

## Thursday, September 15, 2005

- 8:00 am **Poster set up for Sessions I and II**
- 8:30 am **Coffee and light refreshments**
- 9:00-9:30 am **Welcoming remarks**  
David Lightfoot, Assistant Director – Directorate for Social, Behavioral, and Economic Sciences: SBE in the Federal R&D World, Functions of Interdisciplinary Activities for the SBE Sciences
- 9:30-9:45 am **Review of agenda, administrative information**
- 9:45-10:30 am **Project Introductions I**  
Rapid-fire presentations - 3 minutes, one graphic each
- 10:30-11:30 am **Poster Session I**
- 11:30-1:00 pm **Breakout Session I and working lunch**
- 1:00-2:00 pm **Keynote Presentation**  
John O'Loughlin, University of Colorado at Boulder: *The Dynamics of Civil War Outcomes: Bosnia and the North Caucasus*
- 2:00-2:45 pm **Reports from Breakout Groups**
- 2:45-3:30 pm **Project Introductions II**  
Rapid-fire presentations - 3 minutes, one graphic each
- 3:30-4:30 pm **Poster Session II**
- 4:30-5:30 pm **SGER Panel - Rapid Response Research**
- 6:00 pm **Reception, Stafford I 375**

## Friday, September 16, 2005

- 8:00 am **Poster set up for Session III**
- 8:15 am **Coffee and light refreshments**
- 8:45-9:30 am **International Panel**  
Moderator: Wanda Ward, Deputy Assistant Director, Directorate for Social, Behavioral and Economic Sciences  
Panelists:  
Peter Bogason, European Commission  
Hans-Peter Blossfeld, European Science Foundation  
Fiona Devine, Economic and Social Research Council  
Gerard Hodgkinson, University of Leeds  
Theodius Lennon, European Commission  
Wenhui Shan, Fudan University \*  
Wei Zhang, National Natural Science Foundation of China
- 9:30-10:15 am **Project Introductions III - Rapid-fire presentations**
- 10:15-11:15 am **Poster Sessions III (Rooms 595)**
- 11:15-12:00 pm **Infrastructure Session**  
Moderator: Patricia White, Program Director, Social and Economic Sciences, SBE  
Geoffrey Bowker, Santa Clara University – Interoperability Strategies for Scientific Cyberinfrastructure: A Comparative Study

Steven Ruggles, University of Minnesota  
International Integrated Microdata Series

12:00-1:30 pm

**Breakout Session II and Working Lunch**

1:30-2:15 pm

**Reports from Breakout Groups**

2:15-2:45 pm

**Wrap up and General Discussion**

Rachelle Hollander and Keith Crank

NSF funding opportunities, Leveraging NSF funds, The future of HSD, Future PI meetings

## Agents of Change Emphasis Area

**Geoffrey Bowker, Santa Clara University**

Interoperability Strategies for Scientific Cyberinfrastructure: A Comparative Study  
0433369

This project is a comparative study of interoperability strategies within three contemporary cyberinfrastructures. Our methods include ethnographic, interview, and content data analysis to provide a situated social and organizational comparison of three scientific projects employing distinct infrastructures and deploying approaches to achieving data interoperability.

The three projects are:

1. GEON (<http://www.geongrid.org>), a cyberinfrastructure for the US geo-sciences aimed at providing scientific data and resource sharing services to a broad range of disciplines to ensure a more integrated picture of earth processes.
2. LTER (<http://lternet.edu/>), a federated network of biome sites developing an information infrastructure that aims at enabling inter-disciplinary collaboration and preserving data for the long-term in the ecological sciences.
3. Ocean Informatics, nascent initiative for the ocean sciences based at UCSD Scripps Institution of Oceanography that aims at sharing scientific data using a collaborative design environment.

As the new scientific cyberinfrastructure is emerging, a central question being posed is how to share data across multiple distributed organizational and social contexts. While there have been a wealth of suggestions for technical fixes for this pressing concern (particularly important since some of the great political questions of our day, such as preserving biodiversity and developing a sustainable relationship with our environment pivot on the ability to federate data across organizational and disciplinary contexts), there has been little study - and no comparative study - of the organizational and social dimensions of differing interoperability strategies.

Our working hypothesis, drawing on research in the field of social informatics over the past fifteen years, is that the creation of a common shared data infrastructure entails complex negotiations relating to the relative institutional weight of the different actors (institutions have a range of motives for subscribing or not to interoperability strategies), the nature of their disciplinary organization (in particular reward structures; openness to interdisciplinary work; history of use of large datasets) and the nature of their domain work (degree of commitment to long-term data storage and re-use; decay rate of data over time; need to draw on large federate datasets).

Through this study, we develop a grounded understanding of the organizational complexity producing shared scientific cyberinfrastructure.

**Project Website** <http://interoperability.ucsd.edu/>

**Charli Carpenter, University of Pittsburgh**

Children as Legacies of War: Humanitarian Actors as Agents of Change

0452742

### **Overall Mission Objective**

The objective of our project was to explore the humanitarian response to children born of wartime rape and sexual exploitation. We sought both to analyze the social response to such children in conflict settings characterized by mass rape or sexual exploitation by troops and peacekeepers. We also wanted to consider what role human rights advocates in post-conflict situations can play in mitigating negative socio-cultural reactions to children born of mass rape or exploitation. Because of the preliminary nature of the work, the project centered on amalgamating existing data and developing case studies on the issue, and gauging the state of humanitarian knowledge and practice with respect to addressing it, as a prelude to carrying out longitudinal evaluations of the effectiveness of humanitarian initiatives in this area.

### **Progress and (Preliminary) Outcomes**

1) NSF funds were used to convene an interdisciplinary workshop at University of Pittsburgh, bringing together practitioners and academics from a variety of disciplines and seven countries to present papers and discuss the ways in which conflict-affected societies react to children born as a result of wartime rape. The workshop combined theoretical insights about post-conflict justice, humanitarian action, and human rights law with four detailed case studies on Bosnia, Sierra Leone, Uganda and East Timor, each written by practitioners with experience in the field. The most rigorous of these papers were revised and edited for inclusion in a volume of essays on this topic, which is now under review at Kumarian Press.

