USC Dornsife
Dana and David Dornsife
College of Letters, Arts and Sciences
Spatial Sciences Institute

As of June 4, 2021

The USC Spatial Sciences Institute (SSI) is now accepting applications for undergraduate student researchers to work with SSI faculty on their research projects for the 2021-2022 academic year.

We seek USC students who have excellent academic records, show interest in participating in cutting-edge research projects at SSI, and are eager to take advantage of the opportunity to work directly with faculty on their research projects.

Priority will be given to SSI students (Dornsife minors in GIS and Sustainability Science, Human Security and Geospatial Intelligence, and Spatial Studies, and majors in GeoDesign, Global Geodesign, and Human Security and Geospatial Intelligence). However, applications from all majors, minors, and academic programs throughout the University are encouraged. Students of all class standing (including incoming freshmen or transfer students) are welcome to apply. Applicants must be enrolled as full-time USC students in good standing during the research semesters.

The projects generally are structured for an average of 5 – 10 hours/week. **Accepted students will work out their specific work schedules for the semester with the supervising faculty or staff member and will be expected to honor the weekly time commitment for the duration of the semester.**

SSI student researchers are expected to submit their research work for presentation. Venues for presentations include such the SSI's Los Angeles Geospatial Summit on February 25, 2022 at the USC Hotel; the USC SCymposium in April on the USC campus; and the Map Gallery of the Esri User Conference held in July in San Diego. Students also are encouraged to submit their work to appropriate student research competitions, such as the 2022 USC Esri Innovation Program Student of the Year Competition and the annual United State Geospatial Intelligence Foundation GEOINT Symposium.

Past student researchers have presented their results at international conferences such as the Annual Meeting of the American Association of Geographers, the GIS-Pro Conference of URISA, and the AMC SIGSPATIAL conference, and have co-authored published research.

To apply

Please provide:

- A resume which includes your name, contact information, major/minor, year in school, software and programming language competencies, and relevant course projects/skills;
- A current STARS report (not required for a new incoming student); and
- A statement of interest indicating the project(s) for which you are applying. You may apply for more than one project; please indicate the priority of your preferences. If selected, you will be selected for one project only.

Please email your complete application materials to Susan Kamei, Spatial Sciences Institute Managing Director, at kamei@usc.edu, by **5:00 p.m., Friday, July 16, 2021**.

Students selected by the faculty will be notified by the end of July so the research teams can be organized by the start of the Fall 2021 semester.

Questions?

Please email Susan Kamei or Ken Watson, Spatial Sciences Institute Academic Programs Director.

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Data-Driven Equitable Earthquake Relief Planning in Demographically Diverse L.A. County

Orhun Aydin, Ph.D., Lecturer of Spatial Sciences, Spatial Sciences Institute

Project Description

This project focuses on developing a data-driven plan for allocating resources for post-earthquake services required by the population of L.A., ranging from search-and-rescue missions hours to post-earthquake shelters (temporary housing). This work addresses the research question: “What is the impact of heterogeneous socioeconomic groups of L.A. on post-earthquake resource allocation”?

The imminent geologic hazard facing L.A. County is caused by earthquakes that originate from California's terrestrial fault lines (Allen et al., 1995). Destructive faults surround the entire county geographically and cause loss of life and property damage for 10 million residents in the county. Impactsof an earthquake on a population have varying spatial and temporal span, ranging from local impacts that occur where residents are during the earthquake, such as loss of life, to medium spatial (10s of miles) and temporal range (days) impacts such as local disruptions to

road, water and power network, and impacts that span a long time (weeks or months) for the entire county such as loss of property. This project will develop data-driven plans for resource allocation, posing the multi-scale post-earthquake needs as a generalized resource allocation system at the census block level.

The main research question will be answered in three stages that comprise of the following sub-research questions:

(1) Where are the people likely to be during an earthquake?
(2) What are the sociodemographics of most impacted neighborhoods?
(3) Where are the service areas for the L.A. population in the short, mid, and long term?

Data Collection, Curation, and Wrangling

This multidisciplinary project requires collecting data from numerous sources. Undergraduate students will learn how to interact with databases to gather data.

Critical Thinking and Interacting with the Group

Undergraduate researchers will be interacting withother members of the research group. They are expected to attend weekly virtual research meetings and partake in group discussions. Undergraduate researchers are expected to take ownership of the data collection and numerical modeling tasks assigned to them and work with graduate researchers to integrate their work into the overarching workflow.

Numerical Modeling and Coding

Students will be working on enhancing and diagnosing a state-of-the-art spatial partitioning algorithm. For undergraduate students interested in growing in the spatial data science area, code development tasks will be assigned. They will grow their spatial statistics and coding skills by contributing code to the zone generator under my supervision.

Presentations and Integrative Group Activities

Students will be presenting their results in relevant conferences such as the yearly Association of Environmental and Engineering Geologists (A.E.G.) Conference or the American Geophysical Union (AGU) Fall Meeting. Students will work on their technicalpresentation skills and get feedback and support from me for presenting at these conferences.

Process and Criteria for Selecting Researchers

Students interested in social justice, spatial sciences, and data science are encouraged to apply. Once a student applies, the following process will take place:

(1) Evaluation of the CV and statement of interest
(2) If the student is a fit, a short phone call about project scope and their interest
(3) If both sides are interested, attending a weekly research meeting and getting introduced to team members.

Criteria for Student's CV and Research Statement

(1) Technical strengths of the student in either: data collection, programming, social justice, GIS, or computer science
(2) Student understanding of projectgoals and specific tasks required
(3) Clarity and quality of the statement of interest
(4) The overlap between student's goals and project deliverables.

Criteria for phone the phone interview with the student
(1) Willingness to work in a team setup
(2) The time that student can allocate for this project
(3) Willingness to learn topics that they do not know
(4) Interest in spatial science and programming
(5) Interest in multidisciplinary work that extendsbeyond their discipline.

Integrative and Group Activities
Students will be encouraged to present their findings, work in conference presentations, and authorize peer-reviewed journal papers. I will be mentoring undergraduate students in the preparation and delivery of technical presentations.

