**NASA DEVELOP National Program**

**2019 Summer Project Proposal**

**California – JPL**

**Santa Monica Mountains Ecological Forecasting III**

*Analyzing Recent Wildfire Impacts to Assist the Resource Conservation District of the Santa Monica Mountains in Identifying Tree Species to Replant*

**Project Overview**

***Project Synopsis*:** This project will work with the Resource Conservation District (RCD) of the Santa Monica Mountains, the National Park Service, and additional state and local organizations. This project will integrate recent wildfire impacts with previous analysis from the spring 2017 and fall 2017 NASA DEVELOP terms of the extent and spatial distribution of tree mortality due to drought from 2013 through 2018. This project will use Earth observations such as Landsat 8 OLI and SRTM, and data from the airborne missions NASA ER-2 Jet AVIRIS and NASA Gulfstream III UAVSAR to couple climate and species distribution modeling, current and modeled future temperature and precipitation regimes, and topography. Planned end products include burn severity maps, tree species map, and a map of the current existing topographic and environmental conditions. The end products will help partners identify places where native trees have survived both the fire and drought to identify where conditions might be suitable to support native woodlands in the next 50 to 100 years.

***Community Concern:*** Native oak and riparian woodlands support hundreds of endangered, threatened, and sensitive species, in addition to providing billions of dollars of ecosystem services to the Los Angeles region. Current threats from wildfires, floods, drought, and invasive beetles have caused extensive mortality in the past seven years. The recent Woolsey Fire (November 8-21, 2018), has damaged this sensitive area further by burning over 80% of the study area. In order to prevent a collapse of these important ecosystems and to direct restoration efforts, there is a need to know where the trees survived, what physical characteristics on the ground supported that survival, and the extent of fragmentation. The partners are working to develop a conceptual framework to direct and prioritize where to protect existing stands and restore lost stands.

***Source of Project Idea:*** Since her first term initially working with DEVELOP (spring 2017), Rosi Dagit from the RCD of the Santa Monica Mountains has maintained contact with DEVELOP. She contacted the JPL Center Lead Erika Higa and JPL Mentor Ben Holt with this project idea after experiencing the aftermaths of the Woolsey Fire. Satisfied with the products produced by the first two terms of this project, Rosi Dagit drafted a project idea that would help identify locations to support remaining forests and restore lost trees.

***National Application Area Addressed:*** Ecological Forecasting

***Study Location:*** Santa Monica Mountains, CA

***Study Period:*** June 2017 – June 2019; Forecasting to 2050

***Advisors:*** Natasha Stavros (NASA Jet Propulsion Laboratory, California Institute of Technology), Dave Schimel (NASA Jet Propulsion Laboratory, California Institute of Technology)

**Partner Overview**

***Partner Organizations:***

|  |  |  |  |
| --- | --- | --- | --- |
| **Organization** | **POC (Name, Position/Title)** | **Partner Type** | **Boundary Org?** |
| **Resource Conservation District of the Santa Monica Mountains** | Rosi Dagit, Senior Conservation Biologist | End User | Yes |
| **National Park Service, Santa Monica Mountains National Recreation Area** | Joseph Algiers, Restoration Ecologist;  Marti Witter, Fire Ecologist | End User | No |
| **California Department of Parks and Recreation, Los Angeles Division** | Danielle LeFer, Ecologist | End User | No |
| **County of Los Angeles Fire Department, Prevention Services Bureau, Forestry Division** | Jay Lopez, Assistant Chief | Collaborator | No |
| **County of Los Angeles Department of Regional Planning** | Joseph Decruyenaere, Senior Biologist | Collaborator | No |

***End-User Overview***

***End User’s Current Decision-Making Process:***The RCD coordinates efforts with all of the partners for this project to address the development of a Mitigation and Future Forest Priority Map that prioritizes areas of concern and focuses scarce resources for monitoring. The partners use *in situ* monitoring to assess existing vegetation, and they work with collaborators to assess the impacts of the recent wildfires. The partners primarily rely on written reports from affected property owners and local arborists, and there is no spatial analysis at a larger scale to identify all the impacted areas. The partners work on restoring lost stands of the forest by replanting trees and keeping track of pest infestation to prevent further loss.