Evidence from the case studies written by workshop participants and published in the edited volume demonstrate that the societal response to children born of wartime rape and sexual exploitation varies greatly by context, but that regardless of the cultural context they are likely to be a particularly vulnerable population in post-conflict societies due to a variety of factors. These include the health effects associated with trauma during pregnancy and childbirth; affective bonding difficulties between mother and child; the potential for stigma from the mother's community of children viewed as belonging to the outside; and the economic marginalization of rape survivors and their children generally. Factors mitigating these outcomes seem to include the presence of alternative care arrangements for mothers who wish to give up their babies, the availability of psycho-social, medical care and economic opportunities for those who wish to keep their children, the attitudes of the mother's extended family. Hypotheses have also been generated during the research process about the relative severity of the societal impact (and therefore the impact on these children's rights) based on the nature of the sexual violence; the extent to which lineage is visible in the child's features; the religious composition of the victim and perpetrator societies; where the circumstance of conception fall on a scale between sexual exploitation and sexual violence. Ultimately, more comprehensive research is required to explore these hypotheses and determine whether the patterns observed in the case studies are generalizable, as they are based primarily on the anecdotal record and on information cobbled

together from studies primarily designed to address sexual violence against women, rather than children born as a result.

2) Concurrent with the development of the edited volume, which aimed to shed light on and build theory regarding the treatment of these children in post-conflict societies, NSF funds were used to convene a series of four focus groups with humanitarian practitioners to assess the nature of the humanitarian response to this issue. Focus groups were held in New York, Geneva and Pittsburgh, and drew on human rights and humanitarian organizations with some expertise in child protection and/or gender-based violence in armed conflict. The focus groups constituted a means to raise awareness of this issue among humanitarian policy-makers, to gather data on the state of and gaps in existing knowledge and practice, and to engage practitioners in evaluating the methods and objectives of the research project itself. A series of verbatim transcripts is archived at the University of Pittsburgh and currently being analyzed using Atlas.ti 5.0 qualitative data analysis software. This analysis will culminate in a report on the humanitarian response to this issue and will inform the development of a more comprehensive study on this topic.

Generally, the focus groups suggested that little attention has been paid to this specific group in the humanitarian sector. Humanitarian practitioners generally concur on this point, but they disagree over whether this is a good thing: some argue that humanitarian needs are best served by channeling aid to this population in the context of broader groups, rather than addressing their specific needs. Others argue that stigma cannot be overcome and specific health needs addressed without naming the population and the types of discrimination they face. However, references to a few specific programming initiatives were identified during this project that could form the basis of a comparative study on the relative effectiveness of different strategies for promoting these children's rights in the context of post-conflict social transformations.

A third finding, however, is that although there is some recognition of the vulnerability of these children due to societal attitudes about their origins, approaches to conceptualizing their human rights are contested. Participants in the working group and focus groups agreed on the nature of the problem but significant disagreement existed on how to apply the discourse of human rights or of humanitarian action to address their concerns. Several of the theoretical essays in the edited volume suggested that conventional understandings of 'human rights culture' or 'post-conflict justice' do not adequately capture the needs of this population. There was also dissent within the working group on what it would mean to conduct ethical research on this population. We found that the issue needs to be approached with care, and one testable hypothesis about the relative neglect of this issue in the humanitarian sector is precisely that such concerns as these make this population a difficult one to deal with directly.

**Broader Impacts** Several graduate students received training and employment in connection with this project. Synergy was created within the humanitarian sector during focus groups over the course of this project, and efforts were made to connect these practitioners, through the NSF project, to the broader human security research being conducted within the Ford Institute of Human Security at University of Pittsburgh. The PI has also presented scholarly work in connection with the project at the International Studies Association, and the Association of

Genocide Scholars. Additional speaking engagements on this issue were carried out at the UNICEF Innocenti Research Institute in Florence, Italy and at UNICEF's Global Policy Section on New York. In addition to these forms of outreach, the project website includes a select bibliography on this issue as well as a series of short thematic country case-studies.

**Project Website** <http://www.pitt.edu/~charli/warbabies>

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**Damian Fernandez, Florida International University**

Comparative Civic and Place Engagement in Three Latino Enclave Neighborhoods in Transition  
0433947

**Project Description**

With all the talk about rising urban property values in many U.S. cities, gentrification is on the agenda of public agencies and private citizens alike. Gentrification entails a process whereby relatively affluent people move into urban neighborhoods, purchase relatively undervalued single-family homes, renovate them, and reap the rewards of proximity to downtown employment and amenities (or their increased resale value). In some neighborhoods, such as Miami's inner-ring areas, relatively luxurious high-rise condominiums are also being rapidly constructed to address the desire for proximate upscale housing by affluent urbanites. In many cases, those displaced by rising property values are lower-income ethnic minority populations.

In a related, and equally discussed arena, the impact of the rising Latino/a population of U.S. cities has deeply affected public opinion and policy alike. Is the U.S. becoming "Latinized," and if so, what does this mean? Will voting behaviors change? Do Latinas/os behave, civically, in ways similar to Anglo populations, or do they defy established understandings?

This project brings the redevelopment and the Latinization of U.S. cities into conversation. The research entails a three-city comparison of inner-ring Latino enclave neighborhoods: Pilsen (in Chicago), Garfield (in Phoenix), and East Little Havana (in Miami). In all three neighborhoods, established Latino groups face challenges both from new Hispanic immigrants and from relatively wealthy gentrifiers. This research will allow a systematic, comparative assessment of how individuals and groups interact with one another civically through organizations to shape their physical surroundings, and how these surroundings in turn foster or hinder belonging and exclusion. Because the majority of Hispanics in the U.S. reside in urban areas, Phoenix, Chicago, and Miami – with their large and growing Latino populations, their diverse regional locations, and their historic and contemporary roles as gateway cities for Latino immigrants – are appropriate choices for the proposed research.