Past examples of undergraduate student integrative activities are:

Sosa, J. and Aydin, O. Preparing for the Big One: Data-Driven Spatio-Temporal Risk Maps for EarthquakeEvacuation in L.A. County. Link to Event

Gu, Y., Aydin, O., & **Sosa, J.** (2021). Quantifying the Impact of a Tsunami on Data-Driven Earthquake Relief Zone Planning in Los Angeles County via Multivariate Spatial Optimization. Geosciences, 11(2), 99.

Gu, Y., Sosa, J., & Aydin, O. (2020, December). Democratizing Safety during an Earthquake: Multidisciplinary Spatial Optimization for Defining Evacuation Centers with Fair Access in L.A.

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Data Wrangling for Resiliency Planning, Asset Management, and Other Applications

Laura C. Loyola, Ph.D., Assistant Professor (Teaching), Spatial Sciences Institute

Project Description
The redesignation of the Capital Construction Development and Facilities Management Services to Facilities Planning and Management (FPM)[1] offers the ideal time for a student researcher to focus on the importance of data wrangling in support of data-driven decisions for resilient planning, asset management, and other applications. The importance of utilizing spatial data and geographic information systems (GIS) for sustainable and resilient planning has been recognized

[1] USC announces Facilities Planning and Management. See: https://employees.usc.edu/announcing-facilities-planning-and-management/

by planners and real estate developers alike, as well municipalities[2]. While the utility of GIS for asset management is also acknowledged in various locales and for a variety of asset types[3,4], the ability to exploit geospatial technologies relies on geospatial data that are prepared for integration and analysis. Therefore, this research project will focus on the data wrangling that can be executed on various data prior to integration for a specific outcome.

The collaboration between the Dornsife Spatial Sciences Institute (SSI) and the Office of Sustainability (OoS) with FPM provides the necessary partnerships and access to "raw" data through which the student researcher can experience and work through data wrangling for a variety of applications.

Data wrangling, a key skill for data scientists and GIS analysts, is the process of transforming data for the "raw" form into another format that is appropriate for use and integration for a variety of purposes[5]; the goals of which are to provide accurate, actionable data in a timely manner to drive better decision-making[6]. During this process data may be aggregated or parsed, transformed into different data types or structures, and stored for later use. At the culmination of data wrangling, data quality and fitness-for-use are ensured prior to integration for analysis and modeling.

The data for this project are to be shared by FPM to SSI and OoS for research and incorporation into the USC Sustainability Map project (project co-leads the Office of Sustainability and Drs. Laura Loyola and Elisabeth Sedano of the Spatial Sciences Institute). However, the student researcher will specifically focus on data wrangling, with deliverables able to be incorporated into the Sustainability Map, as well as be utilized by FPM and OoS for resilient planning or asset management.

This research project aims to support diverse planning and management needs of USC and the OoS, while providing a student researcher the prospect of working with various USC entities and data specific to the USC campuses and surrounding areas.

Role of Undergraduate Researcher

Six specific recommended data wrangling steps[7] are listed below, with a brief description of how the student researcher will undertake each:

(1) Data Discovery: Since different data are structured and organized in different ways, the first step is to work with a domain expert to become familiar with the data. The student

[2] For example, see Meerow S. and J.P. Newell. (2017. Spatial planning for multifunction green infrastructure: Growing resilience in Detriot. *Landscape and Urban Planning.* 159 (March): 62-75.

[3] See: Makar, C. 2016. Using GIS and asset management to understand hydrant damages and required maintenance. GIST MS Thesis. University of Southern California.

[4] Esri. Best Practice Asset Management https://www.esri.com/en-us/landing-page/industry/electric-and-gas/2019/asset-management-landing-page

[5] ODSC – Open Data Science. 2018. Top data wrangling skills required for data scientists. (September 27). https://medium.com/@ODSC/top-data-wrangling-skills-required-for-data-scientists-8a6b7dc604a7

[6] As highlighted in the Goals of Data Wrangling by Altair https://www.altair.com/what-is-data-wrangling/

[7] ODSC – Open Data Science. 2018. Top data wrangling skills required for data scientists. (September 27). https://medium.com/@ODSC/top-data-wrangling-skills-required-for-data-scientists-8a6b7dc604a7

researcher will work with the FPM GIS Program Assistant to determine data structure and any needs for asset management. We will also work with OoS regarding data needs for resilient planning.

(2) Structuring: Entails organizing the data. This will be done based on the needs defined in the first step and in conjunction with the SSI and OoS.

(3) Cleaning: Includes, but is not limited to, ensuring data are uniformly formatted (for example all dates and addresses associated with the data are formatted in the same way), missing data are acquired or interpolated, geolocations of all data are accurate, etc. This step is likely to be the most time-consuming and all transformations of data will be closely documented to be included in the metadata.

(4) Enriching: For geospatial data this may include geocoding locations that are provided as addresses once the initial cleaning of the data is done.

(5) Validating: Assures data consistency through the use of spatial data quality parameters and further examining data features and attributes in the context of the proposed uses of resilient planning and asset management.

(6) Publishing: This last step will be use case dependent. Any data wrangling done via ArcGIS specifically will be documented and recorded in a ModelBuilder for future iterations with decision notations, data wrangling done outside of a GIS will also be fully documented, and all data and metadata will be packaged for use in various projects.

While the above steps deal with tasks, weekly meetings will be sure to address larger issues of data wrangling for planning and asset management, including policy issues related to resilient planning and best practices of asset management including real-world modeling and visualization and analytics.

Process and Criteria for Selecting Student Researcher

For this project, key attributes sought include:

- Interest in resilient planning or asset management;
- Interest in data wrangling and data integration;
- Understanding of data structures and fitness-for-use; and
- Ability to think of data needs spatially and temporally.

