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Pomona

Spatial Analysis of Potential and Actual Organ Donors

During 2011 and 2012 Michael Reibel of Cal Poly Pomona chaired the data subcommittee of the research team for the Deceased Donor Potential Study (DDPS), funded by the U.S. Health Resources and Services Administration. A response to the leveling off of levels of organ donation, the DDPS was undertaken as a nationwide research effort to determine the maximum possible number of medically suitable organ donors and the medical, demographic and geographic factors associated with successful recovery of those organs.

Dr. Reibel and Co-Chair Dr. Sam Soret of Loma Linda University designed and executed the demographic and geographic components of the study, using medical suitability protocols developed in conjunction with the medical and organ bank experts on the research team. While much of the analysis of mortality and donor data was geared toward the essentially aspatial task of computing overall estimates of the number of potential donors nationwide, other phases of the study were more geographic in nature. Reibel and Soret performed spatial analysis on local estimates of donor potential and of recovery rates of organs from potential donors. These spatial studies, along with statistical models of local variation not discussed here, revealed geographic patterns that were then interpreted in regional context.

Using the filtered expected donor estimates derived by applying the medical suitability filters to vital statistics data, maps of donor counts and donation rates at the county level were constructed: a Donor Potential Rate (DPR), defined as medically suitable potential donors per 100,000 population, and a Donor Rate (DR): the ratio of actual donors to medically suitable potential donors.

Figures 1 and 2 show spatial clusters of these rates scaled by their respective baseline measures. Because of the smoothing algorithm applied, the DPR category of a given region will not always match between the two maps. Through the lens of social geographic knowledge of the U.S. we can interpret the maps as follows: Fig 1 shows clusters defined simultaneously by crude death rates and donor potential rates (the number of medically suitable potential donors per 100,000 deaths). There is no clear county population size or urban effect. DPR appears to vary approximately randomly across cities of all sizes and rural areas. Different patterns of medical practice, however (i.e. differences in diagnostic and treatment norms) strongly influence the pool of patients identified as medically suitable for donation; in some