The PIs form a six-member interdisciplinary team of geographers, political scientists, and an anthropologist. In each neighborhood, teams of two local PIs will work in tandem with local graduates and undergraduates utilizing a combination of quantitative and qualitative methods in four phases, including i) preliminary interviews, ii) large-scale survey, iii) in-depth interviews, and iv) focus groups. Data will be geocoded and georeferenced for spatial analysis in a

Geographic Information System (GIS). The project duration is three years, from January 2005 – December 2007.

### **General Objectives**

The expected outcomes of this research are threefold: to i) foster interdisciplinary synergy resulting in empirical and theoretical advances, and applications of GIS to social research, ii) to spark continuing comparative collaborations amongst academics and between academics and policymakers, and iii) to train underrepresented graduate and undergraduate students. This research is strongly supported by initial findings from pilot research which suggests that inner-ring Latino enclave neighborhoods are sites of intense struggle that telescope broader issues. The intellectual merit of this project arises from its contributions to understanding contemporary urban socio-spatial dynamics. These engage at multiple scales, and include negotiation of i) new Latino diasporas and the perceived ‘Latinization’ of the United States, ii) the unfolding uneven geographies of development, and iii) changing bases of human solidarity and cleavage. Research on civic engagement has largely ignored the spatial arena through which civic engagement is conducted and indeed shaped. Likewise, research on the changing spatiality of cities has paid scant attention to the diversities within immigrant and ethnic groups and how these diversities shape the ways that immigrants and ethnics engage with the physical spaces of neighborhoods in materially consequential ways. The dramatic spatial transformations underway in inner-ring neighborhoods provide an ideal environment to query the assumptions that immigrants and inner-city minority populations are civically disengaged, that civic presence amongst Latinos is lacking, and that decisions over the shape, use, and control of neighborhood spaces is out of the grasp of residents. This research also clarifies debates over the existence and modalities of pan-ethnic solidarity, and addresses assumptions about Latinos as political actors.

### **Progress and Preliminary Outcomes**

As of August, 2005, Phases I and II have been concluded in Miami and Chicago, and Phase II is near completion in Phoenix. Thus 400 surveys have been administered in Miami, 400 in Chicago, and to-date 200 in Phoenix. An Access database is being currently constructed, with data coding and entry scheduled for September (and upon conclusion of Phase II for Phoenix). Phases III and IV of the project, which will encompass in-depth interviews and focus groups in each site, are scheduled to begin in September for Miami and Chicago, and upon conclusion of Phase II for Phoenix. Because survey data has yet to be coded and entered, we currently have no preliminary empirical outcomes. These are expected later in the Fall of 2005.

The PIs and Senior Personnel met in Austin, TX in February, 2005, to discuss launch of the survey phase: design of the survey instrument, random selection methodology, and surveying protocol. We will meet again in Phoenix in November, 2005 to discuss data analysis and the transition to Phase III of the project. In March, 2006 we will present preliminary results at the Latin American Studies Association meeting in Puerto Rico.

Progress on graduate and undergraduate research training has been notable. In Miami 2 graduate and 3 undergraduate RAs were supported during the survey phase (3 of these Hispanic), with similar numbers for Phoenix and Chicago. We expect the training of underrepresented minorities resulting from this project to be substantial and beneficial, in terms of dissertation research

arising directly from the project, co-authored publications with PIs, as well as career choice and/or graduate school for the undergraduate RAs.

**Broader Impacts** Global changes have set in motion new human diasporas, shaped new geographies of wealth and power, and reworked the social and spatial landscape of large cities. Understanding the human and spatial dimensions of these reorganizations, and how people engage with and actively shape them, constitutes the broader impact of this project. Inner-ring ethnic enclave neighborhoods distill broader contentions over immigration, urban redevelopment, political participation, and citizenship. How these issues are addressed is seen by some to shape the very identity of the U.S. Negative or reactionary policy toward Latino immigration as well as anxiety over the perceived ‘Latinization’ of the U.S. might be understood in part as a consequence of insufficiently nuanced knowledge. The research addresses calls for collaboration across a broad range of social science themes (urban studies, ethnic studies, immigration studies) and social science disciplines, as well as integrating a spatial statistics component. Finally, the proposed research directly addresses the educational and training goals regarding Hispanic students of the home institutions of the PIs as well as the PIs’ respective disciplinary associations.

**Website** We had originally planned for the Inter-University Program for Latino Research at Notre Dame to assist in developing a website for this project. However there is not adequate funding, either from IUPLR or the grant, to provide for this. Currently we are looking into the feasibility of graduate assistants at FIU working on such a website. In any event, the website would become relevant only when a significant portion of the raw data are analyzed, which should be mid-2006.

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### **Jefferson Fox, East-West Center**

Understanding Dynamic Resource-Management Systems and Land-Cover Transitions in Montane Mainland Southeast Asia

#### **Overall Mission/Objective**

Contemporary concerns with climate change, global environmental change, and sustainability have rejuvenated interest in the development of an integrative theory of human-environment relationships. Montane mainland Southeast Asia is a region of great biological and cultural diversity that has come under close scrutiny in the last several decades as a result of both real and perceived deforestation, land degradation, and most recently, the conversion of traditional agricultural practices to more permanent cash crop agriculture driven by regional and global markets. This project seeks to understand how resource management systems in montane mainland Southeast Asia are changing in the wake of commodification of resources in order to appreciate how these changes may affect sustainable resource use, landscape transformation, and land cover.

The project is constructed around three broad research objectives:

1. To use an environmental entitlements approach to inform economic, demographic, institutional, and cultural data collection at household, district, provincial, national, and international scales on factors affecting land-cover and land-use change in the region. This analysis will be used to develop narratives of economic, demographic, institutional and cultural change in the region including changing political economics, environmental feedbacks on land use, and external shocks.
2. To link economic, demographic, institutional and cultural data to a comprehensive, high-resolution spatial database of land cover in montane mainland Southeast Asia developed in a project funded by NASA (see below).
3. To develop cellular automata and agent-based models that utilize the narratives of economic, demographic, institutional, and cultural change within the spatial framework to address “what if” questions concerning hypothesized changes in social and biophysical variables and to increase our understanding beyond the available empirical data.

