Symposium: Managing Lands in a Changing Climate to Improve Agricultural Resilience, Food Security, and Health

September 10, 2018

GLOBAL CLIMATE ACTION SUMMIT
AFFILIATE EVENT

Posters Abstracts

From 3:00 – 7:00 PM these posters are available for viewing in the lobby of the Mondavi Center. Those authors whose names are seen in bold will be available for questions during the afternoon networking break and through the evening.

"The Effects of Climate Change on Poultry Production in California" **Sarai Acosta**, Junior Specialist with Population Health and Reproduction, School of Veterinary Medicine, UC Davis and Maurice Pitesky

With the changing climate, significant efforts have been dedicated toward understanding and planning for the effects of climate change on California's crop production. However, far less attention has been focused on adaptation to climate change for California's livestock and poultry industries. Due to the interdependencies between livestock, poultry and crops with respect to animal feed, bedding material and nitrogenous soil amendments, a better understanding of the effects of climate change on California's livestock and poultry industry is vital. For instance, changes in crop production can also affect food safety. As an example, with respect to California poultry production, the non-edible hull of rice is a common litter material used in cage free layer and broiler houses in California. Recent droughts in California have affected the states rice production and hence forced poultry farmers to recycle the rice hulls they use for each flock more often than desired. We identified a 11.08x ($p < 0.05$) increased risk of Salmonella in the poultry processing plant versus birds raised on fresh litter material when rice hulls were recycled three times versus using fresh rice hulls.

In addition, recent regulatory and consumer driven changes in husbandry and welfare practices in commercial poultry will affect productivity, welfare, food safety and poultry health as our climate continues to change. Specifically, as California shifts to more free-range and cage-free operations including aviaries, the effects of heat stress will be harder to control. Heat stress will negatively affect production variables such as feed conversion ratio and uniformity. Heat stress will also make poultry more susceptible to infectious disease causing agents including Salmonella and E.coli. Mitigation of heat stress is very hard to combat for outside and aviary housed hens, especially if these flocks are raised in in-land areas of California where poultry production is currently more common and where temperatures are predicted to increase the most in the state.

As California's climate changes it is important to fully consider how these changes will affect poultry production. In addition it is important to consider how regulatory and consumer driven husbandry and welfare practices need to consider the effects of climate change. Husbandry and welfare regulations and practices should be considered relative to climate change with a specific focus on mitigation of heat stress and continued optimization and recognition of the interdependencies between poultry production and crop production.

"The Impact of Climate Change on Food Security in Northeastern Uganda" **Laura Atukunda**, School of Public Health, University of California Berkeley

Farmers in the Northeastern part of Uganda, in particular, the Karamoja and Teso region, rely heavily on subsistence farming for their food. Rainfall is essential in this process, and with weather patterns becoming increasingly unpredictable, these regions are particularly vulnerable to the impacts of climate change. In the past, communities in this region have experienced droughts that have led to severe food shortages. I will be investigating the impact droughts and irregular rainfall patterns have had on food security and other socio-economic factors in the region. Being that agriculture is a major source of economic growth and food, climate change and variability will likely have a large effect on food availability, income, and overall quality of life in these areas.

"San Joaquin Land and Water Strategy: Exploring the Intersection of Land and Water Resources in California's San Joaquin Valley" **Justin Bodell**, California Conservation and Stewardship Program Manager, American Farmland Trust, and Serena Unger

The 25 million acres of farms and ranches in California are a critical component of the state's climate strategy. If properly protected and managed, our working lands can not only contribute to reductions in greenhouse gas emissions, but they can also capture and store atmospheric carbon. The co-benefits of this natural carbon sequestration are: higher water holding capacity and improved groundwater infiltration, soil health, increased productivity, and ecosystem resilience.

In July 2018, American Farmland Trust (AFT) released San Joaquin Land and Water Strategy: Exploring the Intersection of Land and Water Resources in California's San Joaquin Valley, the first study in California that assesses the resiliency of agriculture in relation to decreasing water availability, a changing climate, and urban growth. This report and the accompanying web-based interactive mapping tool will help planners, municipalities, and natural resource agencies support the agricultural community where it is most vulnerable.

Methods: The work was completed by analyzing the current distribution of quality agricultural land and water resources as well as the future impacts these resources face. Using the San Joaquin Valley Gateway, part of the Data Basin online mapping platform created by Conservation Biology Institute (CBI), as a baseline for current trends in water, agriculture, biodiversity, and energy, AFT and CBI created a spatial analysis reflecting how agricultural land and water resources intersect in the Valley.

Results/Conclusions: Our analysis shows that the highest-quality farmland with the most reliable water resources and the highest potential for carbon-beneficial farming is located mainly around cities, where the risk of development for non-farm uses is highest. While strides have been made by farmers to increase irrigation efficiency and improve groundwater infiltration, future water regulations and an uncertain water supply may reduce the amount of land under cultivation, effectively reducing the potential carbon sequestration benefits.

Our findings and the San Joaquin Valley Gateway (https://sjvp.databasin.org/) platform will be used as the foundation of American Farmland Trust's continued efforts to preserve the Valley's farmland and water resources. By utilizing the findings, AFT will work with local partners and willing landowners to expand innovative farming practices that conserve water and recharge groundwater supplies, utilization of agricultural conservation easements, and adoption of local policies that protect the Valley's farmland.