See Organ Donors *on page 7*

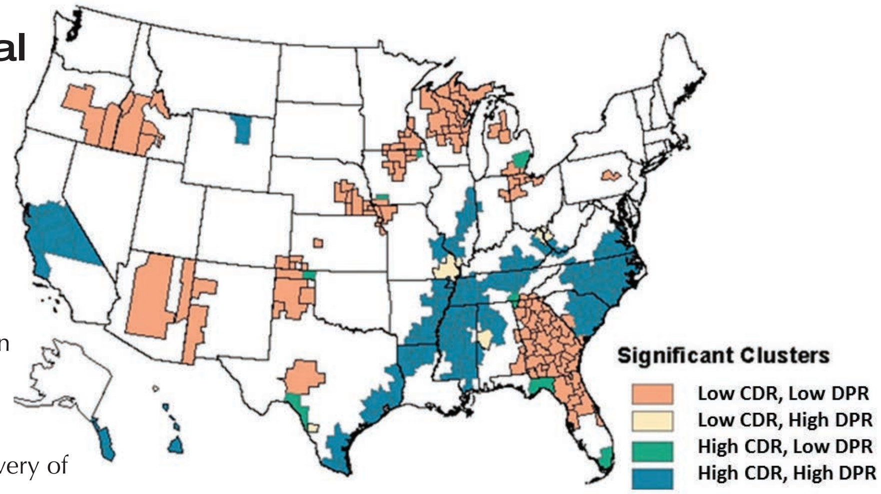

Figure 1. Bivariate Clusters, Crude Death Rate and Donor Potential Rate

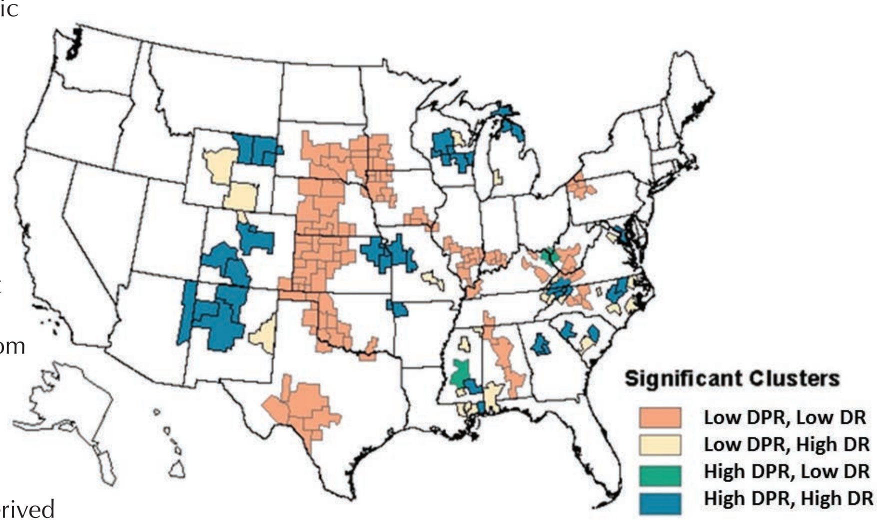

Figure 2. Bivariate Clusters, Crude Death Rate and Actual Donor Rate

INSIDE

SAVE THE DATE

Please join us at the 2013 ESRI International User Conference in San Diego, California, July 23-27.

Online GIS Challenges

In last year's column, we looked at opportunities and challenges for cloud computing with GIS. I wish the picture were clearer this year, but it's still pretty nebulous. A related challenge is how to roll out maps that depend on online resources like ArcGIS Online. On our campus, we are testing Esri's hosted services with our campus map services. The advantages of online GIS and base maps have become abundantly clear to most of us, and available resources have greatly blossomed in the last year. This has led to a rapidly growing set of online maps from students, faculty and staff on our CSU campuses, and many classes are starting to take advantage of the greater ease of creating and sharing maps. This trend will only continue, and we'll no doubt see an increasing expansion of GIS into other disciplines across our campuses. We recently held a faculty workshop on our campus on online mapping, and had to turn people away.

Yet there remain many challenges for online GIS, and all too often we discover problems when we are dependent on online resources. The recent announcement that Bing Maps will be dropped from ArcGIS Online caught many of us by surprise, although the alternative base map choices provide a good array of options, and most are not susceptible to a licensing change as was Bing from Microsoft. Online base maps may also come with a cartographic cost in the form of watermarks, and for limited format maps this may get in the way of clear communication (though there are tricks to hiding these watermarks). The takeaway message for me is that while base maps may be good for short-term projects, for publication quality or for important web maps, it's a better idea to build our own base maps.

All of this is a rapidly moving target, with increasingly diverse players contributing to the game. That's a good thing, as it brings in new creative voices. Who knows where we'll be this time next year, but I'm sure online GIS will continue to be a breaking story.

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Geographical Analysis of Climate Variability in Climate Divisions of California

Impacts on Transportation Planning

Summer heat and winter freeze have considerable impacts on both traveling public and transportation infrastructure. When changing climate and impacts are concerned for transportation infrastructure, its service life needs to be carefully examined, as the service life is typically longer than long-range transportation plans (e.g., 20-30 years) (U.S. Climate Change Science Program, 2008). Any extreme weather events that may manifest during the service life can potentially damage transportation infrastructure and greatly impact the users who depend on it. In addition, damaged infrastructure may need to be closed for maintenance activities, and the monetary cost associated with such closure is not trivial. Two-hour closure on a major interstate highway may cost $1+ million (McCormack and Stimberis, 2010).

California's unique topography, large range of latitude, and close proximity to the ocean add complexity to local climate, and thus it is difficult to draw climate divisions for the state (Abatzoglou et al., 2009). In California, there are seven climate divisions, and the mean air temperature is increasing in these climate divisions. There are also 12 Caltrans districts, but these polygons do not necessarily complement to those of the climate divisions. Some of the Caltrans districts have a wide range of climate conditions due to its topography and proximity to the ocean, and it is assumed further that the trends of climate variables are also unique in these districts. Therefore, this study illustrates the mean climatic conditions and their trends for Caltrans districts. PRISM data, which are gridded estimations of climate data (PRISM Climate Group, 2004), are used for this study, because point locations of climate stations may not necessarily represent linear transportation infrastructure.

This study determines annual mean air-temperature and June-July-August (JJA) mean maximum air-temperature values from 1971/72 through 2008/09 for each grid cell. Linear trends of mean air temperature are also examined at a grid-cell level. Then, individual values calculated for grid cells are summarized by Caltrans districts boundaries.

The ranges of annual mean air-temperature values vary widely between Caltrans districts, and those districts with large ranges of the annual mean air temperature show negatively-skewed distributions (Figure 1). This is primarily due to the topography of these districts, which is spatially heterogeneous. Therefore, the following summary of results should be carefully interpreted.