Oversight and Supervision of Student Researchers

I will closely supervise the student researcher and will hold weekly meetings with the student. Google Sheets containing project data information and to-do lists with task status will be utilized to maintain up-to-date information on the project. The student researcher will maintain a weekly time sheet, with tasks completed. Weekly meetings will be used to plan tasks for the coming week, review the prior week's task status, and address any data related questions and issues. The student will have access to the technical resources of the Spatial Sciences Institute, including access to the SSI Virtual Machine and all associated software.

Integrative and Group Activities

The undergraduate researcher will have several opportunities to collaborate with the Office of Sustainability and Facilities Planning Management. The student researcher will meet weekly with

a larger team of student researchers and faculty from SSI and staff from OoS, and bi-weekly (or as needed) with the CAD Manager and GIS Program Assistant from FPM.

Nature of the Final Research Report
The student will present a poster at Spatial Science Institute's LA Geospatial Summit and the USC SCymposium in Spring 2022. The student researcher will also be a data integration contributor for any projects utilizing the wrangled and published data.

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Predicting Localized COVID Outbreaks with Cellphone-based Locational Data

Andrew J. Marx, Ph.D., Associate Professor of the Practice of Spatial Sciences and the Institute for Creative Technology

Project Description
Among the many puzzling features of the COVID 19 crisis is the geographic heterogeneity of its incidence. While the virus' initial incidence and impact depended on international travel patterns, later trends depended much more on policy-driven factors such as lock-down orders, hospital capacity, and very localized behavior and characteristics including travel to work, general mobility, and housing conditions. Much existing research studies Europe and the United States and focuses on national governments. We, however, propose leveraging highly detailed individual mobility data for five Mexicancities to document the relationship between very localized behavior and future COVID 19 outbreaks. Weintend to model the hospital catchment or service areas of five Mexican cities and then create a daily mobility metric for each of those catchments. We then will correlate this to future outbreaks, providing municipal health care advanced information about how to manage and mitigate the future impacts of COVID 19.

This research leverages data already provided through a commercial partner, Cuebiq (www.cuebiq.com). In Mexico, this data is collected on 1 in 2 cellphone owners, providing their location100 times/day to within 30ft. A city the size Atlanta, can produce more than 1 million rows of location data/day on individual movements. Computing resources are provided by SSI's Human Security and Geospatial Intelligence Lab (https://hsgi.usc.edu).

Role of the Undergraduate Researchers
Students will follow a structured path of analysis under my direction. While the following steps deal with tasks, weekly meetings will address larger issues related to infections disease spread, ethical implications of surreptitiously using cell-phone locational data and principles of signal-to-noise and algorithm development.

- Download, unzip and populate Cuebiq data into my server (Python scripting)
- Geolocate hospitals in five cities and correlate with individual hospital COVID rates (provided online by Mexican government)
- Create preprocessing algorithms to only select residents where pattern-of-life can be

created; spatially subset residents to hospital catchments
- Create an algorithm to calculate daily mobility for each catchment
- Correlate with future COVID rates at each hospital
- Write manuscript

Process and Criteria for Selecting Student Researchers
In selecting the students, I am looking for students with four traits; a student's school or departmentis not considered:
- Passion for working on humanitarian issues
- Background in Python coding
- The ability to think spatially and temporally about high volumes of locational data
- Ability to work professionally as part of a research team

Oversight and Supervision of Student Researchers
Undergraduate researchers will join my Human Security and Geospatial Intelligence Lab and will operate under its current practices. Specifically, they will attend weekly remote meetings with me for an hour lab session where they will go over progress and next steps. In the intervening period, students use a shared Google Drive folder to record their "worklog." In this log they write how much they worked, when and what they did. Students not abiding by the policies are removed from the lab. Students share two lab $8,000 computing servers providing data storage, processing and software necessary for the research project.

Collaboration with Private and Academic Research Partners
Students on this project will regularly meet with collaborators at three institutions: Brennan Lake, Senior Director of Research Partnerships & Data for Good at Cuebiq; Mia Poynor, Core Operations Analyst, Premise Data, and Melissa Rogers, Economics Professor at Claremont Graduate University. They willalso attend weekly lab meetings with other graduate and undergraduate researchers as part of the Human Security and Geospatial Intelligence Lab.

Nature of the Final Research Report
The student researchers will present two posters at Spatial Science Institute's 2022 LA Geospatial Summitand the USC SCymposium in Spring 2022. They are expected to be co-authors on a peer-reviewed journal article and will apply for scholarships to present this research at conferences held Spring 2022.

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The USC Sustainability Map: Developing an Online Interactive Map of Sustainability Projects at USC

Dr. Elisabeth Sedano, Assistant Professor (Teaching) of Spatial Sciences

Project Description

Together with the USC Office of Sustainability, the USC Spatial Sciences Institute is working to develop the USC Sustainability Map, an online interactive map of projects on our campuses that support the university's ongoing goal of sustainability. This project offers undergraduate students the opportunity to research the meaning and importance of sustainability on a university campus while developing their skills in creating and working with spatial data and building online cartographic displays. The students will also gain experience in working with a team, including members of the Office of Sustainability, Facilities Planning and Management, and the Spatial Sciences Institute. The resulting map is envisioned as a public showcase of the variety of sustainability projects at USC, which will be updated regularly as more initiatives are developed on campus.

We are at a critical juncture in human history. After years of willed ignorance, we now recognize that our broad-scale methods of energy development and levels of consumption, along with overuse of natural resources and under-regulation of pollutants, must change. We must develop and implement practices on all these fronts that allow us, and the rest of the life on Earth, to thrive into the future. Universities are ideal changemakers for achieving this goal of a sustainable future. Of course, we are sites of research on human impacts on the environment as well as the science, engineering, and design of new modes of being. We are also places in which these new modes can be implemented both structurally and socially.