***End User’s Capacity to Use NASA Earth Observations:***

*Resource Conservation District of the Santa Monica Mountains –* The RCD has had exposure working with NASA Earth observations due to its past DEVELOP involvement via the first two terms of this project. The RCD coordinated the previous studies using NASA Earth observations and look forward to building upon those with the results of this study.

*National Park Service, Santa Monica Mountains National Recreation Area –* The Santa Monica Mountains National Recreation Area has only used NASA Earth observations as part of the previous DEVELOP projects. Generally, recreation area staff does not have the time or remote sensing expertise to utilize all the data that are collected.

*California Department of Parks and Recreation, Los Angeles Division –* CDPR has used products generated by NASA Earth observations from the previous DEVELOP projects. Generally, CDPR does not have the time or remote sensing expertise to utilize all the data that are collected.

***Collaborator & Boundary Organization Overview***

***Collaborator Support:***

*County of Los Angeles Fire Department, Prevention Services Bureau, Forestry Division**–* The Forestry Division will provide fire history, ignition data, and daily fire danger analysis data. The Forestry Division personnel is composed of professional foresters that are consistently in the field and monitor environmental changes in Los Angeles County.

*County of Los Angeles Department of Regional Planning**–* This organization will provide GIS data layers, including recent LiDAR flights, as well as information on zoning, development patterns, and ecologically sensitive areas protected by county policies and ordinances. The Senior Biologist for Regional Planning will assist in coordinating the results of this study with other county data.

***Dissemination by Boundary Organizations*:**

*Resource Conservation District of the Santa Monica Mountains –* The results of the project will be disseminated to decision and policy makers locally and regionally including the Cities of Agoura Hills, Calabasas, Hidden Hills, Los Angeles, Malibu, Thousand Oaks, Westlake Village, Los Angeles, and Ventura County Planning Departments, Forestry and Fire Protection, Public Works, and public and private landowners and managers. It is anticipated that the maps generated by this project will be incorporated into an area-wide Native Tree Restoration and Mitigation Planting Plan.

***Project Communication & Transition Overview***

***In-Term Communication Plan*:** Rosi Dagit will be the main POC for the project. The team will send a weekly or biweekly project update to the partners by email and have teleconferences as needed to answer any questions the partners may have or address any requests the team has for the project partners.

***Transition Plan*:** The decision support tools and deliverables provided by this study will be shared not only with the main project partners, but also disseminated to all interested stakeholders within the Santa Monica Mountains. Final data and maps will be handed off by email or via the NASA Large File Transfer system, and team members will present their final presentation to the partners during the last week of the term via video conference or in-person if the partners are able to attend closeout.

***Letters of Support*:** Suzanne Goode, Senior Environmental Scientist, California Department of Parks and Recreation, Los Angeles Division

**Earth Observations Overview**

***Earth Observations:***

|  |  |  |
| --- | --- | --- |
| **Platform & Sensor** | **Parameter(s)** | **Use** |
| **Landsat 8 OLI** | burn severity | Landsat 8 will be used to create Normalized Burn Ratio (NBR) which will identify and quantify burn severity to understand tree mortality. |
| **NASA ER-2 Jet AVIRIS** | spectral vegetation indices | AVIRIS will be used to map and detect shrub and woodland vegetation based on each species spectral reflectance. The data will be used to map vegetation and investigate the changes post-fire. |
| **NASA Gulfstream III UAVSAR** | surface roughness, backscatter values | UAVSAR will be used to map burn scars based on the difference in vegetation structure. |
| **SRTM** | land elevation | A digital elevation model created from this dataset will be used to assess the role of slope and aspect on surviving vegetation. |

***Ancillary Datasets:***

Resource Conservation District of the Santa Monica Mountains Oak Study in situ data – 41 study plots will be used for ground truth data

CAL FIRE Fire and Resource Assessment Program (FRAP) Fire Data – Fire data will be used to look at all wildfire occurrences and fire threats in the study area

NPS SMMNRA Inventory and Monitoring Plots – This will be used to check the available stands of trees

USDA National Agriculture Imagery Program (NAIP) – This will be used to create a verification layer for vegetation classification for AVIRIS data

Los Angeles County Sensitive Environmental Resource Areas (SERA) Shapefiles – This will be used as a reference to identify habitats that have important biological functions

Los Angeles County Significant Ecological Areas (SEA) Shapefiles – This will be used to identify areas that represent the highest biological diversity

PRISM Climate Data – This dataset will be used to look at precipitation, temperature, dew point, and vapor pressure deficit which may help with identifying climatic patterns