Caltrans districts 6 and 9 are unique in terms of their mean air-temperature distribution. These districts share a portion of their boundaries, which is the Sierra Nevada, and the grid cells in the vicinity of this shared boundary show the annual mean air-temperature values of below freezing (Figure 1). At the district-level, the general trends of the mean air temperature are all positive, but in districts 6 and 9 these positive trends are also

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continued

occurring in the below-freezing range in some grids. Thus, these positive trends of mean air temperature at the district level have different impacts, especially for the areas experiencing warming taking place in the freezing temperatures (e.g., from snow to rain).

Caltrans districts 8, 9, and 11 in particular have high summertime maximum air temperature, and major east-west highways and railroads run through districts 8 and 11 (Figure 2). While mean air temperature is higher in district 11 than others at the district level, the range of air temperature is larger in district 9 than others at the grid level. The pavement or railroad track temperature could easily be higher than air temperature that is examined in this study, and it can be a cause of rutting of pavement and warping/kink of railroad tracks.

This study has briefly examined air-temperature values at the grid and the Caltrans district levels, and illustrated them with linear transportation infrastructure. Comparing the climate regions of California to Caltrans districts, we can see that there are apparent discrepancies between their spatial extents. Any climatological statistics summarized for the district level may not be representative for a given Caltrans district as a whole if its landscape is spatially heterogeneous. Thus, the use of a grid-level approach is more useful for applications, such as transportation infrastructure. One of the extensions of this study is to focus on and extract grid values of climatic variables using a linear transportation feature. Comparing the extracted grid data to the point data collected along highways, such as by Road Weather Information System (RWIS) sensors, will generate more meaningful and practice-ready results.

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Figure 1: Boxplots represent the mean air temperature and elevation values for 12 Caltrans districts. The values are based on gridded data calculated with the PRISM data set.

Figure 2: June-July-August (JJA) mean maximum air temperature is higher in the southeastern part of the state. While these high mean maximum air-temperature values are a concern, a large departure from the historical mean can be more problematic for transportation infrastructure.

Figure 2

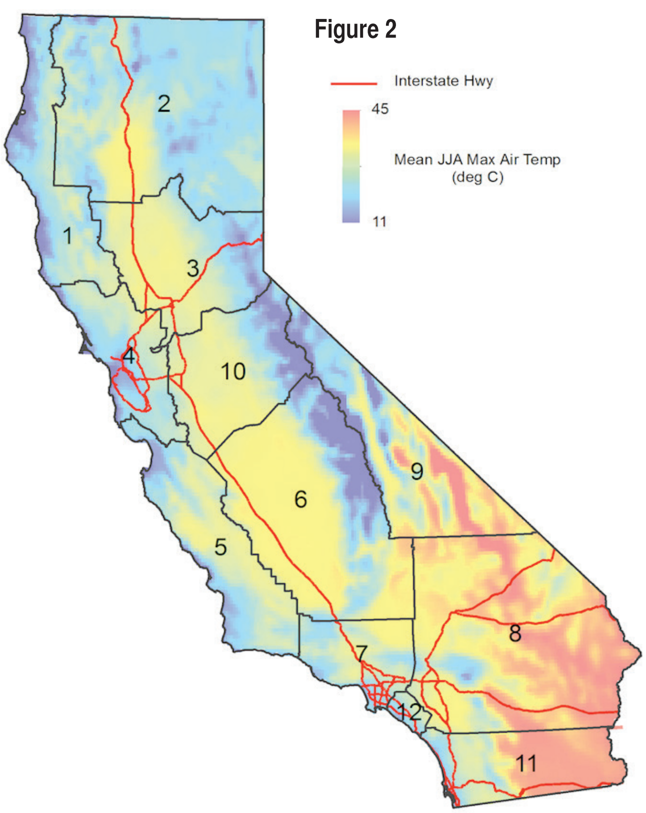
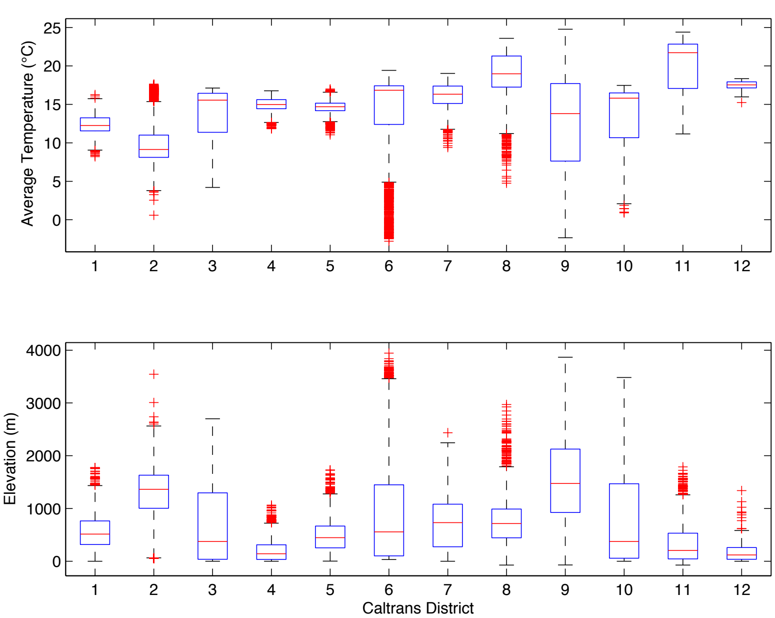