Under the leadership of President Carol Folt, USC is working to institute a variety of lasting changes to make our campuses more sustainable. Structural efforts include construction of "purple pipe" systems to maintain landscaping with recycled water, LEED certification of all buildings constructed since 2010, and a stormwater retention and filtration system installed at USC Village[8]. Socially, we hold zero-waste events and incentivize public transit use with a subsidy for employees. Refilling stations help people on campus stay hydrated with sustainable water bottles rather than single-use plastic purchases, and, recycling bins for paper, plastics, and other recyclables are widely available across campus.[9]

An important part of instilling more sustainable behaviors is to communicate the importance of change and the many ways that campus life fosters sustainability. This is the role of the USC Sustainability Map. The map will be an engaging, accessible resource of all things "sustainable" on all USC campuses and facilities. Appendix A, compiled by USC's Office of Sustainability, lists

[8] Lindberg, E. 2019, January 15. "USC's green guru tackles myths about sustainability". USC News. https://news.usc.edu/153302/uscs-green-guru-tackles-myths-about-sustainability/

[9] USC's Office of Sustainability website describes the variety of sustainability initiatives across campus. See https://green.usc.edu/programs/

the types of data that will be included in the map, categorized by the UN Sustainable Development Goal (SDG) that the data speaks to. The UN SDGs lay out goals for development that promote human and environmental well-being, such as access to clean water (SDG 6), access to affordable and clean energy (SDG 7), and responsible consumption (SDG 12).[10] Users of the map will be able to click on map icons for different types of sustainability structures and initiatives to learn more about them.

An exemplar is the University of Arizona's Sustainability Map (Figure 1).[11] This online map provides the location and background information on facilities and events on campus that support sustainability, organized by theme, such water, energy, and food. The left-hand panel allows the user to filter data on the map by theme. In Figure 1, a water icon has been clicked, and a side panel with information about the structure (in this case, a water harvesting project) has opened up. The panel contains basic data and links to web pages with more information.

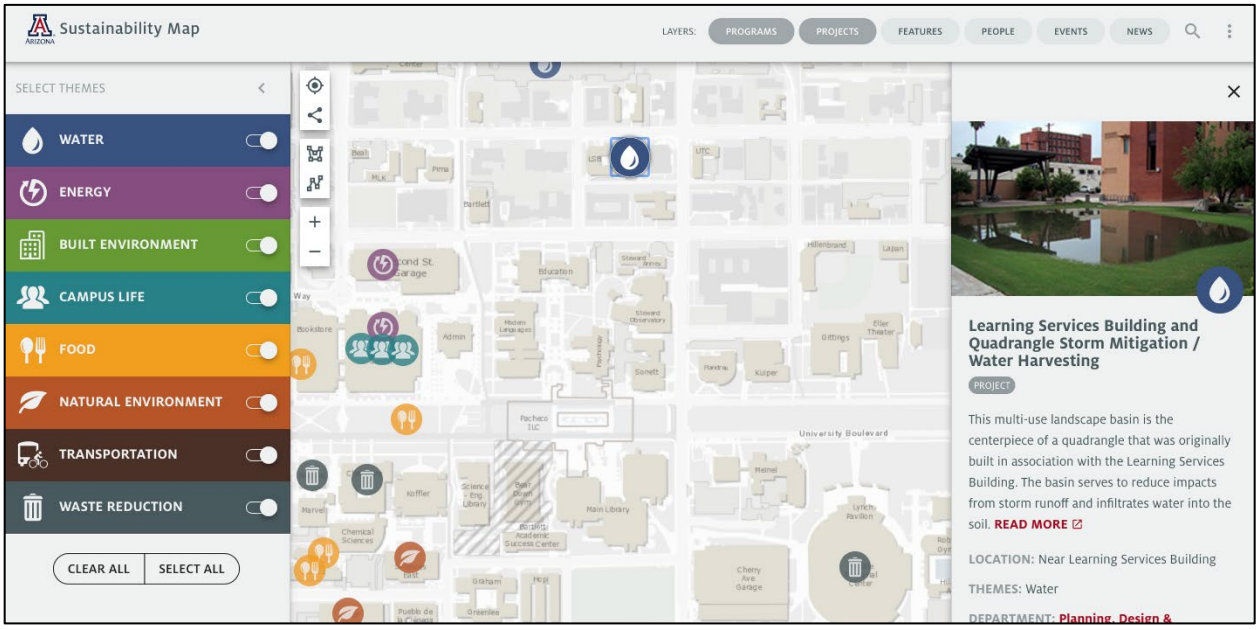

Figure 1. Screenshot of the University of Arizona's Sustainability Map.

The USC Sustainability Map project is currently under way but in its infancy. Project Co-Leads are the Office of Sustainability, and Dr. Laura Loyola and Dr. Elisabeth Sedano of the Spatial Sciences Institute. We have held a series of meetings in the last few months to solidify our partnership, clarify our roles, and itemize steps for development. We currently are working with an undergraduate intern, who is helping to develop the project as course credit. Students funded by URAP would pick up where we leave off at the end of this term.

[10] United Nations, Department of Economic and Social Affairs, Sustainable Development. 2018. "The 17 Goals". https://sdgs.un.org/goals
[11] University of Arizona, Sustainability Map. https://sustainabilitymap.arizona.edu

Steps for Developing and Maintaining the USC Sustainability Map.

1. Identify sustainability-related structures and events to be mapped.
2. Create priority hierarchy for data to be included in initial iteration map vs. data to be added later.

Preparation and processing of top-level priority data to be included in initial iteration:

3. Research whether data exists for each structure and event type, and what USC unit maintains the data ("data owner").
4. For data that exists, coordinate with data owner to acquire either a copy of the data or access to data shared via a web server.
5. Import data into ArcGIS Pro.
6. Analyze data quality and correct errors (e.g. missing data, out-of-date data, incorrect location information, etc.)
7. For data that does not exist, manually create the data in ArcGIS Pro.
8. Confirm all data is spatially compatible and transform data into appropriate map projection as needed.
9. Populate information on individual data features (i.e., information that will be displayed in pop-up window when data icon is clicked).