A multidisciplinary team (including economists, foresters, geographers, and social scientists is collecting economic, demographic, institutional and cultural data and tying these data together in a multi-temporal high-resolution spatial database (the spatial database is being put together as part of a [NASA funded project](#)). Data are being used to develop a narrative of land-cover and land-use change in montane mainland Southeast Asia. We are also building cellular automata and agent-based models to address "what if" questions concerning hypothesized changes in social and biophysical variables and to increase our understanding beyond the available empirical data.

### **Progress and (Preliminary) Outcomes**

To date the project has made significant progress towards completing the first objective of the project, i.e., collecting economic, demographic, institutional, and cultural data at different scales including (1) major river systems (e.g. Mekong, Chao Phraya), (2) river basins (e.g. Upper Ping – 25,000 km<sup>2</sup>) and sub-basins (e.g. Mae Chaem – 4,000 km<sup>2</sup>), and (3) local sub-watersheds (about 10 to 100 km<sup>2</sup> orders of magnitude) and individual community and household levels. These levels are useful in terms of analyzing issues of scale, but are also important because of government programs to encourage development of actors and institutions at these various nested levels. We are using both qualitative and quantitative methods to understand the nature of human and environment interactions in the region.

At the major river systems scale we are working in the Mekong and Chao Phraya basins. We have documented changes in national policies influencing land use (e.g., tenure, taxation, credit, import and export regulations) as well as changes in infrastructure (roads and markets). At the river basin and sub-basin scale we are working in the Luang Namtha basin in northern Laos and the Nan-e watershed in Yunnan. We have conducted focus group and household interviews, participatory exercises (fuzzy cognitive mapping) to learn more about key stakeholders in resource management and historical trend of resource use, as well as socioeconomic factors contributing to land-use and land-cover decisions. This methodological innovation offers promise of being able to make land-use and land-cover change research more participatory, as well as based more on narratives of change from the perspective of local people rather than on the quantitative analyses of panel datasets.

This year we focused on understanding the conversion of upland fallows to rubber in light of the rising price of rubber on the Chinese market. Interviews with local officials and statistical data in China and Laos are helping to build a picture of the impacts of changing policies and markets on land use, and on administrative responses to change. An important finding has been that the same policy may be understood in very different ways by officials in different branches of administration, by local leaders, and by land users themselves. This will have implications in modeling the impacts of land use change of stated national and regional policies.

At the local sub-watershed scale we are working within the two watersheds being monitored in the hydrological portion of the NASA project. One of these sub-watersheds, the Nan-e, is in Yunnan and the other, the Nam Mae Rim, is in northern Thailand. We are utilizing both participatory and more conventional survey research methodologies to develop household resource use histories and to understand the impacts on the landscape of changing markets, changing access to resources, and changing land uses.

The second objective of the project is to link economic, demographic, institutional and cultural data to a comprehensive, geographic information system (GIS) spatial database of recent and current land cover in the region. We have completed significant components of this database including information on the location and size of villages, roads, streams, and agricultural fields, and a digital elevation model with information on elevation, slope, and aspect. We are beginning to key information on individual fields to information collected through interviews with farmers and key informants.

The third objective of the project is to develop cellular automata and agent-based models that utilize the narratives of economic, demographic, institutional, and cultural change to address “what if” questions concerning hypothesized changes in social and biophysical variables and to increase our understanding beyond the available empirical data.

We have developed a first draft of a cellular automata model based on rules that predicts the conversion of fallow land in Southern Yunnan and Northern Laos to rubber. The rules are based on our understanding of the factors that affect farmers’ decisions to convert to rubber (we are currently revising these rules based on what we learned from the fuzzy cognitive mapping exercise conducted this summer). We then prioritized these rules by using Analytical Hierarchical Process (AHP) modeling. AHP quantifies the dominance of a set of decision elements among one another in assessing achievement of a higher-level goal or criterion. Dominance is an abstract mathematical notion of “more-ness”; in practice, dominance being assessed can represent preference on behalf of a decision maker, importance, likelihood, etc. AHP’s capacity to quantify dominance is especially valuable in cases where the decision maker has a good deal of knowledge about a given problem system (especially the structure of the problem—the way that components related to the problem or participating in it are interrelated), but the knowledge is not already cast mathematically as data. An AHP model relies on expert knowledge of the decision maker.

### **Broader Impacts**

The project is structured to allow participants to learn from each other's experiences and to develop a more realistic understanding of the challenges and opportunities involved in developing an integrative theory of human-environment relationships. The project is designed to acknowledge and to meet the urgent need to look at the social implications of land-cover and land-use change on the numerous different ethnic groups found in montane mainland Southeast Asia. One goal of the project is to raise the visibility to policy makers of these groups who are underrepresented in discussions on the human dimensions of global environmental change. The project will produce both integrative publications and articles of more disciplinary focus of research results by the collaborating scientists, both jointly and individually. Dissemination of research results will be facilitated by the experience and established infrastructure of the East-West Center with long-established links in Asia. Research findings will be presented both at local seminars in montane mainland Southeast Asia involving the scientific and development community as well as at international fora.

**Project Website:** <http://www2.eastwestcenter.org/environment/MMSEA/>

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**Stephen Lansing, University of Arizona**

Austronesian Societies: Reading Social Structure from the Genome  
0432262

**Overall Mission/Objective**

Genetic and language modeling, data collection, and analysis can form an essential partnership with the traditional field work of cultural anthropology. Such a combination of approaches can shed important insights into the often nonlinear relationships among the various human social behavioral factors that can influence patterns of relatedness, such as kinship and marriage rules, migration, language drift and historical economic adaptations.

