# Dr. Paul C. Sutton

## Research Statement

My research is in the broad area of the Human-Environment-Sustainability problematic. I bring a geographic perspective and an expertise in GIS and spatial data analysis to bear on interesting interdisciplinary questions of sustainability, ecosystem service valuation, population geography, and the spatial representation of economic activity. For example, economic valuation of ecosystem services attempts to place a dollar value on non-marketed ecosystem functions that provide benefits to humans. Coastal wetlands provide storm protection services in that they mitigate the damage to human made capital caused by hurricanes and their storm surges. The dollar value of these services varies spatially as a function of many things including: frequency of storms, location of coastal wetlands relative to the built infrastructure, and spatial variation in the intensity of economic activity. I devise ways to represent and analyze these phenomena to capture spatial variability in the valuation of ecosystem services. I have a vibrant, multi-pronged research agenda that serves my interests and provides opportunities for my students to make significant contributions to progress in Geography. The following is a summary of my ongoing research contributions and some information about my graduate students.

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### ONGOING RESEARCH CONTRIBUTIONS

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**The NightSat Mission**

My extensive work on the use of nighttime satellite imagery as a proxy measure of population, impervious surface, economic activity, and the human ecological footprint has contributed to interest in the development of a NightSat mission. I serve on the science team of a $150 million proposal to NASA (The P.I. is Chris Elvidge of the National Geophysical Data Center at NOAA in Boulder). As an Urban Metabolism Scientist, I will be responsible to the PI for conducting research that identifies and documents how the improved spatial and spectral resolution of NightSat data products will inform our understanding of the human-environment-sustainability problematic as it pertains to the following: 1) urban growth and land use patterns, 2) mapping and monetizing the human ecological footprint, and 3) characterizing the megapolitan-urban-exurban gradient and its impacts on ecosystem function, habitat fragmentation, and ecosystem services.

**Geo-location and Radiance Calibration of the DMSP OLS Sensor**

I obtained an internal DU grant to build and shine bright lights at the DMSP OLS satellite from dark places. The DMSP OLS has coarse spatial and spectral resolution that contributes to errors in our ability to geo-reference the imagery and separate fires from city lights from lightning. The low dynamic range of the DMSP OLS also presents many uncertainties with respect to the radiometric accuracy of the sensor. This effort focuses on characterizing and calibrating the DMSP OLS imagery by lighting up pixels in dark places using a known and controllable light source.

**Valuation of Ecosystem Services**

I bring my expertise in GIS and spatial data analysis to collaborations with economists and ecologists to make spatially explicit valuations of ecosystem services. The geographic perspective I bring to these analyses takes this research beyond the simple ‘benefits transfer’ model of ecosystem service valuation in which a ‘wetland is a wetland is a wetland’. For example, the values of the erosion control services of boreal forests vary spatially as a function of their location relative to human capital and the frequency and intensity of rainfall.

**Development of independent and objective Sustainability Metrics**

I have developed several simple, easy to measure, and objective metrics of sustainability that correlate strongly with more complex, sophisticated, and well-established metrics such as the Global Footprint Network's 'Ecological Footprint'. I take advantage of spatially explicit datasets that have global coverage to simplify the difficulty of measuring something as abstract as sustainability. For example, in my paper: "*The Real Wealth of Nations: Mapping and Monetizing the Human Ecological Footprint*" I used anthropogenic impervious surface as a proxy measure of the human impact on the environment and net primary productivity as a proxy measure of the earth's natural endowment. I 'value' both globally at 50 trillion dollars and subtract their spatially explicit representations from one another to provide a nationally aggregated and monetized index of sustainability.

**Mapping Economic Activity using Nighttime Satellite imagery**

Economic data such as GDP and GDP per capita is typically only available at aggregate national levels. Many interesting science questions demand better information on the spatial distribution of economic activity and the distribution of wealth. In addition, economic data is non-existent or of suspect quality in many parts of the world. I have used nighttime imagery as a proxy measure of economic activity to produce spatially disaggregated maps of economic activity and to make independent estimates of common statistics such as GDP. I contributed to the development of methods for estimating the fraction of the national economy of India and Mexico that is in the informal sector and mapped it. I also contributed to the production of the first global map of GDP/capita at 1 $km^2$ spatial resolution. This work relating the estimation and mapping of economic activity using nocturnal satellite observations is gaining traction with researchers at Yale and UCLA.