Building out initial iteration of map

10. Research online mapping templates available in ArcGIS Online and choose appropriate template.
11. Choose base map on which to visualize sustainability data.
12. Choose appropriate categories for organization various data layers in the map (e.g., U of A Sustainability Map organizes by themes of water, energy, etc.)
13. Build chosen categories into structure of online map template.
14. Add data to mapping template.
15. Build filters for turning various data categories and/or individual layers on and off.
16. Choose symbology for map icons and add icons to map.
17. Create structure for pop-up information to be displayed (pop-up window vs. side panel; headings and sub-headings of various data attributes to be displayed; etc.)
18. Add titles and branding information to map.
19. Build out web page that will hold the map.
20. Edit share settings on map to allow limited access.
21. Run small-scale test of map and receive feedback.
22. Edit map as necessary per feedback.
23. Share map with public.

Return to top of list and repeat data processes with second-level priority data.

The URAP researcher will be the primary developer who completes the above steps in collaboration with the Office of Sustainability (OoS) and the Spatial Sciences Institute, under the specific guidance of Dr. Sedano and the OoS representative. At time of drafting this document,

we are at step 3 in the above process. Our intern is actively attending meetings with Office of Sustainability, Spatial Sciences Institute, and Facilities Planning and Management representatives to research and acquire data. We hope to complete data preparation and processing of initial data by the end of the semester. The URAP researcher would then pick up and continue development in the fall.

Process and Criteria for Selecting Student Researchers
For this project, key attributes sought include:

- Interest in sustainability
- Understanding of key spatial concepts, including data models and spatial data quality parameters
- Experience with ArcGIS Pro, including collection, creation, and processing of spatial data
- Experience on a prior project that involved the bringing together of many types of spatial data
- Experience in assessment of spatial data quality
- Experience with development of web mapping interfaces with ArcGIS Online, including customization of web mapping templates

Oversight and Supervision of Student Researchers
Students will meet weekly with Dr. Sedano and the OoS representative. Google Sheets containing project information, including data descriptions, to-do lists, and tasks statuses will be used to provide all team members with up-to-date information on the project. Student researchers will maintain a weekly time sheet, recording the tasks completed and time spent on each. Weekly meetings will be used to plan tasks for the coming week, review time sheet for prior week relative to planned tasks, and address content and technical questions as they arise. Students will have access to the technical resources of the Spatial Sciences Institute, including access to the Esri's ArcGIS Pro program via a virtual machine and an Esri site license.

Integrative and/or group activities in which the undergraduate researchers will engage.
This is a collaborative project, and the student researchers will attend frequent meetings with team members from the Office of Sustainability and Spatial Sciences Institute as well as members of Facilities Planning and Management. To date, meetings with our student intern have included Ellen Dux (Office of Sustainability), Laura Loyola and Elisabeth Sedano (Spatial Sciences Institute), and Carol Fern and Jose Delgado (Facilities Planning and Management).

Nature of the Final Research Report
The USC Sustainability Map will be its own deliverable. The initial iteration of the map should be publicly shared and available by the end of the Spring 2022 (if not before). In addition, the URAP student researchers will present a poster at the Spatial Science Institute's LA Geospatial Summit in February 2022 and the USC SCymposium in Spring 2022.

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Analyzing Urban Change and Inequality in India and China

Jefferey Sellers, Ph.D., Professor of Political Science, Public Policy, and Spatial Sciences

Project Description

This project, supported by the Provost's Undergraduate Research Associateship Program and other sources, employs a variety of geocoded data from diverse sources to analyze spatial inequality in the rapidly developing urban areas of India. Soon to be the largest country in the world, India is undergoing a remarkably fast transition to an urban society. As the Subcontinent urbanizes, the juxtaposition of new development with rural settlement is creating dramatic disparities in the built environment between upscale development clusters and emerging slums. The project combines online real estate listing data, remote sensing images, other geospatial data and a variety of administrative, planning, electoral and demographic data. The analysis includes comparison of Indian regions with a parallel selection of Chinese urban regions.

This project is part of a wider research program that analyzes spatial data on social, economic, political and spatial change in urbanizing regions around the world. The aim of the project will be to compare patterns of urban settlement and its development, with an emphasis on the expansion of urban settlement into rural areas, the role of informal settlement and the survival of rural village structures. The project revolves around analysis of high and middle resolution remote sensing images to compare matched urbanizing districts in selected cities of each country. The project builds on previous research that has generated comparative citywide metrics of urban form in China and India (Sellers et al. 2020), classifications of the built structures in urbanizing neighborhoods, and analyses of real estate listings data (Sellers and Wang 2018; Sellers and Li 2019). This project will draw on newly available data, including high resolution satellite imagery, to analyze and compare urban expansion among several Indian regions, and extend the methods to comparison with Chinese urban regions.

Criteria for selecting student researcher

Preferred credentials: GPA of at least 3.5, basic knowledge of statistics and familiarity with geographic information systems and one or more related programs (ArcGIS, Python, Google Earth, Ecognition, Excel, and Stata, SPSS, or R). Knowledge of comparative international politics, urban issues, developing country settings (particularly India or China), budget analysis (Accounting) or Mandarin a plus but not essential.

Student responsibilities and supervision

As Provost's Undergraduate Research Associates, students working on the project will be expected to carry out some combination of the following responsibilities:

- map, catalogue, and analyze the built environment and its evolution in selected sites on the urbanizing periphery of Indian and Chinese cities.

- construct comparative databases of land use metrics, administrative and planning data, census data, electoral data and economic data to compare governance arrangements for urban regions
- collect additional data through the internet, official documents, Google Maps and Google Earth on the character of the main firms, institutions and other establishments in the study sites
- analyze the variations between the selected sites in each country, along with the differences between different regions and countries.

Hours are negotiable, averaging 8-10 hours/week, and work may be carried out remotely. Students will meet weekly with the supervising professor to discuss progress, trouble-shoot problems, and agree on next steps. Prior to meeting each week the student will submit a report on their hours worked and what they did.

Parts of the project will integrate teamwork with other undergraduate and graduate researchers active in the project at USC, and in some cases with the researchers from India and China in the wider research team.

Final research products

The work of the undergraduate researchers will be geared toward preparation of a poster for the Undergraduate Research Symposium in the Spring of 2022, and an eventual peer-reviewed article manuscript. The research will ultimately contribute to a longer, coauthored book manuscript comparing the governance of urban development in India and China.