Figure 1



GIS Across the Curriculum
Planting TULIP Bulbs at CSUSM

Every summer at California State University San Marcos (CSUSM), Instructional & Information Technology Services (IITS) holds a summer workshop for faculty entitled: Technology Utilization in Learning and Information Platforms (TULIP). The purpose of TULIP is to provide technical support to faculty members who would like to use technology tools to enhance their courses. Faculty submit competitive proposals describing the goals and student learning outcomes for their projects, which are reviewed by IITS staff. Instructors who are selected to participate in TULIP meet with IITS specialists throughout the summer, implement their project during the fall and participate in a technology showcase during the spring. Participants also receive a small stipend.

In 2012, TULIP included a GIS track for faculty who were interested in adding geospatial components to their courses. GIS resources at CSUSM have been somewhat limited in the past: the campus does not have a GIS Center and is now in the process of launching a Geospatial Studies minor, so including GIS is a new idea for most faculty on campus. Six professors from diverse fields took the plunge, developing materials and projects adding geospatial thinking to their courses. These professors met periodically with a GIS Specialist and an Instructional Developer from IITS throughout the summer and fall, developing and implementing their new course components. The GIS Specialist provided technical support and training and assistance with data acquisition, while the Instructional Developer assisted the faculty member in designing assignments which would integrate well with their existing course and enhance student learning outcomes.

Here are some examples of the courses and projects that were implemented as part of this year's TULIP program:

Professor Kimberley Knowles-Yanez, Liberal Studies, GEOG 320 (Patterns of San Diego): Students used ArcGIS Explorer Online, ESRI Community Analyst Online and Google Earth to examine geospatial patterns (e.g., natural resources, demographics, business and employment, etc.) in San Diego County. Students also completed a capstone project, using ArcGIS Explorer Online to create map presentations about individual cities.

Adjunct Professor Lea Roberg-Chao, Kinesiology, KINE 404 (Introduction to Epidemiology): Students used monthly state-level data from CDC to study the flu season of 2010-11. Their final group assignment was to create a map presentation in ArcGIS Explorer Online that illustrated the initial outbreak and subsequent spread of flu within an individual state.

Professor Staci Beavers, Political Science, PSCI 417 (Presidency in the U.S.): Students used ArcGIS Online to research past electoral vote and Congressional vote outcomes. The class collaborated on an online Electoral College map, hosted on CSUSM's ArcGIS Online account. Students predicted the vote percentages and electoral vote outcomes for battleground states, editing map data to submit their predictions.

Assistant Professor Theresa Suarez, Sociology, SOC 313 (Race/Ethnic Relations): Students will work collaboratively on an online map documenting the presence of ethnically-based mascots at high schools in California.

Adjunct Professor Kathy Shellhammer, Sociology, SOC 495 (Capstone Seminar in Community Service): Students used ArcGIS Online and Community Analyst Online to research the demographics of the neighborhoods served by the local community organizations that hosted their internships. Students used this information to better understand the communities served by the agencies.

Associate Professor Minda Martin, Visual & Performing Arts, MASS 302 (Media Production and Context): Students in this course create a short "postcard video" that portrays where they live and spend their time. They used ArcGIS Explorer Online to create map presentations to storyboard their videos.

The buzz generated by these courses encouraged non-TULIP participants from these departments and others (e.g., Anthropology, Marketing) to schedule GIS instructional presentations and add GIS-based assignments to their courses as well. We hope that providing this additional support for non-geographers who wish to add GIS to their courses will continue to expand geospatial thinking at CSUSM.

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At Cal State San Marcos, GIS can lead you in many different academic directions.

Spatial Analysis of Satellite Telemetry Data

Detecting Activity Patterns of California Condors using GIS

The use of satellites to track individual animals through space and time is revolutionizing our understanding of animal movements and habitat use. Research on cryptic species that move long distances or inhabit remote or inaccessible areas has been especially aided by satellite telemetry, as the vantage point from space can provide a relatively unbiased look at how these individuals move and conduct activities.

