quarter, though they did complete ample work, so we can expect a substantially larger invoice for them in Q2.
>
> Total project spending amounts to $173,203.52 for Q1 2022. $2,674,592.40 has been spent to date.

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

> There is potential for us to request a 6-month no-cost extension, if available. We will communicate directly with program managers should we think this to be necessary.

ADDITIONAL COMMENTS

> We thank SGC for your continued support of this project, and look forward to sharing the full Natural Climate Solutions Toolbox with you soon.