While most current research focuses on genetic structure at the population level, this project will use non-coding neutral genetic markers to study the emergence of patterns of relatedness among individuals within communities. Results from our previous research show that a change in mode of production (from tribal horticulture to irrigated rice production) leaves clear traces in the genetic patterns of small Balinese communities. This project will look for comparable genetic signatures in neighboring populations. The aim is to gain a better understanding of the major variables that affect patterns of relatedness among human groups.

To address these questions, this project, in cooperation with the Eijkman Institute and the National Language Institute in Jakarta, has been collecting DNA and language samples from communities throughout Indonesia where good archaeological data on the age and relatedness of settlements can be used to test assumptions about migrations and population histories based on genetics. In addition, the National Language Institute has provided 1000 word lists from dozens of villages. The Eijkman Institute is interested in medical genetics issues; this project is focused on “community” genetics. Thus, our goals are quite complementary.

New mathematics models and statistical analyses of the genetic data supplemented with computer simulations, e.g. agent-based modeling, are needed because standard population genetics models assume that the dynamics have reached equilibrium, an unwarrantable assumption for the short time spans of concern here.

### **Progress and (Preliminary) Outcomes**

The period from June to November, 2005 is primarily devoted to the collection of data – both genetic and linguistic – from a variety of parts of Indonesia. Here is report from the first two excursions.

**Sumba:** A total of about 420 blood samples were taken - approximately 50 samples from men in 8 Sumbanese villages. The villages chosen were based on two criteria: they represent different language areas, and they are considered old source villages, from which other villages later were created as daughter settlements. They are patrilocal, organized into clans, which practice preferential marriage to mother's brother's daughter. The more traditional the village, the more this preference is enforced—in extreme cases infant girls are already promised to their husbands. Local health workers who speak the local language(s) helped each subject fill in a questionnaire and consent form. We tried for 4 generations of pedigree information, or as much as they could remember, noting the origin village for wives, and how many kilometers away from the husband's origin village. Typically 3 to 7 clans occupy one of these old source villages, so it was not too hard to find men who are not brothers or first patricousins.

Inaccuracies were found in the Swadesh word lists for Sumba. Thus, native speakers from each language or dialect were videotaped pronouncing the 200 words on the list.

There was interesting variation in the social structure of the villages we studied – in Eastern Sumba, society is more hierarchical. Heads of clans have many wives (up to a dozen). They also own slaves. It will be interesting to see if these differences in contemporary social structure will show up as historical trends in the DNA data.

Finally, the blood samples taken in Sumba will be used for a hepatitis study, and the results reported back to the people via the public health offices.

**Flores:** Indonesian archaeologists led by Teuku Jacob report the existence of “pygmies”, i.e. modern Austronesian-speaking farmers of very short stature, in the village of Rampasasa near the cave where a team of Australian and Indonesian archaeologists discovered the bones of “*Homo Floresiensis*” in 2003. These pygmies are very small modern Indonesians, culturally Manggarai.

We obtained blood samples from men in Rampasasa, including a handful of men short enough to qualify as pygmies. We also measured their height and weight. We also spent 9 days with people from the local public health department, collecting samples from pygmies in other villages. Interestingly, the pygmies are firmly convinced that they are the descendants of a small furry forest hunter who married a human woman. The pygmies are both men and women, and they often (but not always) marry one another. They look quite distinctive and do not seem to be just

a collection of short farmers. The Eijkman Institute plans to look for abnormalities in thyroid function from the blood samples.

While we were collecting these samples, two teams were also trying to extract DNA from the bones discovered in the cave. One team is based at the Eijkman Institute; the other at the Max Planck Institute in Leipzig.

Throughout our travels in Flores, we asked people about the existence of very short people, but found no other pygmies until we reached a village in the Ende region of Central Flores, where we found two possible pygmies (they are a bit taller) and obtained their blood, in a village where we also took 45 more samples from the men.

After the pygmies, probably the next most interesting samples came from the region of Bajawa, in the mountains of Central Flores. Two villages that were sampled trace their descent matrilineally, in contrast to their immediate neighbors who are typical patrilineal eastern Indonesians. In one matrilineal village, we took samples from women as well as men.

We have more to do on Flores including samples from the extreme eastern end of the island, and the adjoining islands in the direction of Alor, which is populated by people who speak Papuan languages (unrelated to the Austronesian languages of Flores). In Tucson, we are working along three strands in preparation for the data.

**Linguistic Component.** The Indonesian lexical database, which has already been largely completed, but will be finalized with the entry of the new data currently being collected, the organization of lexical data and inferences based thereupon will proceed in three steps:

**Grouping of lexical items into cognate sets.** For example, the words for *fire* will be organized into groups, the words for *water* into groups, on the basis of superficial similarity. Typically, words which group together for one item will generally group for others, although this will not always be the case due to the complex nature of language change and the idiosyncracies of lexical replacement. We plan to develop a program which that search a lexical items and group them according to phonological similarity. The comparison can be done first at the segmental level, and then more finely at the featural level.

**Establishment of regular sound correspondences and reconstruction of the paths of sound change.** These correspondences will ultimately reconstruct the original phonetic values of the words in question (we are fortunate to have as a check the reconstructed proto-language ancestral to all Austronesian languages outside of Taiwan, Proto-Malayo-Polynesian). When this is completed, then it will be assessed how many languages show the same sound changes taken together as a group.

**Identification of loans and interpretation of sound change strata.** Loan words often stand out because they superficially appear to be inherited, and will fail to display the sound correspondences expected from the normal evolution of the language. The best explanation is that the word has been borrowed from a contiguous language. The second way in which

contact can be discerned is through shared sound changes. If such changes between can be shown to be recent, but older sound changes are not shared, then the best explanation is that they share these more recent sound changes because they have come into contact with each other and the changes are part of an areal phenomenon.

**Genetics.** The specific aim is to develop a comparative genetic framework for different compartments in the human genome, Y-chromosome binary and microsatellite markers, mtDNA and autosomal short tandem repeats (STRs).