The California condor (*Gymnogyps californianus*) is an iconic endangered species, having received international attention by scientists, policy makers, and the general public for the last five decades. The condor is considered a flagship endangered species, representing a considerable range of conservation challenges, and serves as an example of how science, captive breeding, reintroductions, and intensive management can save a species from the brink of extinction. The condor is also a good candidate for investigating how we might mine satellite telemetry data for additional information useful for applied conservation because: (1) a large number of individuals in the population are outfitted with satellite telemetry, (2) condors use a wide variety of habitats and range over large areas, and (3) the population is expanding, meaning that it will be useful to managers if we can identify where condors are performing specific activities (e.g., nesting, perching, roosting).

Visual observations and ground-based telemetry can provide behavioral data, although the information is often spatially and temporally limited and sample sizes can be small for wide-ranging species. Automated satellite telemetry offers continuous position reporting and unbiased spatial coverage, but to date has lacked thematic content such as the time, place, and duration of particular activities.

Over the last two years, a team of academic and federal government researchers have been working on the challenge to apply data synthesis techniques to convert basic satellite position reports into information on condor behaviors and spatially specific activities.

Procedures developed for this study use a combination of models and geographic information systems (GIS) to identify condor transit flight, perching, roosting, and nesting activity based only on hourly telemetry position reports. By modeling the spatio-temporal sequences of "dots on the map" it is possible to characterize animal behavior patterns. As one example, if the spatial and temporal telemetry patterns from two birds are strongly correlated, our models calculate probability of courtship behavior prior to nesting. In another example, if a condor has a telemetry signal in one location in the early evening followed by signals in the same location the next morning we can assume this location was used as a roost site. Such models have been developed and applied to over 300,000 position records from 50 condors over a seven year time-span.

We identified 31,268 extended perch locations and an additional 15,483 overnight roost locations by translating basic location, speed, and time data into characterizations of bird activities. This approach also correctly identified nine of the ten known nest sites occupied by condors outfitted with telemetry transmitters based only on the telemetry data. The spatial locations of these activities were mapped using GIS. This new analysis approach represents a significant advantage over simple location and movement data normally associated with wildlife telemetry, and is applicable to a wide range of species. For more information, please contact the author.

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Figure 1: Adult condor "AC-6" on Tejon Ranch. Photograph by Christopher B. Cogan

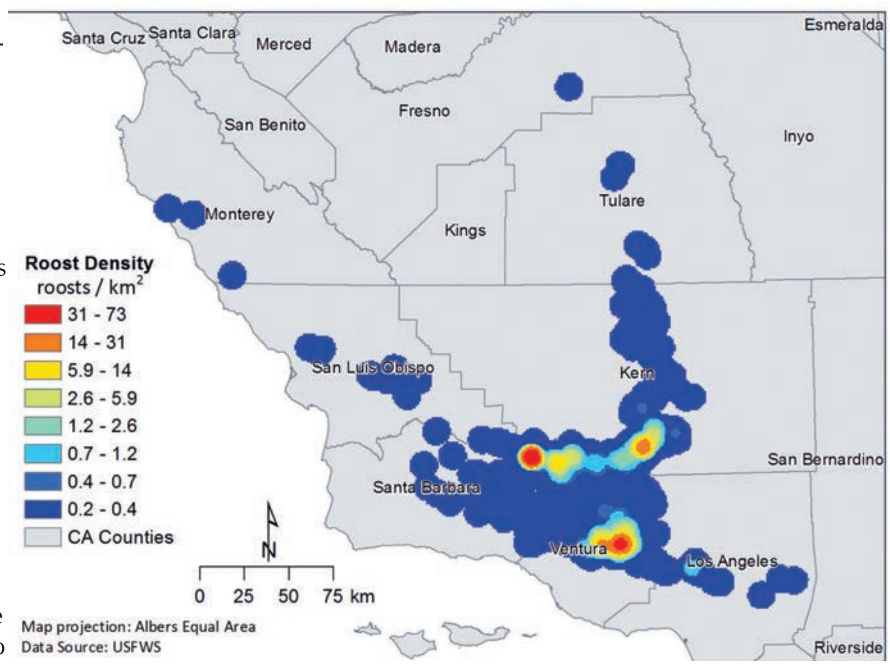

Figure 2: California condor roosts in southern California, 2005 – 2012, as determined by analysis of satellite telemetry data. Roosts are represented as a density field of condor roost events with values ranging from zero to 73 roost events per square km using an 8 km density distribution kernel for smoothing.

