Academic year in review, 2023-2024

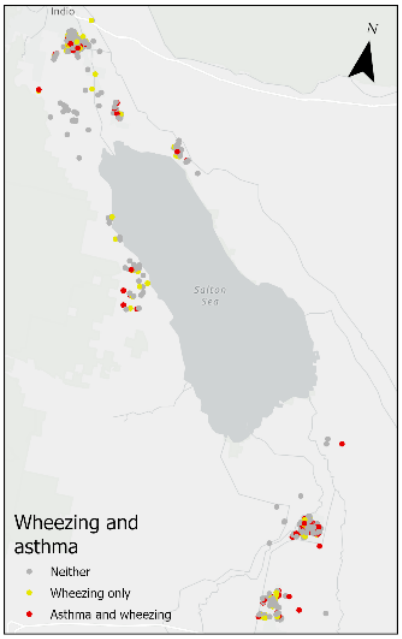
Research

The Center for Geospatial Sciences promotes cross-disciplinary work and aims to leverage geocomputational and geoinformatics methodologies to solve problems, enhance decision-making, and improve public policy. We work with various stakeholders and research groups within the UC system, the United States, and Internationally, along with numerous government agencies and private companies. The following short report highlights a handful of successes and active collaborations for CGS for the 2023-2024 academic year.

1. NSF D-ISN: TRACK 1: A Holistic Approach to Discovery, Modeling, and Interdiction of Drug and Human Trafficking Networks in the U.S. Southwest

This project ($1m) employs a multi-scale geocomputational approach that analyzes and develops macro- and micro-level interventions for discovering and interdicting illicit networks. This project enhances national public safety, health, and welfare by improving our understanding of drug and sex trafficking networks, detecting their operational patterns, and developing mechanisms to disrupt their activities. We include rigorous fieldwork with detectives, survivors, and analysis methods from social sciences, operations research, computer science, and information science. The structured data repository resulting from this project will be publicly available to the research community. We actively collaborate with the Las Vegas, San Diego, Phoenix, and Honolulu Police Departments in this project, and last year, we produced two manuscripts that are currently under review (*Transactions in GIS*; *IISE Transactions*).

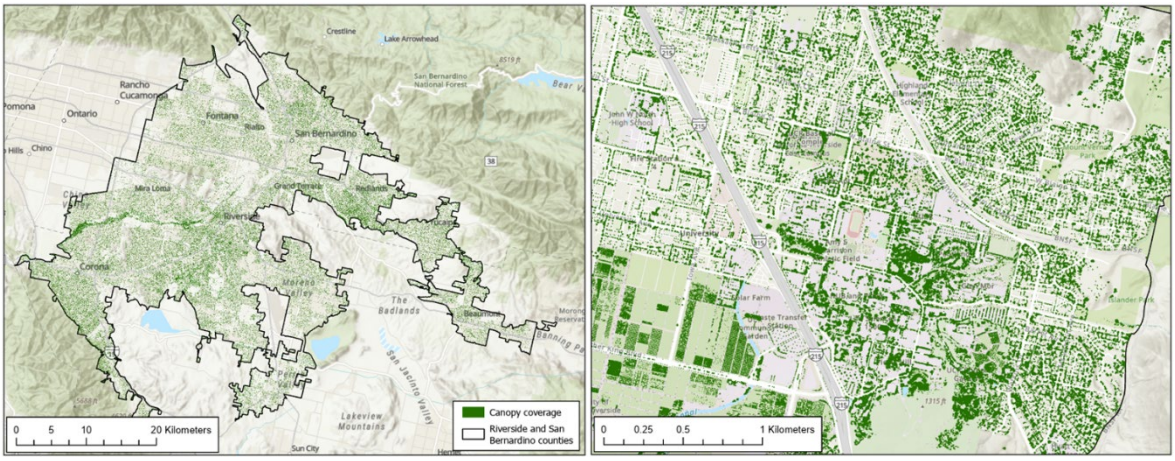
2. *Asthma incidence rates among the population living near the Salton Sea*



For this project, David Lo (Director, BREATHE Center) contacted CGS to perform subcontract work ($37.7k) to assist in developing and deploying geospatial models designed to determine the potential environmental causes of asthma incidence patterns among Californians who live near the Salton Sea. The methodological framework introduced by the CGS provides empirical support for the hypothesized mechanical pathway of fertilizer runoff leading to bacterial growth and the subsequent production of airborne toxins. Specifically, our findings indicate that the strongest physical factor linked to asthma incidence rates is the predominant wind direction and strength above and near the Salton Sea – the wind carries those bacterial toxins from the Salton Sea to communities located southeast of the Sea. This ongoing project has resulted in the submission of one manuscript (*Environmental Health Perspectives*).