We have examined genetic variation on the non-recombining portion of the Y chromosome (NRY) to investigate the paternal population structure of hunter-gatherer population from Borneo, several isolated groups from Mentawai and two subaks from Bali. A set of 71 biallelic markers and 12 STRs on the NRY were genotyped. We have developed two nanoplex PCR reactions to survey 18 autosomal microsatellite polymorphisms. The systems were chosen to insure that none of them are closely linked, maximizing statistical independence. While the bulk of progress towards autosomal STR typing is anticipated to be in year 2, we have typed some 200 samples from different Bali populations.

**Mathematical Modeling.** Recent results in both the biophysical and biochemical literature give very refined answers on the nature of microsatellite evolution. The biochemical experiment is based on direct observation of mutations in parent-child pairs. The biophysical assays are *in vitro* experiments to analyze DNA polymerase errors in copying microsatellite sequences. The suite of models suggested by these experiments are amenable, using the theory of Markov processes, to exact analytical expressions for the probability distributions for the change in microsatellite length over any given number of generations. This gives, in a precise statistical sense, best possible estimates for time to most recent common ancestor. A preprint is nearly completed with software implementation soon to follow. The next modeling project involves examining the social structures as a random network.

### **Broader Impacts**

The project will result in the creation of new analytical tools, both statistical and computational, to investigate genetic population structure at the fine-grained level of resolution provided by microsatellites and will also provide a computational framework for integrating genetic analysis with models of language evolution. These tools will open new possibilities for the empirical study of fundamental anthropological questions well beyond the study region for this project.

More broadly, this project is quintessentially about marginalized populations. Only under the backdrop of solidly understood population genetics can the impact of selection and survivability be measured using medical genetics. In addition, a more foundational understanding of the kinship networks that are created to support economies can prove to be a cautionary tale to those transnational entities that seek to impose broad and blunt instruments for development. Thus, dissemination of these ideas and methods are central to the project. We have been invited to work with indigenous groups in the Philippines to extend these ideas to that region. In addition, a video about the project will be produced by a leading British film-maker.

**Rosa Matzkin, Northwestern University**

Hedonic Models of Location Decisions with Applications to Geospatial Microdata

0433990

The sorting of firms to locations, workers to firms, and families to neighborhoods are important elements of economic life. Central to the theory of local public goods and housing markets is the sorting of people into group of agents, in order to exploit their comparative advantages. Agents specialize in the activities that are most beneficial to them. Peoples' choices about where to work and live, and firms' choices about where to locate and operate, are dynamic processes driven by a variety of factors, many of which are geospatial in nature. These geospatial factors include inherent physical attributes (e.g. rivers), human-created physical attributes (e.g. public infrastructures), and dynamic social and economic interrelationships (e.g. geopolitical entities like school districts, taxing bodies, or local zoning boards.) Two issues have limited the scientific understanding of these types of processes and their role in human and social dynamics. First, data limitations have often prevented social scientists from accurately measuring a combination of geospatial and socioeconomic factors at a scale sufficiently fine to disentangle the role each plays in economic and social decision processes. Second, sophisticated economic models accounting for the diversity and heterogeneity of firms and consumers and the richness of the equilibrium sorting process are only now reaching their full empirical potential. This project addresses both issues. It develops spatial social science tools to track the geospatial characteristics of human social sorting processes (of both firms and households), and it uses this together with new developments in hedonic analysis. This provides a method for modeling social dynamics by estimating the value of location-specific attributes, both for inherent geophysical attributes as well as for those that are created over time by human interaction. The model generates a characterization of the equilibrium resulting from the sorting process of firms, workers, and households, and provides a structure that can be estimated with the generated geospatial data. This will enable researchers to describe spatial data, and allow them to identify and estimate structural features of the data, which can then be used to understand how the economic and social system will respond to changes in the economic environment such as technological and demographic changes. Several data sources will be combined in this project to create measures of geospatial attributes, and use them with the hedonic methodology to study specific empirical models of location decisions and location equilibrium.

Our research activities during our first year have concentrated on developing the tools necessary to apply hedonic equilibrium to specific empirical models of the dynamic process of location decisions. The development of these tools required work on the theory, computation, and estimation of these specific models. On the theoretical front, we have worked on the theoretical properties of equilibrium in hedonic models. This work has included investigation of the links between hedonic economies and the mathematical theory of optimal transport, study of the theoretical properties of hedonic equilibrium including existence, uniqueness, the possibility of bunching, and the dependence of equilibrium properties on parameters. On the computational front, we have been developing algorithms to compute equilibria in hedonic models. On the econometrics front, we have worked on developing the econometric tools necessary to estimate hedonic models.

This project will develop and combine theoretical and empirical advances in hedonic models of human and social dynamics with advances in spatial social science. It will provide a better understanding of the dynamics of sorting. It will provide modeling tools to study the mechanisms of social and economic dynamics in the context of location decisions. It will provide empirical tools to measure geospatial attributes. These new tools will be applicable to many policy relevant issues that have important social implications, including environmental justice, racial segregation, school quality, community infrastructure, public amenities, and noxious facilities. Researchers in many fields, including economics, geography, GIS science, and regional science, will be able to take advantage of the new tools, which will be widely disseminated.

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**Rosamond Naylor, Stanford University**

Agricultural Decision-Making in Indonesia with ENSO Variability: Integrating Climate Science, Risk Assessment, and Policy Analysis

0433679

The objective of this project is to assess the potential impacts of El Niño-Southern Oscillation (ENSO) events on precipitation and agricultural production in Indonesia under conditions of global warming. The project entails three steps: 1) the construction of empirical downscaling models (EDMs) that link output from global climate models (or general circulation models, GCMs) with regional-scale precipitation more suitable for the specific study of Indonesia; 2) the statistical linking of these downscaled rainfall patterns with agricultural production in Indonesia; and 3) the construction and application of a risk-assessment framework for analyzing critical thresholds of climate impact and adaptation strategies for coping with changed climate conditions in the agricultural sector. An important challenge is to understand and quantify the magnitude and patterns of uncertainty that propagate through each step of the analysis.