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Using spatial analysis to understand the environmental and neighborhood-level risk factors in pediatric health care at the Children's Hospital Los Angeles

Jonathan M. Tan, MD MPH MBI CMQ, Assistant Professor of Anesthesiology and Critical Care Medicine, Children's Hospital Los Angeles and the Keck School of Medicine at the University of Southern California

Project Description

Disparities in hospital-based health care have traditionally been viewed through the important lens of race and ethnicity. Factors known as the social determinants of health including, education, access to care, socioeconomic status, the built-environment and environmental exposures also are known to contribute to health and health care disparities. Unfortunately, social determinants of health can be difficult to study due to limitations in standard electronic health record systems. For example, while it is known that some children have an increased risk

of critical care use for asthma, important factors such as neighborhood risk factors and air pollution exposure are not standardly measured. Improving and innovating health care needs to also incorporate the social determinants of health.

This study proposes to use spatial linkage and analysis methods in order to provide deeper insight into the social determinants of health among pediatric patients that require admission to the pediatric intensive care unit, require general anesthesia for surgery and those who see pediatric pain medicine specialists. Expanding upon research work that the faculty lead has conducted, the undergraduate researchers in this URAP project will help study the important social determinant of health factors that may influence clinical care delivery and outcomes. This will be conducted by spatially linking US Census data and other important environmental data with electronic health records of pediatric patients. Students will have an opportunity to work with electronic health records of children at CHLA and how spatial science can be applied to better understand how to improve a hospital-based health system.

The goals of this project(s) will be to:

- Conduct geocoding of electronic health record data and visualize where patients come from who receive care at a children's hospital
- Use spatial analysis to understand the epidemiology and variation of social determinant of health factors with pediatric critical care patients
- Use spatial analysis to understand the epidemiology and variation of social determinant of health factors with pediatric anesthesia patients
- Create maps to visualize patients in the electronic health record that receive care at a children's hospital.

The research that each student will contribute to will be critically important to expanding our knowledge of the spatial dynamics that influence health care and health care delivery. Under the direction of Dr. Jonathan Tan, two or three students will be involved in the above research endeavors throughout the academic year (Fall 2021/Spring 2022).

Role of the Undergraduate Researchers

As Undergraduate Research Associates, each student will be expected to work both independently and collaboratively with the rest of the supervising faculty member's research team.

Some of the responsibilities that students can expect include:

- Fill out the appropriate paperwork and standard clearances to work with patient electronic health records
- Conduct accurate geocoding of patient records
- Spatially link US Census Data and Environmental Health Data with patient clinical data.
- Create 2D/3D maps and analyze socioeconomic and environmental factors in thecontext of clinical care.
- Present research updates in our interdisciplinary team meetings.

- Contribute their experience, education and problem-solving skills in individual and group collaborative research planning sessions with the goal of improving pediatric health care delivery.
- Improving their analytical skills, problem solving skills and communication skills as they build a portfolio of work for future endeavors.
- Collaborate on poster presentations and on a manuscript for publication.
- Present research at local and national scientific conferences.

Expectations of hours for each student can be flexible depending on the work and stage of research. For the undergraduate researcher involved in the academic semesters, each of the undergraduate researchers will be expected to average 8-10 hours/week with some of the work carried out remotely.

Criteria for Selecting Student Researchers

Student researchers will be selected on the basis of having important skills that are necessary for the project. Familiarity and experience with statistics, geographic information systems and spatial analysis will be important. Some content knowledge or interest in learning about public health, pediatric health care, social determinants of health, environmental health would be desired. Students who are motivated to improve and innovate health care through spatial data and information would be a great fit.

Student supervision and guidance by faculty

Students will meet weekly with the supervising faculty member, Dr. Jonathan Tan, with the goal of discussing research progress, guide the research in the proper direction, answer any questions about the research and plan for the week ahead. Prior to each meeting the student will submit a brief summary, to be discussed as appropriate, on the hours worked as well as summary of research progress. These brief summaries will be informal and provide preparation for the weekly meetings.

In addition, the primary supervising faculty member will be available at all times to the student via phone, text, or email in order to serve as a resource for the research as well as for any other guidance the student would want regarding other academic pursuits or career planning discussions. While the undergraduate can work remotely for many parts of this project, dedicated space can be provided to students as needed.

Integrative and Group Activities

Student researchers will be integrated as part of the faculty member's clinical informatics research team that has representatives from the CHLA Department of Anesthesiology Critical Care, the USC Keck SOM Department of Anesthesiology, and the USC Spatial Sciences Institute. Members of this team include other physicians and health care professionals conducting informatics and spatial data science research. The student will be invited to these research

meetings in order to learn from others, learn about the importance of an interdisciplinary research team, and also share their own work. The student will also be working alongside other undergraduate and graduate researchers involved in our team.

Final Research Report Submitted to Office of Undergraduate Programs

Students will be able to provide a final research summary report of their work to the Office of Undergraduate Programs. In addition, the undergraduate work will be conducted with the expectation that the student participates in the presentation of the work at an academic conference. Identified conferences to present the research work includes the Los Angeles Geospatial Summit (organized by USC SSI) in 2022, the USC SCymposium held at USC, and the Esri User Conference held in July 2022. In addition, we will encourage students to support their work at appropriate student research competitions. Students will also be a co-author on peer-reviewed publications that stem from the student research work and contributions.

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USC Urban Trees Initiative Phase Two: Geospatial Analysis for the City of Los Angeles

John P. Wilson, Ph.D., Professor of Sociology and Spatial Sciences, and Beau MacDonald, GIS Project Specialist

Project Description

USC Spatial Sciences Institute (SSI) interdisciplinary teams encourage undergraduate student researchers to collaborate with faculty and staff to conduct actionable applied research, often with public agencies as clients. This year, a four-student SSI team was essential to our Urban Trees partnership between the City of Los Angeles and five USC entities, working with community organizations and civic leaders in neighborhoods near the USC Health Sciences Campus to optimize the health and quality of life benefits envisioned by planned expansion of our urban forest.