"Communicating the "state of the science" of key soil health practices in California" **Tom Tomich**, Director, Agricultural Sustainability Institute at UC Davis. UC Sustainable Agriculture Research and Education Program, and Kate Scow, Sonja Brodt, and Laura Crothers

Emerging movements – climate-smart agriculture, carbon farming, regenerative agriculture – share a common goal of pulling carbon out of the atmosphere and storing it in managed soils, potentially producing a wealth of benefits beyond atmospheric carbon reduction. But while there is hunger from farmers,

ranchers, policymakers and the public for information on how to develop a climate-smart agricultural system in California, the research informing these practices is being communicated in piecemeal fashion.

The Agricultural Sustainability Institute (ASI) and our partners have conducted a rich body of research on key climate change topics, including the impact of fertilizer use on greenhouse gas emissions, the potential for perennial crops to serve as carbon sinks, and the value of soil-building practices for climate adaptation and mitigation. Through a climate-change-focused communications campaign, we are building on this body of work to move the conversation of agriculture's role in climate change forward by increasing public awareness and policymaker knowledge of the "state of the science" of soil health and how it relates to climate change.

Methods: This project assembles and shares credible research on specific climate-smart agricultural practices, including their effects on soil health, carbon sequestration, greenhouse gas emissions, and soil microbial communities. This research includes new discoveries from ASI's 25-year-and-counting Russell Ranch agricultural dataset and our research and educational materials from our 32-year-old statewide Sustainable Agriculture Research and Education Program. These results will be shared through media channels and other means, including white papers, fact sheets, web and social media, and hands-on demonstrations.

Conclusions: Stewardship practices on cropland and rangeland may hold potential in some contexts in mitigating climate change and creating a more resilient food sector. The potential of these "climate smart" stewardship practices needs to be assessed and communicated.

"Smart Solar Siting on Our Nation's Agricultural Lands" **Jimmy Daukus**, Senior Program Officer, American Farmland Trust

America needs more renewable energy—smart solar siting maximizes the potential for solar energy while minimizing the impact on our most productive farmland and resilient habitat. Many U.S. states have set ambitious goals for reducing greenhouse gas (GHG) emissions and significantly increasing the generation of renewable energy. This will require dramatic increases in solar and wind energy.

These efforts create important opportunities for farmers and landowners to reduce their energy expenses and earn new income, but also pose a real and urgent threat to farmland. Flat, open farm fields, often the most productive farmland, are highly desirable for solar siting. In many parts of the country, this new pressure compounds a severe "competition for land" between housing, food production, habitat and now renewable energy. However, new research in California and Colorado is documenting that regions can more than meet their ambitious solar energy goals on marginal and developed land without sacrificing its productive farmland and sensitive wildlife habitat. AFT's Smart Solar Siting efforts address these issues and provide resources for communities, organizations, landowners, and farmers to achieve the dual goals of expanding solar energy generation while protecting farmland. Working in partnership with state and local groups, AFT helps to:

- Map the most productive, versatile, resilient agricultural land leveraging new maps from AFT's Farms Under Threat initiative
- Identify marginal lands more suitable for solar siting and analyze potential supply to achieve renewable energy goals
- Develop best practices, policies, and case studies and create a clearinghouse of information
- Train and provide technical assistance to local communities, land trusts, and individuals
- Advocate for policies to support smart solar siting at state and local levels; and
- Communicate how smart solar siting can be a win-win for farmers, renewable energy, the public, and the environment.

"Conserving Agricultural Land to Protect the Climate: The Role of Agricultural Conservation Easements in California" **Matt Dunnahoe**, Environmental Planner: GIS and Conservation Easement Monitoring, California Department of Conservation, and Shanna Atherton

Aims and results: The Sustainable Agricultural Lands Conservation Program (SALC Program) provides grant funding for conservation of agricultural land at risk of conversion to other uses. Prioritization is focused on lands in agricultural use at the highest risk of conversion in close proximity to growing communities. This poster aims to convey the progress in conserving land through agricultural conservation easements throughout the state. The map features progress over three rounds of funding and the distribution of easement projects by county with the important farmland categories. The content highlights easements as one component of a broad strategy to foster a more resilient agricultural sector. Annual SALC Program funding has increased and has been consistently oversubscribed. The Sustainable Agricultural Lands Conservation (SALC) Program complements investments made in urban areas though the purchase of agricultural conservation easements, preparation of agricultural land strategy plans and other mechanisms that result in Greenhouse Gas (GHG) reductions.

The SALC program makes investments in agricultural land conservation with revenue from the California Climate Investment (CCI) fund allocated to projects that reduce greenhouse gas emissions while providing additional benefits to California communities. CCI funds are derived from quarterly cap-and-trade auction proceeds administered by the California Air Resources Board. The Department of Conservation, Division of Land Resource Protection, works in cooperation with the Natural Resources Agency and the Strategic Growth Council to implement the program.