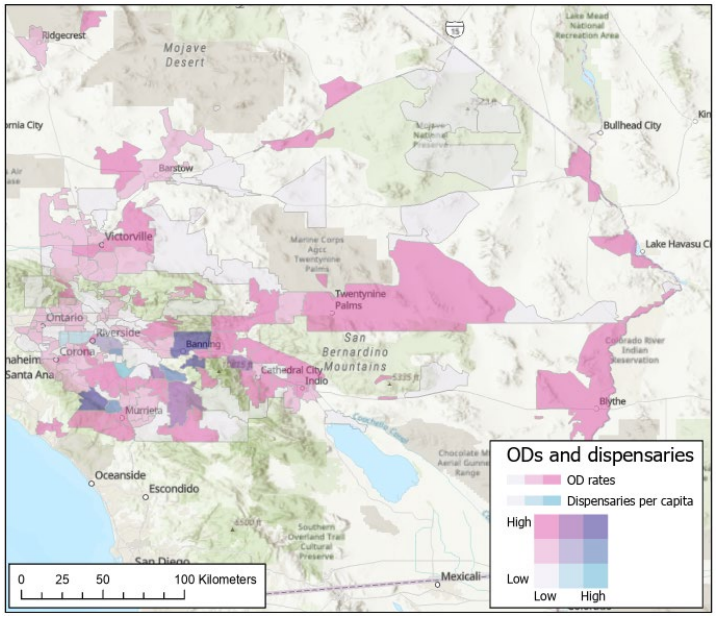
3. The relationship between socioeconomic status, heat, and canopy cover

Chikako Takeshita, Associate Professor of Gender and Sexuality Studies, also contacted CGS to perform subcontract work ($10k) for her OASIS award, "Heated Experiences: Building Climate Resiliency in Inland Southern California." Specifically, Dr. Takeshita was interested in constructing a spatial data warehouse to investigate the geographic distribution of tree cover throughout Riverside and San Bernardino, along with the relationship between canopy cover, street-level



temperature, and population demographics. Our findings helped shed light on some of the spatial inequalities faced by poorer residents of Riverside and San Bernardino, with many of those households experiencing dramatically higher local temperatures in their day-to-day activities. Our work helped inform a new course developed and taught by Dr. Takeshita, *GSST171: Environmental Health and Social Justice*.

4. Do cannabis dispensaries and opiate overdoses exhibit a spatial relationship?



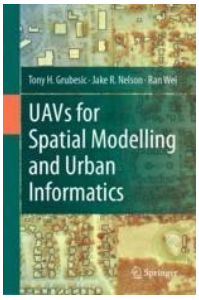
Dr. Christopher Fichtner, UCR's Chair of Psychiatry and Neuroscience, subcontracted ($8k) with CGS with OASIS funding to help his team investigate whether the presence of cannabis dispensaries in neighborhoods of the Inland Empire exhibited any spatial relationship with opiate overdoses. Our findings suggest that the effects of dispensaries on overdoses were likely hyperlocal. This work has resulted in one publication and a presentation of our results at the American Psychiatric Association Annual Meeting. Our investigation and work with Dr. Fichtner will continue into 2024-2025.

5. Equity, Sustainability, and Community Engagement in AI-Integrated Disaster Management

This large award ($250k) from the UCR OASIS program (PI Basak Guler and Co-PIs Hamed Mohsenian-Rad, Tony H. Grubesic, and Ran Wei) explores Artificial Intelligence (AI)'s role in disaster management, including climate change intensified disasters, is becoming increasingly more significant. It has critical applications in damage assessment, crowdsourcing, prediction, planning, and preparedness. However, to successfully utilize AI for emergency and disaster management, it is crucial to develop holistic response strategies that address the priorities and needs of the communities. Customized or tailored tactics are necessary to align resource allocations with local needs while considering existing neighborhood capacities, resilience, and the utility of the AI-integrated decision-making process.