Most of the work in the first year has focused on step 1 (above): developing plausible estimates of the climate—and in particular, precipitation—over Indonesia under future climate scenarios. Unfortunately, GCMs are notoriously poor at simulating the hydrological cycle in tropical regions, especially over the Maritime Continent (including Indonesia). GCMs, however, do a reasonably good job reproducing large-scale circulation in the tropics, which is highly related to the hydrological cycle. A primary task during the first year of our research has thus been to develop and evaluate a series of empirical downscaling models (EDMs) that relate large-scale circulation patterns to regional-scale precipitation in the observed (historical) record. Our results show that the EDMs are skillful in predicting and cross-validating precipitation during the dry season (May-August) and during monsoon onset (September-December).

The EDMs appear to have less skill during the wet season and monsoon withdrawal (January through April). These findings are consistent with previous research, and with physical relationships between the hydrological cycle and large-scale circulation. The EDMs will eventually be used in our project to relate the GCM simulated large-scale circulation to regional hydrology under future climate scenarios. Precipitation over the Maritime Continent is controlled by the seasonal cycle (the monsoon) and by the El Niño – Southern Oscillation (ENSO). Thus, it is important that future precipitation estimates provide reliable information about both

phenomena. To complicate matters, ENSO's influence on precipitation in Indonesia is quite different during different phases of the seasonal cycle. For example, although ENSO produces similar large-scale sea-level pressure (SLP) patterns during the wet and dry seasons over Indonesia, ENSO's influence on precipitation is markedly different during the two seasons. As a result, EDMs that do not distinguish between wet and dry seasons tend to simulate precipitation poorly. Our initial research has shown that the EDMs should reconstruct the seasonal cycle and variability separately, and that this reconstruction is feasible.

An additional complication with using EDMs to predict future climate involves choosing the best large-scale predictor variables with which to relate precipitation and the large-scale circulation in *both* today's climate and in a warmer world (due to increased greenhouse gases). Our working hypothesis is that it is unlikely that an EDM that is trained on the instrumental record from today's climate will be a complete model for estimating the mean changes in regional scale precipitation due to global warming. Specifically, if global warming creates a mean climate change that has no analog in the current climate record, then a downscaling model that is trained entirely from the observed record will not be able to simulate the regional climate changes due to global warming. For example, if increased greenhouse gases create an overall warmer mean climate (as projected by the climate models), there may be an enhanced hydrological cycle due to the atmosphere's ability to 'hold' more water vapor—with little or no change in the circulation patterns. Thus, the average specific humidity (the mass of water vapor per mass of dry air) in the atmosphere may be a good predictor of an overall enhancement of rainfall over Indonesia due to global warming, while circulation changes may be a better predictor of ENSO's influence on precipitation (in both past and future climates). Consistent with this hypothesis, our preliminary research has shown that the sign of predicted precipitation change over Indonesia is sensitive to the choice of predictor variables.

A major research question, then, is: "Which large-scale variables best predict future precipitation over Indonesia?" We can begin to answer this question by using the output from the fourth assessment report (AR4) of the Intergovernmental Panel on Climate Change (IPCC), including present day and future climate simulation output from some 20 GCMs (this number varies depending on which variable is desired). These model simulations provide a valuable resource for identifying which large-scale variables are most useful for predicting future precipitation changes. In this case, we use the same EDM framework to identify relationships between modeled large-scale circulation and modeled *large-scale* hydrology over the Maritime Continent (we are not downscaling, but the statistical techniques are the same). We will then use these model-based 'EDMs' to reconstruct precipitation during the model's future climate scenarios. We are currently developing and evaluating these EDMs within the IPCC AR4 models.

During the first year we have also begun designing the risk assessment framework and matching it to the expected climate model outputs. Specifically, we have been assessing various critical threshold indicators for future climate impacts on agriculture in Indonesia. The threshold indicators that appear to be most plausible include the duration of the monsoon, the percentage of "normal" rainfall (based on a long-run average) in the wet season, and the delay in rainfall onset in the wet season. We have regressed these indicators on rice production in the main harvest

season and throughout the crop year using historical data and have found highly significant relationships.

### **Work in progress**

During the second year of our research project, we will design GCM experiments that identify how ENSO influences the large-scale circulation over the Maritime Continent under an altered (future) mean state. As we develop these scenarios, we recognize that an essential component of our risk assessment framework is the quantification and propagation of uncertainty throughout the analysis. Thus, it is important that we design the GCM simulations such that they address the dominant sources of uncertainty in future climate scenarios. We have begun this analysis by exploring the main patterns of uncertainty in the IPCC AR4 model simulations via principal components (PC) analysis. Our initial results have shown that the dominant pattern of uncertainty resembles that of ENSO events.

We are currently preparing a manuscript that explores the skill of the EDMs as a function of season, predictor variable, and statistical technique. We are in the midst of evaluating the different EDMs in the IPCC AR4 models, and will be organizing those results into a separate manuscript over the next year. We have hired a graduate student at the University of Wisconsin to help evaluate how large-scale patterns of variability relate to regional-scale precipitation. The treatment of uncertainty in our climate models remains a major topic of ongoing research.

During year two we will continue to identify other critical threshold indicators, such as the probability of 2-3 consecutive dry years, the number of cloudy days, and temperature extremes. We will need to use longer-run scenarios and crop-based models to determine the strength of these indicators. We also plan to regress the indicators against corn and other non-rice crops that are important for food security in Indonesia. The information from this assessment is being used for the design of climate model output in step 1. Our work will continue to be an iterative process in years 2 and 3. We have also hired a graduate student at Stanford University who is beginning to work on stakeholder assessment of and expert opinion on critical thresholds. She expects to conduct fieldwork on these topics in year 2.