"A Flexible Approach to Planetary Health Education in Africa" **Marie Pelagie Elimbi Moudio**, ISA Planetary Health Ambassador, University of California Berkeley

The growing population in many African countries, coupled with the climatic and environmental changes, calls for building a generation of environmentally conscious African innovators. One key solution to this challenge could involve incorporating planetary health and sustainable design thinking incorporated in primary and secondary education curriculums.

The current educational structure in most African countries does not accommodate the insertion of new and complex learning topics such as planetary health. As such, the goal of this project is to develop short applied learning modules that provide targeted knowledge and skills in sustainability related challenges with an underlying focus of planetary health and an understanding of the earth as a connected system in which human activities affect animal and environmental systems. These 1-3 day long courses will provide more planetary health focused learning options for students. The length of these courses is chosen intentionally for easy knowledge transfer and training of future instructors and will supplement targeted gaps in educational system on the continent. At the end of each module, students will work in small teams on an idea of their design to practice the skills that they have received.

The first part of this study involves surveying educators, students and parents from African countries so as to extract information about the gaps in their various educational system on the continent. This will be done using online surveys and in person interviews with explicitly pre-defined groups. A list of country specific topics will be catalogued and used in the future to develop targeted and socially germane planetary health learning modules. In the future, these topics will be developed into learning modules with the participation of educators and students from specific countries. A free online knowledge channel will be created to store and share these learning modules.

"Comparison of the effects of two-stage drying and conventional drying in walnut quality" **Lucía Félix-Palomares**, Graduate Student, Biological and Agricultural Engineering, University of California, Davis and California Walnut Board and Commission and Irwin R. Donis- González

Walnuts (Var. Chandler) dried using a newly proposed two-stage drying process (Treatment-1), were compared to the conventional drying process (Treatment-2). This was pursued, as conventional drying

causes walnut over-drying, non-uniform moisture content (MC) distribution, negatively affects quality, and is energy intensive.

Method: Walnut samples were randomly collected from one grower over the 2016-harvesting season. For Treatment-1, 36 samples were dried in a conventional bin dryer with heated air (43°C/48-h) to ~8% MC. For Treatment-2, 36 samples were dried in a conventional bin dryer with heated air (43°C/12-h) to ~12% MC, and continued to be dried for 48-h with unheated ambient air (8-20°C/53-93% relative humidity) in a prototype dryer to ~8% MC. After dried, samples were stored at 10°C and analyzed in triplicate for MC, water activity (aw), force to crack shell and visual subjective quality. Differences between treatments were compared using Multivariate Analysis of Variance.

Results: Levels for MC and aw were significantly higher ($P<0.05$) in the two-stage drying system (MC=8±1.2%, aw= 0.7±0.1) compared to conventional drying (MC=7±1.5%, aw= 0.5±0.1), but close to appropriate levels to maintain optimal quality and safety (≤8% MC, ≤0.7 aw). There was no significant difference between treatments regarding the required force to crack sample shells (Treatment-1=113±16 $N \cdot s^{-1}$, Treatment-2=113±20 $N \cdot s^{-1}$), ($P<0.05$). Walnut visual subjective quality dried by Treatment-1 was significantly higher (7.1±1.1 quality index) ($P<0.05$) than quality of walnuts using Treatment-2 (6.5±0.8 quality index). Two-stage drying (Treatment-1) yielded walnuts with similar required force to crack, and higher visual quality than conventional drying (Treatment-2), representing advantages to walnut growers. Further improvements will be pursued to obtain walnuts with MC and aw levels below, but close to the acceptable level.

Significance: This project could yield a commercially feasible drying system that can reduce energy use, increase drying capacity and improve product quality, enhancing the competitiveness of dried food producers.

"Building a sustainable future through land stewardship networks and regenerative agriculture practices on ranches in the Sacramento and San Joaquin Valleys" **Elizabeth L. Porzig,** Senior Ecologist, Point Blue Conservation Science, and Kelly Garbach, Breanna Owens, Carrie A. Wendt, Alicia Herrera, Bonnie Eyestone, Nathan Reese, Katie Guntly, Corey Shake, Bree Schnelle, Tiffany Russell, Suzie Winquist, Alissa Fogg, Katharine Howard, Kyle Marsh, Luke Petersen, Kelly Weintraub, , Wendell Gilgert, and Geoffrey R. Geupel

We integrate scientific research and technical assistance to catalyze regional land stewardship networks among ranchers and conservation professionals in the San Joaquin and Sacramento Valleys. This applied science approach engages ranchers using a "partner biologist" model (jointly hired between the USDA Natural Resource Conservation Service, Point Blue Conservation Science) in eight counties below the state and federal poverty level, with some of the largest CalEnviroScreen underrepresented communities in the region. These agricultural communities are vulnerable to the negative effects of multiple air, water, and soil pollutants, including nitrogen runoff from fertilizers, pesticides, carbon dioxide and greenhouse gases. Ranchers are uniquely positioned to drive positive, place-based improvements in soil, air, plant, water, and wildlife habitat resources by implementing regenerative agriculture practices, such as prescribed grazing. The resulting ecosystem services of clean air, water, and healthy soil—provided by rangelands with regenerative agriculture practices—can support thriving wildlife populations as well as human health and livelihoods.