**Issues of Scale and Representation in Geographic Data**

My paper titled: *Building and Evaluating Models to Estimate Ambient Population Density* won an award for its contribution in this area of scale and representation. Figuring out how best to represent spatially and temporally varying phenomena in a digital environment is a fascinating problem of scale, classification, and abstraction. The simple idea of representing the spatio-temporal variation of intra-urban population density is a good example of how this is not really a simple problem. In my efforts at modeling proxy measures of population density, economic activity, and ecosystem service value I have enjoyed struggling with these insurmountable problems and hope to make further contributions to methods that will inform our understanding of the roles these phenomena play in questions of sustainability.

**Measuring Learning Outcomes for undergraduate Geography Students**

I am actively involved in identifying what it is, exactly, that we believe we are teaching to undergraduate geography students. End of course student evaluations are not a measure of teaching effectiveness. I applaud efforts at the development of instruments such as the AP Human Geography exam that attempt to actually measure what students of Geography have presumably learned. I am developing metrics of 'Learning Outcomes' for undergraduate degrees in Geography because I think it is imperative that we as faculty in this discipline can answer questions like: "*What will I learn from taking a degree in Geography that I won't learn from taking some other degree?"*

**Graduate Student Advising for Paul Sutton** (1999 – Present)

| Name | Degree | Type | Year | Role |
|---|---|---|---|---|
| Pete Biven | PhD | Dissertation | current | Advisor |
| Qing Liu | PhD | Dissertation | current | Advisor |
| Amir Siraj | PhD | Dissertation | current | Advisor |
| Mike Finn | PhD | Dissertation | current | Advisor |
| Michael Dunnington | MS | Non-Thesis | current | Advisor |
| Brenton Wonders | MS | Thesis | 2010 | Advisor |
| Tilottama Ghosh | PhD | Dissertation | 2010 | Advisor |
| Chris Rice | MS | Non-Thesis | 2009 | Advisor |
| Austin Stevens | MS | Non-Thesis | 2009 | Advisor |
| Ryan Abeloe | MS | Non-Thesis | 2008 | Advisor |
| Deep Bhari | MS | Non-Thesis | 2008 | Advisor |
| Patrick Duffy | MS | Non-Thesis | 2008 | Advisor |
| Kerry Shakarjian | MS | Thesis | 2008 | Advisor |
| William Jeffrey | MS | Thesis | 2007 | Advisor |
| Andrew Bingham | MS | Non-Thesis | 2006 | Advisor |
| Patrick Hayward | MS | Non-Thesis | 2005 | Advisor |
| Yaneev Golombek | MS | Non-Thesis | 2005 | Advisor |
| Matthew Kascak | MS | Non-Thesis | 2005 | Advisor |
| Lisa Piscopo | PhD | Dissertation | 2005 | Advisor |
| John Van Auken | MS | Thesis | 2004 | Advisor |
| Heather Hicks | MS | Non-Thesis | 2003 | Advisor |
| Maryanne Koshak | MS | Thesis | 2003 | Advisor |
| Brenden McNeil | MS | Thesis | 2003 | Advisor |
| Thomas Murray | MS | Non-Thesis | 2003 | Advisor |
| Katherine O'Connor | MS | Thesis | 2003 | Advisor |
| Anita Olsen/Hoover | MS | Non-Thesis | 2003 | Advisor |
| Susan Parks | MS | Thesis | 2003 | Advisor |
| Jason Thoene | MS | Non-Thesis | 2003 | Advisor |
| Christopher Grubb | MS | Thesis | 2002 | Advisor |
| Frank Orr | MS | Thesis | 2002 | Advisor |
| Janice Vaughn | MS | Thesis | 2002 | Advisor |
| Andrew Kuster | MS | Thesis | 2001 | Advisor |
| Alex Muleh | MS | Thesis | 2001 | Advisor |
| Jessica Noonan | MS | Thesis | 2001 | Advisor |
| Heather Knight | MS | Thesis | 2000 | Advisor |
| Keri Konarska | MS | Thesis | 2000 | Advisor |