Re-examining Travel Time to Work

Among the more recent nuances introduced into urban transportation research is the concept of "travel time ratio" (Schwanen and Dijst, 2002). While traditionally, we have attempted to either increase average vehicle ridership or reduce travel time (or vehicle miles travelled), as evidenced by a number of travel reduction ordinances that appeared in the 1980s and 1990s, research over the last two decades has gradually pointed to the importance of how people perceive their commute time in terms of the number of hours worked. In their research, Schawnen and Djist (2002) illustrated that for most commuters, travel time to work was less than 10% of total work hours, (work hours include the time it takes to commute to work). This translated to about 3.5 minutes for every hour worked, or about 28 minutes for an 8-hour work day. Much earlier, Golob et al. (1995) had discovered a similar pattern in California. The concept of travel time ratio complicates transportation planning by highlighting the difficulty of reducing travel time for those whose commute time is between 15 to 20 minutes. Furthermore, it suggests that an improved job-housing balance may not produce the desired modal split (e.g. higher transit ridership). In other words, the concept of travel time ratio may lead to a nuanced understanding of the urban form.

In order to illustrate this, we need to spatialize "travel time ratio" (Modarres, 2011) and examine its geographic distribution. This can be accomplished by using the American Community Survey (ACS) data for Los Angeles and Orange Counties. This database provides socio-demographic profile and commuting information (e.g., travel time to work, mode of travel, and hours worked per week) at the individual level. However, with the use of PUMAs (Public Use Microdata Areas), we can spatialize this information.

The 2010 ACS data contains information for nearly 5.4 million commuters in Los Angeles and Orange Counties. With a mean of 8.8 and standard deviation of 15, the travel time ratio (at the individual level) varies significantly. This is due to the presence of extreme commuters and people with unusual employment, such as construction contractors who may travel extensively in any one day. For the purpose of this article, I have removed those whose travel time ratio is larger that 15 (i.e., 15 minutes for every hour worked) and those reporting a work week of longer than 60 hours. This reduced the number of individual commuters to 4.8 million (an 11% reduction). For this population, average travel time (Mean= 24.5 minutes and SD=14.7), hours worked per week (Mean=38.9 and SD=9.2), and the resulting travel time ratio (Mean=6.5 and SD=3.7) appeared to be more reasonable (with significantly lower SD values).

To examine the geographic variation of travel time ratios, the average values for each PUMA were calculated. The regional results, illustrated in the map below, suggest that while Palmdale, in the northern part of the county, has an expectedly high travel time ratio, so do portions of South LA.

See Travel Time *top of next page*

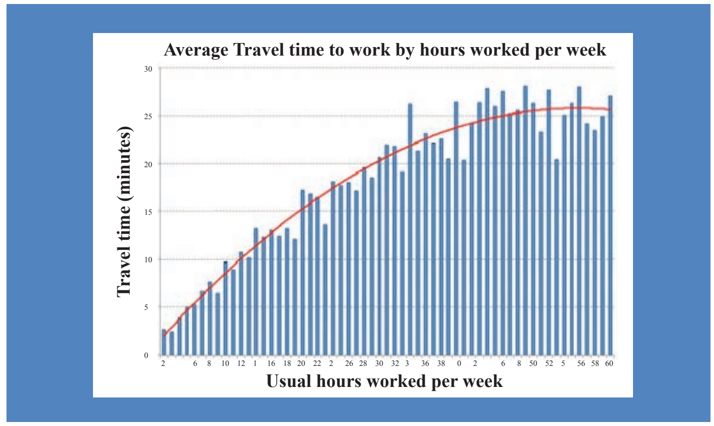

Figure 1: This line graph illustrates that as the number of work hours per week increases, so do average travel times. Actually, the trend line suggests that at about 50 hours per week, average travel times stabilize at about 28 minutes. This is consistent with previous research discussed earlier.