Nevertheless, there is considerable debate surrounding how to best make technical assistance accessible and scalable with respect to promoting regenerative agriculture practices, which has often resulted in barriers to adoption, especially in underrepresented, rural ranching communities. This applied scientific research bridges this critical gap in three ways, by: 1) developing a handbook to train partner biologists to engage with ranchers and ranching enterprises; 2) creating technology partnerships to present real-time data on relationships between grazing management and ecological outcomes for soil carbon; and 3) hosting workshops for ranchers, ranching enterprises, and specialists that provide technical assistance in the

ranching community. The outcomes and feedback from these three activities has prompted the next step of designing a free, open-source, web-based information clearinghouse for land stewardship and conservation in the Sacramento and San Joaquin Valleys.

"Developing resilience to climatic changes in traditional Egyptian agricultural systems" **Sara Habiba**, International Student Ambassador Program- UC Global Health institute + UC- Berkeley

Aims: The impacts of climate change on Egypt are expected to be catastrophic. A projected 1 meter sea-level rise may lead to the loss of a quarter of the Nile delta, the most fertile land that accounts for two thirds of Egypt's agriculture. Agriculture is a major contributor to the Egyptian economy; accounting for over 25% of all the jobs. However, the farming is dominated by small farms that use outdated techniques and not in compliance with internationally recognized standards.

Many agricultural practices severely threaten natural habitats and biodiversity and compromise the well-being of humans, animals, and plants. The objective of this study is to evaluate current national and international efforts for sustainable agriculture in Egypt. The goal is to identify the challenges coupled with successful approaches in engaging farmers to implement changes that improve farming practices in resilience to climate change.

Methods:

1) Review of scientific literature and publicly available data sources coupled with a review of institutional and international agriculture- related projects in Egypt that evaluate sustainability and resilience to climate change.
2) Analyze the findings and elucidate roadblocks to implementation of sustainable practices.
3) Funding to develop a questionnaire and administer to a sampling of farmers in the Nile Delta region will be sought to further evaluate problems in achieving sustainable farming practices in response to climatic impacts in the region.

Conclusion: Given the growing population with an increasing food-demand and water insecurity, many national efforts and international investments are targeting sustainable agriculture and reserving biodiversity Egypt as mitigation and adaptation strategies for climate change. However, many of the on-farm mismanagement in the Nile Delta have risen from lack of public knowledge and farmer education. Adaptive capacity depends on many socio—economic factors. The success of institutional policies depends on effective approaches of engaging the farmers. Therefore, taking advantage of low cost, accessible and attractive information instruments can be highly recommended in changing the social norm and vision of the farmers on a broader scale.

"American Farmland Trust's Farmers Combat Climate Change Initiative" **Jimmy Daukus** and Kara Heckert, American Farmland Trust

Farmers and ranchers are critical in the fight against climate change. Protecting farmland and limiting sprawling development can curb one of the largest sources of carbon emissions: transportation. In addition, farmers and ranchers manage more than one billion acres of U.S. land, which can mitigate climate change by absorbing vast amounts of carbon and locking it in the soil. American Farmland Trust's National Farmers Combat Climate Change Initiative, which is deployed is several major agricultural regions in the country, consists of 3 major strategies:

1) Protect farmland and promote smart growth to reduce emissions

2) Provide technical resources to scale up the adoption of soil health practices and carbon farming

3) Build support among the farming community and advance policies by promoting good land stewardship practices and investment in climate smart agriculture.

"Understanding Resource Integration in Smallholder Systems of Indian Sunderbans for Achieving Long-Term Farm Sustainability in Climate-Challenged Conditions" **Rupak Goswami**, Sangita Patra and Purnabha Dasgupta, Integrated Rural Development and Management Faculty Centre, Ramakrishna Mission Vivekananda Educational and Research Institute, West Bengal, India and Somen Nandi, Department of Chemical Engineering & Global HealthShare® Initiative, University of California, Davis, CA, USA"

Smallholder farms in Indian Sunderbans are characterized by resource-poor conditions, vulnerability against biotic and abiotic stresses, climatic variability and structural constraints. Since this ecologically challenged region is predominantly operated by smallholders and the prevalence of poverty is also high among them, investment in these small farms warrants inclusive growth, reduced vulnerability of farm families and rapid reduction in poverty. Sustainable intensification in smallholder system, in the context of rapidly changing climate, is thought to be a powerful and pragmatic solution to this challenge. Farmers of these regions have developed diverse resource integration strategies, often in the forms of integrated farming systems, to combat the vulnerabilities caused by climatic variations. This has especially increased abruptly after the incidence of cyclonic storm Aila that hit Sunderbans in 2009. Understanding the structure of such changed resource integrations and relating them to diverse sustainability outcomes of small farms can answer the fundamental questions such as, which resource integration works best in smallholder systems, in terms of which sustainability parameter(s) and for whom.

We propose a methodological outline to explain these compelling questions. We conceptualize farm resource integration as a network of farm components and propose to compute their whole network and node properties. We also propose a theoretical framework to assess farm sustainability in Indian Sunderbans that envisages social, economic, environmental and vulnerability dimensions of sustainability. Then, we aim to relate the network properties of the farms with their sustainability parameters for different farm types identified by multivariate statistics. This will help us identify the nature of intervention (resource integration) that works best for a given group of farms and will logically lead to informed technological interventions in climate-challenged areas.