USDA Natural Resources Conservation Service Gridded Soil Survey Geographic (gSSURGO) Database - Soil data will be used as a potential predictor of optimal tree planting sites

***Modeling:***

Maximum Entropy (MaxEnt) (POC: Steven J. Phillips, AT&T Research)

***Software & Scripting:***

Esri ArcGIS – Raster manipulation and analysis, image enhancement, and map creation

Harris Geospatial ENVI – Analysis of vegetation

University of California Santa Barbara (UCSB) Viper Tools – Multiple endmember spectral mixture analysis (MESMA)

**Decision Support Tool & End Product Overview**

***End Products:***

|  |  |  |  |
| --- | --- | --- | --- |
| **End Product** | **Partner Use** | **Datasets & Analyses** | **Software Release Category** |
| **Updated 2017 Tree Species and Burn Severity Maps** | This product will provide an updated 15 m high-resolution map of the tree and vegetation species in the Santa Monica Mountains before the Woolsey Fire event. The overlaid Burn Severity Maps will show the remaining distribution patterns of vegetation after the fire and will provide guidance where restoration and management are needed. | Following the processes from the prior term, the Multiple Endmember Spectral Mixing Analysis (MESMA) method from the UCSB Viper Tool will be used to classify the AVIRIS data into specific vegetation classes (tree species). Landsat 8 OLI will be used to create burn severity maps using the Normalized Burn Ratio (NBR). UAVSAR will be used to detect burn scars based on the difference in backscatter from burned to unburned areas. | I |
| **2018 Map of Annual Climate Variables** | This product will be used to identify areas that could support newly planted woodlands in 2050 based on current precipitation and temperature patterns. | This will be a continuation product from the prior terms end product by incorporating data for 2018. Annual minimum and maximum temperature and annual precipitation will be generated from PRISM climatic data. | I |
| **Existing Conditions Map** | The map will help illustrate where oak and riparian woodlands survived both the drought and wildfires. They will be used to prioritize risk areas, examine the rate of mortality and potential causal factors, focus monitoring efforts, as well as provide guidance on where restoration is possible and management is needed. | This will be a combined product from the burn severity maps created from Landsat 8 OLI, burn scars from UAVSAR, climate variable maps from PRISM data, tree species maps created from AVIRIS, and topography from SRTM. These will be validated using data collected from individual trees in randomly selected plots distributed throughout the western Santa Monica Mountains. | N/A |
| **Predicted Suitable Woodlands Planting Sites Map** | End users will integrate this map with the conceptual framework for future forest retention and restoration that is concurrently being developed. | The high-resolution maps showing remaining oak and riparian woodlands from AVIRIS will be integrated with species distribution model results from MaxEnt with existing information on die-back and wildfire mortality (Landsat 8 OLI and UAVSAR) to identify potential sites where restoration efforts could be focused. | N/A |

***End-User Benefit*:** The RCD of the Santa Monica Mountains has a long history of leadership in establishing collaborative efforts to address resource management issues on regional and local scales. Developing the proposed end products will provide direction to the partners on a) where trees survived both drought and wildfire; b) prioritizing areas of concern to focus scarce resources for monitoring and restoration; c) allowing for more targeted education and outreach; and d) assisting managers in identifying the highest priority areas where forests could persist into the future.

**Project Timeline & Previous Related Work**

***Project Timeline:*** 3 Terms: 2017 Spring to 2019 Summer

***Multi-Term Objectives:***

* **Term 1:** 2017 Spring (California – JPL) – Santa Monica Mountains Climate
  + A variety of existing and new landscape-level datasets were compiled and integrated including topography, vegetation, and other proxies for evaluating health and condition. These were validated using data collected from individual trees in randomly selected plots distributed throughout the western Santa Monica Mountains. The partners benefited from the time series results of the Radar Vegetation Index and sought areas of greatest change as priority areas to focus their management efforts.
* **Term 2:** 2017 Fall (California – JPL) – Santa Monica Mountains Ecological Forecasting II
  + The second term of the project more closely examined the role of topography, fuel moisture, temperature, and other climate variables on the drought phase and post-rain conditions by adding the coverage for 2017. The team was able to create a high-resolution vegetation species map from AVIRIS data for 2013 and looked at LiDAR data to create fire danger maps. This study generated maps of drought effects to further constrain the impact of beetle infestation and tree diebacks in the Santa Monica Mountains. The RCD was involved in working on a local paper to showcase the findings and have used the maps to determine areas that will suffer more from future drought conditions for their management practices.
* **Term 3 (Proposed Term):** 2019 Summer (California – JPL) – Santa Monica Mountains Ecological Forecasting III
  + This project aims to show the spatial locations within the study area that would be suitable for native woodlands in the future. The partners would use this information to prioritize planting areas to bolster wildfire recovery, especially after the Woolsey Fire effects. Burn severity maps, topography, extreme temperature, and precipitation maps overlaid with the tree species map will be provided to illustrate distribution patterns and identify which trees species, if any, have remained or showed green up events during spring 2019. These tree species will then have a higher priority when planting new seedlings.