To characterize existing conditions and guide the creation of scenarios that combine scientific analyses with needs and priorities of residents, students created and mapped a diverse array of geospatial data about built and natural environments, neighborhood diversity, and socio-economics status. They made high-level presentations to various groups, including to USC President Folt; regularly participated in community outreach; and received a first prize recognizing the impact of their research at the USCymposium. Please see “90,000 Trees for Los Angeles” on the SSI website https://spatial.usc.edu/ssis-john-wilson-leads-the-usc-urban-trees-initiative/ and the USC Urban Trees Initiative webpage https://publicexchange.usc.edu/urban-trees-initiative/ for additional information and our report “Maximizing the benefits of increased urban canopy on the Eastside of Los Angeles.”

In 2021–2022, we will work with local neighborhoods surrounding the USC University Park Campus. We have planned another rewarding partnership with the City of Los Angeles that

includes LA's Chief Forest Officer, experts from StreetsLA and other City agencies, the non-profit organization Northeast Trees, and multiple USC entities, led by SSI's John Wilson. USC collaborators include the USC Dornsife Public Exchange and Department of Earth Sciences, the USC School of Architecture, USC University Relations, and others.

Our focus is a scientific and holistic data-driven approach to help guide the growth of our urban forest; to promote health, sustainability and resilience; improve the environment and biodiversity; adapt to a changing climate; and support our neighbors. Potential benefits from enhanced more-equitable tree canopy distribution as they may relate to heat-mitigation, carbon storage, water quality, or reduction of particulate matter pollution; and providing input on scenarios for new green infrastructure are other research interests. Urban forests provide ecological and environmental services that strongly contribute to enhanced human well-being and advance sustainable development goals. Urban forestry is a transdisciplinary field with economic, environmental, and social impacts that affect everyone in a community, and which operate at range of spatial and temporal scales. We look forward to listening to and learning from our neighborhood stakeholders and contributing our detailed understanding of the urban forest at community engagement meetings in the months ahead.

Role of student researchers and criteria for selection

Students will enhance their geospatial analysis and cartography skills, and applicants should have completed a suite of academic coursework that allows them to work proficiently with ArcGIS Pro, ArcGIS Online, and other relevant software. GIS experience and an appreciation for data science will be required to support our City of Los Angeles and Northeast Trees partners.

Student research assistants will learn to support field experiments to collect air pollution and related data as it informs the selection of LA urban tree species and their optimal planting configurations along streets, within parks, on school grounds, and on private property.

Expectations include: maps, charts, and baseline analyses integrated with regular presentations to our larger research team; contributions to one or more publications at the conclusion of this research; participation in twice-weekly meetings; and collaboration with other student researchers to create posters or presentations for the 2022 SSI Geospatial Summit and USCymposium.

Students from various majors including Geodesign may find this opportunity intriguing, and we request a statement that describes your knowledge, skills, abilities, and specific interests.

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Building and Expanding the SSI ArcGIS Hubs: "USC Sustainability Hub" and "USC GeoHealth Hub"

John P. Wilson, Ph.D., Professor of Sociology and Spatial Sciences, and Beau MacDonald, GIS Project Specialist

Project Description

USC Spatial Sciences Institute (SSI) interdisciplinary teams encourage undergraduate student researchers to collaborate with faculty and staff to conduct actionable applied research, often with other USC entities as clients. This year, a three-student SSI team launched the successful USC GeoHealth Hub application: https://usc-geohealth-hub-uscssi.hub.arcgis.com. Their effort leveraged an open-data platform to create an interactive website to host a variety of spatial and non-spatial data to allow a broad audience to participate in health research, access diverse health-related data, encourage healthy lifestyles, and connect population, health, and place. Students were engaged in site design, UX/UI, data gathering, creation, visualization, and quality control, and regularly consulted with ArcGIS Hub developers and education specialists at geospatial software and services provider Esri, and met with US EPA EnviroAtlas scientists.

The team made multiple highly focused presentations that were critical in securing research funding and support from five GeoHealth Hub partners, including the Southern California Environmental Health Sciences Center, and four other Centers and Institutes associated with USC's Keck School of Medicine (KSOM). Their academic recognition included an interdisciplinary first prize at the USCymposium.

In 2021–2022, our student team will expand the GeoHealth Hub and build a new "USC Sustainability Hub" – a data platform that connects University Operations with academics to support overall USC Sustainability. Once fully developed, it will support new and more meaningful forms of engagement; provide opportunities to develop content and share related data with collaborators and constituents including decision makers and communities we serve; and inspire action to promote sustainable behaviors. This resource will help USC students, staff, faculty, and administrators by organizing data, tools, and people through information-driven initiatives.

We plan to integrate maps, spatial and non-spatial data like PDFs, tables, and spreadsheets, and geospatial data services created or curated by SSI, the USC Office of Sustainability, and USC Facilities Planning and Management, plus other University data partners. Energy, Water, Recycling, Green Buildings, Transportation, Ecology and Habitat, Landscaping, Sustainable Food, and Community Development are potential data categories. Please see examples from other organizations who are using Hub to communicate here: https://hub.arcgis.com/pages/gallery

Our technology uses Esri's ArcGIS Hub software that is part of USC's Esri site license administered by SSI. The ArcGIS Hub platform provides tools to share open data, create websites, and organize around initiatives (e.g., student outreach, sustainability plans, and progress on SDGs; clinical

trials and cohort studies). Configurable apps to encourage and support engagement include surveys and next-gen crowdsourcing, place explorers, interactive stories and infographics. Apps, maps, story maps, dashboards, and charts included in initiative templates allow us to share data and stories in intuitive ways and show progress and accountability. Esri provides strong support, appreciates our product feedback, and continually improves Hub architecture and the ability to collaborate.

Role of Student Researchers

First steps for the Sustainability Hub focus on research, plan development and ongoing documentation; followed by site configuration incorporating tech considerations; data management, access, sharing, and update privileges; gathering data from contributors and stakeholders; and focus group input to help identify scope and extent of individual candidate datasets for first launch.