"Anchors in Resilient Communities: Market Transformation in Northern California" **Lucia Sayre**, Western Regional Director, Healthy Food in Health Care Program, Health Care Without Harm and Lauren Poor and Tara Marchant

Anchors in Resilient Communities (ARC) is a multi-stakeholder initiative that began in 2015 with a commitment to address social determinants of health by leveraging the assets and capacities of Bay Area anchor institutions and community-based partners. ARC seeks to redirect the values, principles, and practices of anchor institutions toward investment in the regional economy. The desired result is expansion of community wealth and ownership, improved health outcomes, and strengthened capacity within low to moderate-income communities of color to be resilient in the face of climate and economic disruption. ARC is co-coordinated by Emerald Cities Collaborative and Health Care Without Harm, with representatives from Bay Area anchor institutions in the health and education sectors including Kaiser Permanente, Dignity Health and UCSF, non-profit organizations, lenders, foundations, community leaders, and government.

Methods and Results: In 2016, ARC conducted an assessment of anchor demands for products and services and community capacities that could "ramp up" to meet those demands. The assessment led to recommended opportunities to advance ARC's goals including social enterprises in local and sustainable food, clean energy, and green business. The assessment found that anchor institutions in the East Bay collectively procure goods and services totaling $6.8 billion per year. FoodService Partners (business providing meals for large healthcare facilities) is building a state-of-the-art Food Production Center in Richmond, CA through their wholly owned subsidiary company, MyCultiver. FoodService Partners shares common goals with ARC stakeholders to strengthen the local economy and build a regional food system.

ARC's role in building a robust Northern California food system is to identify, aggregate and coordinate the purchasing power, assets and capacity-building needs of regional stakeholders. This will foster:

- a stronger supply chain ecosystem of locally-owned community enterprises supporting economic development for residents,
- sustainable food production helping mitigate climate change effects and improve healthy food access and,
- growth for aggregators/processors to meet growing demand within area institutions for healthy, sustainable and local foods.

The poster highlights the: origin of ARC; assessment of demand and capacity; regional food systems project (values-focused business, mapping the foodshed, regional workforce assessment); evaluation (logic model, partnership evaluation, dashboard measuring staffing and supply chain impact); and lessons learned.

"Sowing the seeds: Farmland conservation for a general audience" **Bruce Gwynne**, Senior Environmental Scientist, California Department of Conservation, and Julia Goolsby, Graduate Fellow

At the Division of Land Resource Protection (DLRP), we protect farmland. To do so, we must find ways to communicate our sometimes complicated ideas, because our actions are part of a larger system that works to prevent impacts from development, climate change, and other threats to agricultural land. Clear and directed communication creates a common understanding between our team and collaborators. That understanding is the foundation for innovation and resilience.

The aim of this poster is to present highlights from our investigation into science communication, such as a large infographic. At the poster session, we will explain our methods of determining audiences, language, and design. The poster is grounded in real examples from the DLRP, which also comprise the results section of this poster. Furthermore, we will discuss our conclusions from our investigation, including the reasons why general audience outreach is important for an organization like the DLRP, and how our outreach methods might be more equitable.

"Promoting Soil Health and Fertility Management Innovations: Barriers, Motivations, and Enabling Conditions" **Joanna Ory**, Postdoctoral Fellow, UC Berkeley Department of Environment, Society, Policy and Management (ESPM) and Alastair Iles, PhD. Associate Professor, UC Berkeley Department ESPM, Claire Kremen, PhD. Professor, UC Berkeley Department ESPM; Tim Bowles, PhD. Assistant Professor, UC Berkeley Department of ESPM

The overall goal of the project is to increase the adoption of best management practices for soil health management in California. To achieve this goal, our objectives are to identify barriers, motivations, and enabling conditions that affect the ability of California farmers and ranchers to implement soil health management practices, including those practices that sequester carbon and have the potential to impact climate change. In particular, we will look at barriers to cover cropping, use of compost, reduced tillage, and diversified crop rotation.

The poster will present the findings from a Summer 2018 statewide survey of University of California Cooperative Extension Specialists (UCCE), county-level Resource Conservation District (RCD) advisers, and Natural Resource Conservation Service (NRCS) personnel about what trainings they offer, their perspectives on discussing climate change with farmers, and which farmer innovations they see as most valuable regarding soil health. Preliminary data analysis shows that 50% of respondents discuss climate change with the farmers they work with, with many citing that carbon is a key component to soil health and something that all growers can do to address climate change. Those respondents that do not discuss climate change cite unreceptive growers in the areas they work as the main reason it is not part of the conversation related to soil health. The agricultural professionals rated cover cropping and rotational grazing as the most important practices for building soil health. The survey also showed that the most

important barriers to adoption include low or uncertain profits for growers, high costs of maintenance, and high short-term costs of adoption. The poster will also include policy recommendations with specific recommendations for overcoming barriers for best management practices for long-term soil health and climate change.