| Name | Degree | Year | Role |
|---|---|---|---|
| Amanda Gierow | PhD | current | Committee |
| Ben Tuttle | PhD | current | Committee |
| Joseph Hoover | PhD | current | Committee |
| Kimberly Henderson | PhD | current | Committee |
| Kristina Yamamoto | PhD | current | Committee |
| Sharon Gabel | PhD | current | Committee |
| Sutapa Bandyopadhyay | PhD | current | Committee |
| Emily Sanschagrin | MA | 2010 | Committee |
| Katherine Williams | MS | 2010 | Committee |
| Brett Machovina | PhD | 2009 | Committee |
| Kristina Yamamoto | MS | 2009 | Committee |
| Lauren Morse | MA | 2009 | Committee |
| Sean Tierney | PhD | 2009 | Committee |
| Kevin Gilmore | PhD | 2008 | Committee |
| Duane Holt | MS | 2007 | Committee |
| Ben Tuttle | MS | 2006 | Committee |
| Megan Gall | MS | 2006 | Committee |
| Migdalia Ortiz | MS | 2006 | Committee |
| Tim Vowles | PhD | 2006 | Committee |
| Andrea Santoro | MS | 2005 | Committee |
| Frank Dong | MS | 2005 | Committee |
| Heidi Rolander-Peterson | MA | 2005 | Committee |
| Jared Long | MA | 2005 | Committee |
| Mindy Syfert | MS | 2005 | Committee |
| Francine Beck | PhD | 2005 | Committee |
| Christine Richter | MA | 2003 | Committee |
| Katherine O'Connor | MS | 2003 | Committee |
| Michael Alonzo | MA | 2003 | Committee |
| Joanne Stewart | MA | 2002 | Committee |
| Darrick Kizlyk | MA | 2000 | Committee |

| Totals | # of Students |
|---|---|
| PhD (advisor) | 6 |
| MS Thesis/Project (advisor) | 16 |
| MS non-thesis (advisor) | 13 |
| **Total (primary advisor)** | **35** |
| PhD (committee) | 12 |
| MS (committee) | 10 |
| MA (committee) | 8 |
| **Total (Committee member)** | **30** |

## Student Dissertations and Theses for whom I served as Primary Advisor

**Tilottama Ghosh (PhD) :** Shedding light on the spatial distribution of economic activity using nighttime satellite imagery

**Lisa Piscopo (PhD):** Explanation of variability of CSAP scores in Colorado Public Schools

**Brenton Wonders (MS):** An analysis of error introduced during equal-area map projections

**Bill Jeffrey (MS)**: Does Urban Sprawl Correlate with Commuting Time?

**Marianne Koshak (MS):** Using GIS to Identify Areas in Colorado Underserved by the Vaccine for Children Program

**John Van Auken (MS):** Evaluation of Spatial Analytic techniques to predict the next crime in crime series

**Heather Knight (MS):** GIS Web Application for Air Quality Monitoring Station Information in the National Parks

**Keri Konarska (MS):** Evaluation of the Scale Dependence of Ecosystem Service Valuation; A Comparison of NOAA-AVHRR, and Landsat TM Data Sets

**Brenden McNeil (MS):** Implementation of a 3-D GIS Application at Timpanogos Cave NM, Utah

**Andrew Kuster (MS):** Using GIS to Develop a Non-Ticket Shoreline Parcel Acquisition Plan for Public Access Preservation

**Jason Thoene (MS):** Implementaion of a GIS for Regional Management of Leafy Spurge (Euphorbia Eusula) and Yellow Starthistle (Centauraea Solstitialis) in the Western US

**Frank Orr (MS):** The New Pueblo Freeway: A project website using ArcIMS

**Jessica Noonan (MS):** Growth in Denver: Assessing the Roles of Population and Land Use Decisions in the Denver Metro Area using Landsat imagery and US Census Data

**Susan Parks (MS):** Spatial Pattern Analysis of Landsat ETM Satellite Imagery to Determine Logging Extent and Intensity in the Eastern Amazon

**Chris Grubb (MS):** A prototype of the Kansas City Regional Crime Analysis Geographic Information System

**Alex Muleh (MS):** Development of Custom Microsoft .NET and ESRI Arc Objects based line of Sight tools for location suitability, Launch planning and Telemetry Tower Placement