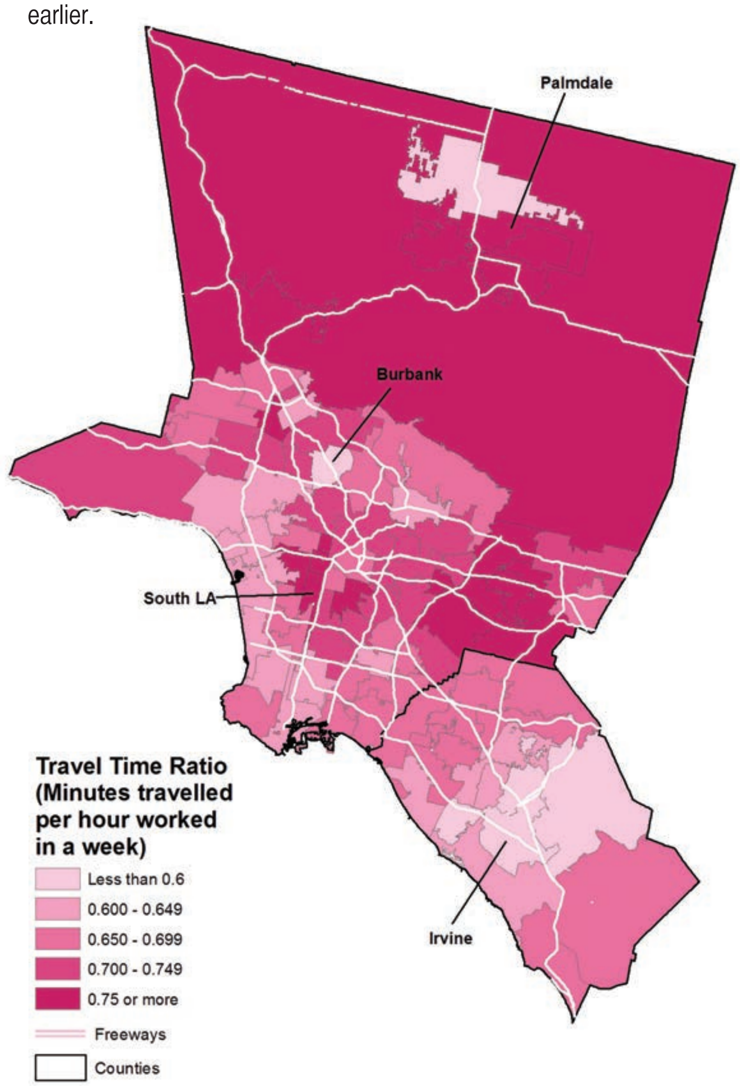

Figure 2: This map illustrates average travel time ratios for all commuters in any one PUMA. Travel time ratio is calculated by dividing one-way travel time to work (in minutes) by total hours worked in a week. Example: For someone with a 20-minute commute and a 40-hour work-week, the travel time ratio is 0.5 (i.e., 20/40).

Travel Time *continued from page 6*

This could be explained by a number of factors, including long commutes by public buses to distant work places. By contrast, Irvine in Orange County displays low travel time ratio values. This is consistent with previous findings and indicative of the importance of employment centers, where housing values and household incomes are better balanced. Job-rich areas such as Burbank also portray reasonably lower travel time ratios, while most areas in the eastern and northern sections of Los Angeles County report longer average commutes and larger travel time ratios.

This brief article illustrates the importance of travel time ratio as an important variable in urban transportation planning. As we focus on better job-housing balances, this indicator could be an additional tool for measuring our success, or lack thereof.

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Modarres, A. (2011) Polycentricity, Commuting Pattern, Urban Form: The Case of Southern California." International Journal of Urban and Regional Research, 35(6), 1193-1211.

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Organ Donors *continued from front page*

cases distinctive state boundary effects (notably Georgia) hint at a regulatory or institutional reason for these differences.

Another probable source of observed variation in donor potential rates is distinct differences in the age specific mortality rates and causes of death for rural southern African Americans. Unlike urban African Americans, this group also has higher donation rates relative to medically suitable deaths, although it is not clear whether this is due to cultural differences or more aggressive recovery practices by organ recovery teams. In Figure 2, variation in donor rates are distinctly geographic: lower rates are seen in dispersed low density regions such as the prairies, and higher rates in some areas of the mountain west where populations are tightly clustered locally. Some metropolitan areas, notably Kansas City and Atlanta, have both high donor potential rates and high relative donor rates, thus yielding more recovered organs than other comparable areas.

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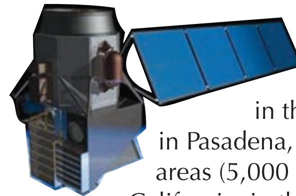
Hyperspectral *continued from back page*



to shortwave sensor (60-m spatial resolution, 380-2510 nm, 214 bands). A NASA team, based in the Jet Propulsion Laboratory (JPL) in Pasadena, will fly the jet to cover six large areas (5,000 to 30,000 km2) of California, in the spring, summer and fall of 2013 and 2014. These airborne data will provide a unique opportunity to work with hyperspectral imagery over large areas and through time, a key advantage offered by a satellite such as HyspIRI.