We will manage, describe and organize data, test dynamic links and open data APIs, and choose and implement filters. Site design, UX/UI, troubleshooting, and creation of additional visualizations will proceed in parallel by midway through the process; followed by incorporating user feedback, making data adjustments and assuming more will be added over time but ensuring that we have the breadth of information desired.

After launch, we will solicit more feedback, make modifications to the site accordingly, and imagine new or expanded initiatives built on top of the Sustainability Hub.

GeoHealth Hub plans include updates to core social and environmental determinants of health, like data from CalEPA's EnviroScreen, the USDA Food Access Research Atlas, and the US Census Bureau; geographical expansion beyond California; testing national-scale air quality data options; and work with Esri to integrate new options for Hub data API connections. We plan to incorporate additional maps and other data visualizations including dashboards and story maps, and to implement new data sharing and collaboration protocols for KSOM partners. We expect that users will be able to access or download up-to date and longitudinal-survey data shared by thousands of organizations around the world, leveraging index and search capabilities to find and filter data.

Criteria for selecting student researchers

Research applicants should have completed a suite of academic coursework that allows them to work proficiently with ArcGIS Pro, ArcGIS Online, and other relevant software. Students will learn about the ArcGIS Hub. An interest in public health or sustainability issues or both and an appreciation for data and metadata, plus familiarity with various types of geospatial datasets and non-spatial data is desirable.

Expectations for researchers include participation in weekly meetings and regular presentations to our larger research team; potential contributions to one or more publications at the conclusion of this research; and collaboration with other student researchers to create posters or presentations for the 2022 SSI Geospatial Summit and USCymposium.

Students from various majors including Geodesign may find this opportunity intriguing, and we request a statement that describes your knowledge, skills, abilities, and specific interests.

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Mapping Ghost Smelters: Understanding health risks and racial injustice behind the historical lead smelters in the United States

An-Min Wu, Ph.D., Assistant Professor (Teaching), Spatial Sciences Institute

Jill Johnston, Ph.D., Assistant Professor of Preventive Medicine and Spatial Sciences, Keck School of Medicine

Project Description

Secondary lead smelters primarily recycle lead-acid batteries which produce wastes and can contaminate the air and soil of the surrounding areas. In the United States, these smelters flourished across the United States between 1930s and late 1960s (Eckel et al. 2001). While the majority of facilities are long gone, their toxic legacy remains as elevated levels of toxic metals like lead persist in the soil of the residential areas at or near these historical smelters. Soil lead contamination continues to expose residents nearby, and poses particular danger to the health ofyoung children. Serious and long-standing health problems including mental and physical development are known to affect young children from even low intake of lead in the environment (Levin et al. 2008).

A total of 431 historical lead smelters in the United States identified by Eckel et al. (2001) using the metal industry directories along with the historical Sanborn fire insurance maps were largely unknown to the U.S. Environmental Protection Agency (USEPA) that regulates hazardous waste The study was later investigated by the reporters in the USA Today where they tested 21 sites in 13 states and revealed the lead contamination in the soils were unsafe for children to play (USA Today 2012; Scheer and Moss 2013). This scientific report triggered the EPA initiative on investigating these 'ghost smelters' for potential superfund sites up to 2016 (USEPA Office of Land and Emergent Management 2017).

To our knowledge, the majority of the historical lead smelters to date are still not remediated. Our aims are to map the locations of these smelters, and to analyze the nearby community composition to understand whether the potential lead contamination disproportionately harms toparticular groups (by race, ethnical groups, income levels and etc.). The addresses of the ghost

smelters are not immediately available in the Eckel et al. (2001) or EPA reports, and previous investigation outcomes by the USA Today reporters are also mostly not made available. Research and contact for the ghost smelter addresses are required before properly parsing and geocoding the available addresses for mapping these ghost smelter sites. Following the mapping, an in-depth exploration and analysis of the ghost smelters with the socioeconomic and demographic factors in the surrounding neighborhoods will be conducted. These factors will be spatially overlay and analyzed with the ghost smelters in order to quantify health risks of the uncleaned historical smelters to different population across the United States.

The student will research the history of environmental health injustice that systemically embedded in our built environment; the student will also learn and practice spatial data engineering and data analysis using both MS Excel, statistical computing programs (such as STATA or R) and Geographic Information Systems (GIS) (such as ArcGIS Pro). The resultingmaps will be made public via online tools such as ArcGIS StoryMaps.

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Student Involvement

The student will be working with both Dr. Johnston and Dr. Wu in developing the research plan. The student will learn to comprehend their GIS analysis skills, particularly on data cleaning, geocoding, overlay and exploratory spatial data analysis. Besides GIS analysis, the student will also learn other research skills, including literature search, statistical computation as well as generating an online Story Map to communicate scientific results to the public. The student will work on the proposed research for 9 hours per week on the task basis using software ArcGIS, MS Excel, and R/STATA during Fall 2021 and Spring 2022.

Student Selection Criteria and Process

The student should be interested in environmental pollution and environmental health issues, have knowledge about GIS fundamentals and some experiences in ArcGIS. The student should

have taken 1-2 GIS-related courses by the start date with an averaged GPS of 3.0 or above. The final decision will be made before the start of Fall 2020.

Student Group Activities and Faculty Supervision
The student will work closely with both Dr. Johnston and Dr. Wu. Specifically, Dr. Johnston will supervise the student in researching historical lead smelter locations and their links to community health issues; Dr. Wu will mentor the student in geocoding and mapping for the historical smelters as well as identifying population composition surrounding the historical smelters. The student will meet with Dr. Wu to discuss and report the progress on a weekly basis, which is online until the campus reopens.

In addition, the student will be asked to attend Dr. Johnston's lab meetings to discuss the research problems encountered and identify potential solutions with other students in a regular basis. The student will also be encouraged to present at the annual Los Angeles Geosummit and SCSymposium for sharing their research outcomes.