***Previous Terms:***

2017 Spring (California – JPL) – Santa Monica Mountains Climate: Using NASA Earth Observations to Determine the Extent of Drought-Related Dieback in Oak Woodlands within the Santa Monica Mountains

2017 Fall (California – JPL) – Santa Monica Mountains Ecological Forecasting II: Utilizing NASA Earth Observations to Determine Drought Dieback and Insect-related Damage in the Santa Monica Mountains, California

***Related DEVELOP Work:***

2018 Fall (California – JPL) – Mojave Desert Ecological Forecasting: Monitoring Bighorn Sheep Habitat by Assessing Vegetation, Topography, and Soil Moisture

2018 Fall (Colorado – Fort Collins) – Colorado and New Mexico Disasters: Using NASA Earth Observations to quantify tree mortality and burn severity and to inform management on Ranches and Open Lands.

2016 Summer (Idaho – Pocatello) – Eastern Idaho Disasters: Developing Fire Susceptibility Models Using Remote Sensing to Identify Wildlife Habitats in the Sagebrush-Steppe Ecosystem Threatened by Wildfires

**Notes & References:**

***Notes*:**

* Rosi Dagit will provide a variety of GIS data layers relating to current oak woodland distribution and ground level assessments.
* The National Park Service has extensive GIS layers including a fine-scale vegetation map and detailed fire history data including burn severity. The NPS has a large vegetation plot dataset from vegetation mapping and post-fire monitoring. Additionally, the Service has baseline data for cumulative impacts of drought on net primary productivity.
* California Department of Parks and Recreation can provide study sites in Malibu Creek and Topanga Creek State Parks to assist with analysis.
* Fire data reports: <http://www.fire.lacounty.gov/forestry-division/fire-weather-report/>.
* Rosi Dagit is coordinating an integration of climate modeling with researchers from UC Davis, UCLA, University of California Cooperative Extension, Southern California Coastal Water Research Project, and National Park Service. Based on how far communications go, the team may either use their climate model or use MaxEnt’s species distribution model.

***References:***

Dagit, R., Contreras, S., Dauksis, R., Spryka, A., Queally, N., Foster, K., …Chang, E. (2018). How can we save our native trees? Drought and invasive beetle impacts on wildland trees and shrublands in the Santa Monica Mountains. Resource Conservation District of the Santa Monica Mountains. Retrieved from <https://www.rcdsmm.org/wp-content/uploads/2016/04/Drought-and-Invasive-Beetle-impacts-RCDSMM-1.2.18.pdf>

Dagit, R. (2018). Drought and beetle impacts to native trees in the Santa Monica Mountains: what does the future hold? International Oak Society (conference proceedings in press).

Riaño, D., Chuvieco, E., Ustin, S., Zomer, R., Dennison, P., Roberts, D., & Salas, J. (2002). Assessment of vegetation regeneration after fire through multitemporal analysis of AVIRIS images in the Santa Monica Mountains. *Remote Sensing of Environment*, *79*(1), 60-71.

Roberts, D. A., Gardner, M., Church, R., Ustin, S., Scheer, G., & Green, R. O. (1998). Mapping chaparral in the Santa Monica Mountains using multiple endmember spectral mixture models. *Remote Sensing of Environment*, *65*(3), 267-279.

Venturas, M. D., MacKinnon, E. D., Dario, H. L., Jacobsen, A. L., Pratt, R. B., & Davis, S. D. (2016). Chaparral shrub hydraulic traits, size, and life history types relate to species mortality during California’s historic drought of 2014. *PLOS One*, *11*, e0159145.