"Investigating the effects of drought-resistant Makoni tea bush leaves extracts on Staphylococcus aureus" **Ashley Jean Sango**, University of California Global Health Institute Planetary Health Center International Student Ambassador

Nosocomial bacteria are a class of bacteria which thrive in hospital settings, being found on floors and equipment, causing hospital acquired infections. The bacteria can enter the body through open or broken skin, resulting in increased morbidity in immune compromised patients, and can be fatal for intensive-care patients.

Leaves of the drought resistant Fadogia ancylantha (Makoni tea) grown in the Eastern Highlands of Zimbabwe have been shown to exhibit antimicrobial properties in previous studies. As a bush indigenous to Southern Africa region, including Zimbabwe, it is readily accessible and could potentially be grown commercially to benefit the environment and the economy. The objective is to extract phytochemicals from the leaves of Makoni tea and to determine the antibacterial activity of the phytochemicals on S. aureus.

Using antimicrobial sensitivity tests namely: agar-disk diffusion and broth microdilution, I will investigate the effect of the Makoni Tea leaf extracts on S. aureus, and the extent of antibacterial activity is analyzed. If Makoni tea leaves exhibit antibacterial activity against S. aureus, and further research defines other bacteria or ailments it can act against, the combined health and economic benefits of the drought resistant bush can reduce deforestation rates in places beyond where it is indigenous, whilst simultaneously lowering the cost of healthcare for people who cannot financially access drugs.

"Resilient Greens: Nutrition, Toxicology, and Availability of Edible Weeds in the East Bay" **Daphne Miller**, School of Public Health, University of California Berkeley, and Philip B. Stark, Thomas J. Carlson, and Kristen Rasmussende Vasquez

Foraged leafy greens are consumed around the globe, including in urban areas, and may play a larger role when food is scarce. Due to evolutionary selection, edible weeds thrive in places where humans disrupt the soil and they are more tolerant of environmental extremes than most commercial crops. Climate change may select for weeds and for herbicide-resistant weeds. It is thus important to assess the safety and nutritional value of wild greens foraged in urban environments.

Methods: Field observations, soil tests, and nutritional and toxicology tests on plant tissue were conducted for three sites, each roughly 9 square blocks, in disadvantaged neighborhoods in the East San Francisco Bay Area in 2014–2015. The sites included mixed-use areas and areas with high vehicle traffic.

Results: Edible wild greens were abundant, even during record droughts. Soil at some survey sites had elevated concentrations of lead and cadmium, but tissue tests suggest that rinsed greens are safe to eat. Daily consumption of standard servings comprise less than the EPA reference doses of lead, cadmium, and other heavy metals. Pesticides, glyphosate, and PCBs were below detection limits. The nutrient density of 6 abundant species compared favorably to that of the most nutritious domesticated leafy greens.

Conclusions: Wild edible greens harvested in industrial, mixed-use, and high-traffic urban areas in the San Francisco East Bay area are abundant and highly nutritious. Even grown in soils with elevated levels of heavy metals, many species are safe to eat after they have been rinsed in cold water. They could contribute to nutrition, food security, and sustainability in urban ecosystems in a changing climate.

"Quantifying impacts of developments in a changing climate: Case study of Botswana mines" **Mokganedi Tatlhego**, PhD Student, University of California Berkeley

Land cover and land use change that accompanies large scale economic developments in developing countries has raised debates on the health, sustainability and future of natural systems in these environments. In Botswana, mining remains the main source of national income and with the recent growth of the mining industry, and a desperate need for sustainable intensification, quantifiable assessments of environmental impacts are essential for future land management and decision making. Although previous studies have demonstrated trends of effects of mining with age and intensity, it remains unclear how we can quantify contribution of mining to environmental health in the face of a combination of climate change.

Aim: The aim of this investigation is to determine the impact of mining on the environment in a semi-arid region of Botswana, taking in consideration the existing changes brought by climate change.

Methods: I employ satellite imagery analyses to neighboring regions in Botswana, Damtshaa with an open pit diamond mine and subsistence farmers, and Mokoboxane with no mining and subsistence farming. Assuming similar, soil, natural vegetation and geological settings and topography, I determined land cover and land use changes before 10 years Damtshaa mine began until 10 years after it was fully functional, at five-year intervals.

Results: Under both scenarios the greatest change in vegetation was clearing due to constructions of buildings, roads or enclosures, leading to an increase in bare ground and reflective surfaces. A significant loss of vegetation and ecosystem services around mining region is due to a change from natural to built-up areas, while in the control region vegetation mostly changes from grasslands/forests to shrubs. The results of this investigation depict that the complexity of how land is employed in rural Botswana settings introduces a challenge of quantifying impact of climate change alone, or that of a certain land use type. Here a distinction of impacts of a combination of climate change, mining and mixed subsistence farming in Damtshaa is noticeable from that of a combination of mixed farming and climate change in Mokoboxane. Future work should introduce a region devoid of any anthropogenic land use, or a simulation of what one would be like.