The project aims to tackle these critical social and environmental challenges, informing the roadmap and decision-making infrastructure to achieve equity, sustainability, and community engagement in AI-integrated disaster management for common climate-exacerbated natural disasters. The proposed research contributes to the horizontal goals of OASIS in sustainability, innovation, and social inclusion. It will establish the foundation of sustainable AI in disaster management (sustainability), develop the algorithmic principles of AI-integrated disaster management for fairness and sustainability (innovation), and enhance the quality of service, community engagement, and representation of under-represented and underserved communities in data-driven systems (social inclusion). Furthermore, the research contributes to the vertical goal of OASIS in sustainable transportation and infrastructure. It addresses sustainability in logistics for disaster management and critical infrastructure hardening, such as the energy infrastructure, and examines its impact on AI-driven computations. We are developing a new manuscript during the summer of 2024 to provide our deliverable to the project.

6. UAVs for Spatial Modeling and Urban Informatics



After three years of work, CGS researchers Tony H. Grubesic and Ran Wei (along with Jake Nelson from Auburn University) released their book *UAVs for Spatial Modeling and Urban Informatics*. This book aims to provide a wide range of real-world applications in using unmanned aerial vehicles (UAVs) for geographic observation, spatial modeling, and urban informatics. Specifically, UAVs are incredibly effective platforms for connecting people, places, and technology. This book explores the utility of UAVs for monitoring, measuring, and improving urban infrastructure systems, urban sustainability, and the urban environment. The dynamism of cities provides opportunities for economic, social, and environmental change, but benchmarking and measuring cities continues to be challenging. This challenge is due, at least in part, to a lack of monitoring systems that can collect and analyze data at a granular enough scale to capture the nuance of local phenomena. UAVs offer a promising mechanism to fill this niche, serving as a measurement platform that can rapidly and inexpensively collect data and monitor change in cities. However, their use is fraught with social, operational, regulatory, and technical challenges for successful deployments. We provide six unique applications of UAVs for urban analysis, detailing relevant policy and empirical questions, UAV mission parameters, data collection, spatial modeling, and the associated empirical results. Further, we discuss how best to integrate these results into actionable geospatial intelligence and policy development to improve city infrastructure systems, sustainability, the environment, and neighborhood quality.

7. Additional Funded CGS Research Projects

a) *Spatiotemporal Models to Evaluate the Potential Value of Sterile Insect Technique (SIT) for Control of Navel Orangeworm (NOW).*

The California Pistachio Research Board and California Almond Research Board are funding this project to develop spatiotemporal agent-based models to explore multiple scenarios for using sterile insect techniques in tree nuts.

b) *Health Equity in Emergency Trauma Care: Analysis of disparities in the pre-hospital emergency trauma care system.*

The National Institute of Child Health and Human Development is funding research that uses geospatial analysis and predictive models to socio-spatial disparities in availability and access to both EMS and trauma centers among critically injured trauma patients and developing predictive models to evaluate the effect of rapid transport by EMS and timely access to trauma center on outcomes.

c) *Risk Prediction and Optimizing Outcomes to 1-year after Firearm Injury Among Children using Emergency Services in the United States.*

The National Institute of Child Health & Human Development is sponsoring research for using three national cohorts of children 0 to 17 years requiring emergency services and employing machine learning and geospatial analysis to develop and validate risk prediction models for firearm injury and short-term mortality using individual-, home-, incident-, and county-level factors.

Events and teaching

CGS engages in several outreach activities each year as well, including the following:

- An annual presentation of ongoing CGS research at UCR's Geospatial Meetup.
- Drone demonstration for graduate students in Mapping for the Common Good (PBPL 255).
- Joint activities and scholarship with the student GIS club.
- Research presentations at the North American Regional Science Association Annual Meeting and the Association of American Geographers Annual Meeting.

CGS faculty teach a suite of geospatial and geoinformatics classes, and this year was no exception, with the following classes:

- PBPL 010 – Introduction to Geographic Information Systems
- PBPL 180 – Urban Informatics for Public Policy
- PBPL 255 – Mapping for the Common Good
- PBPL 273 – GIS and Public Policy

- Our CGS team is developing a curriculum for the Spatial Data Science and Public Policy Major/Major. UCOnline is funding a large portion of this work ($140k).

Forecasted activities for the 2024-2025 academic year

Many of the CGS research projects will likely continue through Autumn 2024 and Spring 2025. In addition, CGS is resubmitting one large NSF (Law and Science) proposal in August and completing work on another (NSF) that aims to examine STEM educational opportunity access and its potential inequities in U.S. high schools. In addition, the Abundance Policy Research Consortium, a research group organized by UC Berkeley, appointed CGS Associate Director Edward Helderop as the digital connectivity expert to develop empirically informed policy recommendations for California. This appointment included a research award of $40k to Eddie and the CGS team.