Top left: Artist conception of the HyspIRI satellite sensor. *Source:* http://hyspiri.jpl.nasa.gov/

Bottom: NASA's ER-2 high-altitude research aircraft in flight. *Source:* http://www.dfrc.nasa.gov/gallery/photo/ER-2/Medium/EC01-0232-6.jpg

Dr. Clark's research team based in CIGA will focus on mapping California's natural vegetation from the simulated HyspIRI imagery. The team will work at two classification scales: at the life-form level for all images acquired and at the National Vegetation Classification System (NVCS) alliance level (i.e., community scale) for images covering Bay Area coastal mountains and Yosemite National Park. Vegetation spectral properties measured by remote sensors result from the chemical absorptions, structure and physiology of plants and other background materials in a pixel. Hyperspectral processing techniques will be used to exploit the high spectral resolution of the imagery to identify those spectral properties that best distinguish different vegetation types. Techniques will include spectral mixture analysis, narrowband indices, spectroscopic analysis, and decision-tree classifiers. In addition to spectral detail, the time-series of images will provide valuable information on plant seasonal changes (e.g., changes in leaf color) that can further improve vegetation discrimination. A major goal of this research is to demonstrate the potential of HyspIRI to provide more detailed, accurate and temporally-stable maps of diverse floristic types relative to what is possible with conventional satellites, such as Landsat. Finally, the CIGA team will explore spectral-temporal variation within vegetation alliances with relationship to underlying environmental and seasonal factors.

In support of this research, students will collect alliance-level data in the field and life-form samples using Google Earth imagery embedded in a web-based tool, as well as help with image processing and GIS tasks. First results from the life-form mapping effort should be available for next year's Geospatial Review!

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Discriminating California's Natural Vegetation Types with Multi-temporal Hyperspectral Imager

The Hyperspectral Infrared Imager (HyspIRI) is a satellite currently being considered by NASA to improve our ability to map and monitor the Earth's ecosystems and provide timely information on natural disasters (hyspiri.jpl.nasa.gov). In contrast to existing Earth-observation satellites, which typically provide images from a few broad bands of energy in the electromagnetic spectrum (i.e., multispectral), HypIRI will be a hyperspectral sensor, or imaging spectrometer, that provides images using energy from hundreds of narrow spectral regions. These images extend beyond what human eyes can sense in visible light to include near-infrared, shortwave and thermal energy. This technology should improve our ability to map the Earth's surface, such as natural and anthropogenic land cover, plant chemistry, physiology and stress, natural disturbance (e.g., fire), and environmental disasters. However there is a need to demonstrate this capability in support of HyspIRI mission planning.

Dr. Matthew Clark, in Sonoma State's Center for Interdisciplinary Geospatial Analysis (CIGA), is one of fourteen principal investigators to be awarded a new three-year research grant within NASA's HyspIRI Preparatory Airborne Activities and Associated Science program. Dr. Clark and fellow researchers in this program will use images from NASA's airborne hyperspectral sensor (AVIRIS) acquired at 70,000 feet from an ER2 jet to simulate images that could be acquired from HyspIRI's visible

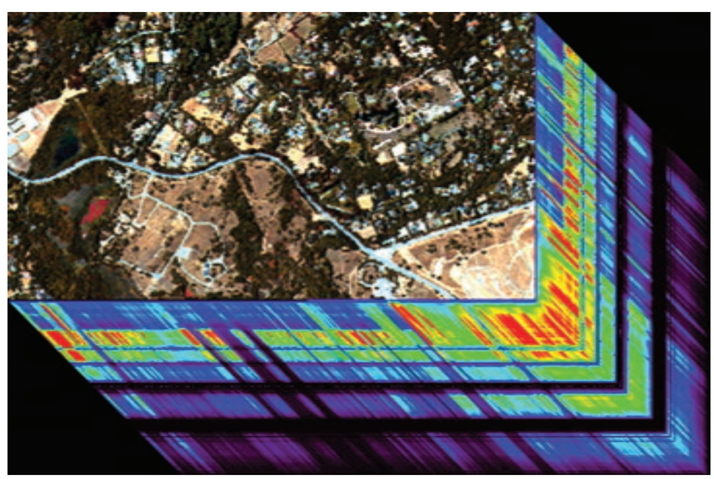

Figure 1: Hyperspectral image of the Jasper Ridge Biological Reserve near Stanford, made from an AVIRIS image with 224 bands, acquired from the AVIRIS sensor.

See Hyperspectral *on page 7*