"Urban agriculture, food security and health - A Case Study of Dar es Salaam, Tanzania" **Kwinoja Kapiteni**, MPH Candidate, University of California Berkeley and Baraka Kalangahe, Japhet Killewo, Sophia Papageorgiou, Paige Passano

Introduction: Dar es Salaam city - located along the coastal region of Tanzania - is experiencing rapid urbanization, with average annual population growth rate of 5%. The available resources are not sufficient to support the increasing demands, and therefore problems such as fresh water scarcity, water pollution and food insecurity have become chronic. Dar es Salaam is situated within coastal plains, which experience extreme flooding during the rainy seasons (March to May and October to December). The flooding and high salinity levels of the soil render the city unsuitable for intensive agriculture. However, to meet food demands of the growing population, urban agriculture is becoming increasingly popular. Although urban farming is a promising strategy to improve food security and nutrition, the practices and techniques currently utilized are unsustainable and potentially damaging to the environment and human health.

Aims: The two aims of this study are 1) To discuss the effects of rapid urbanization on food security and environment of Dar es Salaam region 2) To describe the impact of current urban farming practices on coastal environment and health of Dar es Salaam residents

Methods: The study will utilize a mixed methods approach. Urban farmers in the city will be identified and selected through their Savings and Credit Cooperatives. Surveys, focus groups discussions and in-depth interviews will be administered to gather information on farming practices such as land use, sources of water, fertilizer/manure application, level & frequency of production, and crops diversity. Food security and health data will be obtained from the Dar es Salaam Health and Demographic Surveillance System Database.

Conclusion: Use the gathered data to propose sustainable urban farming practices and recommendations for managing urbanization

"Effects of dormant drought stress on Prunis dulcis bloom; or, what if it doesn't rain in the winter? **Michael Rawls**, Masters student, Department of Plant Sciences, Horticulture and Agronomy graduate group, UC Davis, and Kenneth Shackel and Jiong Fei

Little is known about the effects of dormant drought stress in tree crops. With the recent California droughts extending through winter dormancy the need to investigate this in order to be prepared has become apparent. If irrigation during dormancy is found to be unnecessary, water could be saved, and if irrigation if found to be beneficial, yield could be increased. Almonds are a major crop in California where about 80% of the world's almonds are produced and research there has provided substantial knowledge about the effects of drought stress on almonds during the growing season. Extending the research into the dormant period would allow for a more complete understanding of drought effects in almond production in order to improve irrigation management and increase water use efficiency "crop per drop". Due to rainfall, winter drought stress experiments in the field can be an unreliable. Therefore a potted tree experiment was undertaken. Four year old Nonpareil Almond trees (Prunis dulcis) were subjected to six different treatments (n=5) of two drought stress levels, medium and high, and three durations, along with an unstressed control group (n=5). Drought stress was quantified using stem water potential (SWP) measurements on one year old twigs. Because winter transpiration is very low, a cover crop was grown in the pots to ensure a drought stress was established, then when the desired drought stress level was achieved, the cover crop was cut and a covered structure was used to maintain the stress by excluding precipitation. Levels of SWP were around -3 bars for the controls, -10 bars for the medium, and -20 bars for the high stress.

Two years of data indicate that dormant drought stress can cause a delay in bloom. A range of one month in first bloom dates was observed and were statistically significant ($p<0.0001$) with the level and duration of drought stress. However, leaf out dates were not affected. These results potentially have large implications for orchard management practices and will be studied further.

"Resource Conservation District Carbon Farming as part of the solution" **Kristen Murphy**, Project Coordinator, CA Association of Resource Conservation Districts

Aims: To educate and promote carbon farming; to widen partner and producer network

The Resource Conservation Districts (RCDs) in the State of California help address pressing statewide issues like climate change, reducing the impact of the drought, protecting water, creating habitat for fish and wildlife, restoring critical habitat for endangered and threatened species, reducing the risk of catastrophic fire, and improving soil health on natural and working lands. RCDs get conservation done on the ground and are dedicated to being an active part of the solution. Carbon Farming (CF) involves implementing practices known to improve the rate at which CO2 is removed from the atmosphere and converted to plant material and/or soil organic matter. Carbon farming is successful when carbon sequestration resulting from enhanced land management and/or conservation practices exceed carbon emitting.

Methods: The Carbon Cycle Institute (CCI), working with Marin RCD and NRCS, has developed the process to develop Carbon Farm Plans, including planning and resource assessment approaches. A set of online tools (COMET) developed by researchers at Colorado State University and NRCS guides the process of developing a Carbon Farm Plan and allows the quantification of GHG benefits. Carbon Farm Plans (CFPs), begin with the CCI and RCDs working with a farmer or rancher to assess all the on-farm opportunities to reduce GHGs and sequester carbon, while enhancing climate change resiliency and wildlife habitat. Land management within this framework leads to enhanced rates of photosynthetic carbon capture through practices such as riparian restoration, hedgerows, and windbreaks that increase the provision of important ecosystem services including improved wildlife habitat and water, and thus increasing climate resilience in agricultural lands.

Results/Conclusion: To date, 36 carbon plans have been completed, covering 34,855 acres in 10 counties across California. When these plans have funding to be implemented, these projects will sequester an average of 0.79 Mg CO2e per acre per year, totaling up to 330,425.4 Mg CO2e by 2030. The RCDs have just begun their outreach and are only at the beginning of broaching the full potential of carbon sequestration on natural and working lands across the State. Because the carbon farm planning process is broadly conceptual rather than prescriptive, we anticipate an iterative dialogue with growers and foresters that creates ongoing innovation and novel approaches to the process as we move forward with scaling the work.

"The Policy Enabling Environment for Climate Smart Agriculture: A Case Study of California"

Jessica Rudnick, PhD Candidate, University of California Davis, Dept. of Environmental Science and Policy, and Josette Lewis

Climate smart agriculture (CSA) provides a framework for balancing multiple dimensions of agriculture and food systems in an era of climate change: agricultural contributions to global greenhouse gas (GHG) emissions, vulnerabilities to climate change impacts, and the relationship between agricultural productivity, incomes and food security. As the global climate agenda grows around CSA, the framing often searchers for "triple wins" – practices that can mitigate emissions, increase resilience or adaptation, and increase productivity; however, in many cases, there are necessary trade-offs among these three objectives. Thus, the challenges to implementing CSA lie in the prioritization or reconciliation among these three objectives and their translation into coherent policies across multiple sectors and agencies or ministries.

This paper describes California's adoption of CSA principles to illustrate how synergies and trade-offs are addressed in a policy framework that spans regulatory measures, incentive programs, research and technology development that is both climate specific and arising from other environmental and economic priorities. California's framework is anchored in a commitment to reduce GHG emissions by 40 percent of 1990 levels by 2030. With its Mediterranean climate, management of competition for scarce water resources also plays a strong role in the State's CSA strategy. Here we discuss how the policy framework has evolved and provide specific examples where agriculture has benefited and where it is constrained due to the balancing of CSA objectives.

This case serves to summarize the evolution of implemented CSA initiatives in one of most productive and well-resourced agricultural regions of the world, however lessons learned and strategies for continued work will be useful as transferable knowledge for many regions around the globe developing CSA policies and plans. California's participation in international efforts on climate change and agricultural innovation further highlights the importance of sharing the State's best practices and lessons learned in the process of integrating agriculture into its climate action framework.

"County-Level Economic Risk Assessment of California Wildfires on Livestock Production"

Kathleen O'Hara, DVM, MPVM, Graduate Student, Center for Animal Disease Modeling and Surveillance, School of Veterinary Medicine, University of California, Davis, and Matthew Shapero, Rebecca Ozeran, Stephanie Larson, Sheila Barry, Josh Davy, Max Moritz, Luke Macaulay, Beatriz Martínez-López

Wildfire is a growing concern worldwide, as climate change is anticipated to increase wildfire frequency and intensity. California experiences thousands of wildfires each year, resulting in thousands of acres burned and millions of dollars of damage. The specific impact these fires have on the livestock industry has not been assessed. This economic risk assessment aimed to provide a county level assessment of the risk of fire, the risk of cattle farms being affected by fire, and the expected losses in burned acreage and dollar damage if a fire were to occur. Probability of at least one fire, and probability of at least one cattle farm being impacted by a fire, were calculated based on historic incidence of fire, and fire overlap with known cattle farm locations from 2008-2016. The range of acres burned and dollar damage in each county were modeled using Pert distributions of historic fire data. These data were then used to perform a serial rank-

ordering of California counties by highest probability of fire, highest median dollar damage, highest median acreage burned, and highest probability of a farm being affected by a fire, respectively.

Based on this analysis, Santa Barbara, Placer, and Los Angeles counties are ranked at highest risk for a fire with high economic losses. Kern, Butte, Los Angeles, Riverside and Shasta, have the highest probability of a farm being affected by fire. These data provide the foundations and target areas to conduct more in-depth economic analyses and objective information on which to base future funding decisions for fire response and indemnity resource allocation.

"Modeling of air temperature to elucidate future plant phenology via the deterministic fractal geometric approach" **Mahesh L. Maskey,** PhD Candidate, Department of Land, Air and Water Resources, University of California, Davis and Tapan B. Pathak, Daniele Zaccaria, Carlos E. Puente, Laura Foglia

While temperature is one of the paramount attribute in understanding climate change that has been impacting on environment and ecosystems, past researchers have made several efforts on modelling temperature records. To overcome the inherent limitation, this research establishes a novel approach to model the temperature set using the fractal–multifractal (FM), a deterministic geometric approach, which has been found successful in describing, simulating and downscaling rainfall and streamflow records gathered daily over a year. This study, concentrating on air temperature set, focuses on encoding and downscaling 115 years of such sets gathered near Sacramento and employing at most 7 geometric parameters. Results show that both encodings and downscales of air temperature via the FM method are possible, with accumulated errors that are less than merely 1% on the average, for both applications.

Given the remarkable success on mining information, successive geometric parameters over the available consecutive years were used to provide temperature predictions, one-year ahead, via: (a) statistical time series models, (b) neural networks, and (c) conventional Markov matrices, based on geometrical information from the past. As found in previous studies for streamflow, this study also reveals that the FM approach can produce reasonable forecasts that not only capture the accumulated temperature sets but also preserve statistical attributes as well as the overall "texture" of the records.

This study not only validates geometry of temperature set based on past FM information as a prediction but also make sure different stages of plant phenology or pest cycle in terms of growing degree days which are useful information in climate studies and agriculture management.