Finally, we are beginning to organize the outreach component of our project. In November 2005, Naylor, Falcon, and Battisti will travel to Indonesia to meet with policymakers in different agencies (e.g., Ministry of Agriculture, Planning, Finance, and Food Logistics) and discuss the use of our model for short- and long-run planning purposes. We will also work with staff within the Food Security branch of the Ministry of Agriculture to transfer the model for ongoing use within the agency.

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### **Bryan Norton, Georgia Institute of Technology**

Ecological Boundary-Setting in Mental and Geophysical Models  
0433165

**Epigram:** "[T]he future of operations research is past....[M]anagers are not confronted with problems that are independent of each other, but with dynamic situations that consist of complex

systems of changing problems that interact with each other. I call such situations *messes*. Problems are abstractions extracted from messes by analysis; ...Managers do not solve problems: they manage messes," Russell Ackoff, a founder of Operations Research, 1979.

When agencies and the public direct their attention to an environmental problem, they explicitly or implicitly bound that problem by associating it with a particular system at a particular scale. We have promised in our research to learn more about problem formulation. Specifically, we have promised to look at the special role of boundary-setting in problem formulation. We start with it as given that most environmental management problems are better described as "messes," and that a-contextual analyses of ideal outcomes and algorithmic "solutions" cannot provide the guidance necessary to address these messes (epigram).

Our research will focus on the problem formulation phase of the decision process and on the role of spatial modeling in that process. The proposed research will develop and employ social science techniques for dealing with spatiality to address the general subject of problem formulation as a weak point in decision analysis. More specifically, the work will focus on the role of *perceptions* and *values* in the determination of boundaries, exploring two parallel but complementary research questions.

- How do geophysical modelers set spatio-temporal boundaries when they "model" an environmental problem?
- How do social perceptions and values of community members involved in management processes affect boundary-setting in the formulation of environmental problems?

These two parallel lines of research thus begin from different disciplinary and methodological starting points, but pursue complementary objectives—to understand the role of spatial models in problem formulation.

Two key types of values will be emphasized: (a) "sense of place values"—values that residents associate with a locality; and (b) spatial dimensions of equity issues, as private and public decisions may create differentials in the quality of life within and across physical and political boundaries. Sense of place is hypothesized in the context of experiential discounting as critical to the development of individual and social identities that frame the way environmental problems are experienced, informally bounded, and formulated. Similarly, values derived from relative social status are important in determining the spatial boundaries used to characterize environmental problems.

Three case study areas, where team members have established a research presence, have been chosen: St. Louis, MO, Chicago, IL, and Atlanta, GA. A comparative lens will be used to examine formulation of three types of environmental problems: sprawling land use patterns, management of water quality and quantity, and brownfield redevelopment.

What we need, given we are dealing with messes, is an integrative orientation that is highly contextual and comprehensive, but capable of incorporating information from the special sciences into a larger, integrated picture. Adaptive management (AM), while accepting the open-

ended nature of the management problem, nevertheless promises to offer a comprehensive approach to environmental monitoring, science and decision making in the sense that it justifies taking action in the face of uncertainty through learning by doing. Although our research is just beginning, we have, in the hope of better understanding what exactly would be involved in a comprehensive, trans-disciplinary and trans-scientific approach, undertaken a broad search of the multiple literatures devoted to better understanding and guiding environmental decision making and policy development. Our goal was to "place" our research in an intellectual landscape, so we can figure out what our unique contribution can be. Table 1 represents a first try at a taxonomy of decision analyses often applied to environmental policy deliberations.

In our own work, a variety of methods will be developed and employed to study the processes by which individuals and interest groups identify, articulate, and modify perceived boundaries of environmental problems. Selected methods of garnering information about stakeholders' mental models include elicitation of perceptions through interviews, discourse analysis of documents, and revealed preference valuation. These methods will be combined with the use of agent-based GIS modeling techniques to achieve integration and to provide linkages between social scientific data and geophysical models as a way of clarifying the role of space-time boundaries in the articulation of environmental problems.

The most central split in Table 1 is between a-contextual and contextual decision-making. The former analyze outcomes by measuring some "objective" measure of behavior, such as utility or preferences (wtp), which are value measures that require—and carry with them—no information about the decision context. In our research, we will explore contextual approaches in detail, examining what initially appear to be five distinct approaches/perspectives on environmental decision making and policy. Contextual Decision Making rejects algorithmic decision tools as unlikely to serve as a comprehensive guide to decision making and seeks rationality in decision making by concentrating on process rather than expected outcomes.

Advocates of the various forms of contextual analysis analyze processes, offer heuristics to improve problem formulation, and equate better decisions with improved problem formulation, improved understanding, and improved communication. These approaches are contextual in the sense that they recognize that local features of the decision situation are important, and that the very meaning of a real environmental problem is anchored in a **place**, which includes the physical features of a geographic location, and also the peoples who live there, and their institutions and politics.

**Table 1: Contextual Models of Environmental Decision Making: A Taxonomy**

<b>ACONTEXTUAL MODELS</b>	<b>CONTEXTUAL MODELS</b>
<b>Shared characteristics:</b> -Outcome oriented -Algorithmic	<b>Shared Characteristics</b> -Seek Rationality in Better Process -Non-algorithmic
<b>EXAMPLES OF</b>	<b>VARIANTS ON CONTEXTUAL MODELS</b>

## A-CONTEXTUAL MODELS

- Rational choice
- Decision trees
- CBA
- Game Theory
- Operations research/ optimizing

<b>Approach</b>	<b>Muddling Through</b>	<b>Cognitive Science</b>	<b>Critical Systems Theory</b>	<b>Postpositive Policy Analysis</b>	<b>Adaptive Management</b>
<b>Advocates</b>	Lindblom, Simon	Kempton, Paolisso, Bostrom et al. (risk comm.)	Ulrich, Midgeley	Lasswell, Forrester, Habermas, Dryzek, Clark	Holling Lee
<b>Process emphasized</b>	Negotiation and Compromise	Cognition and Learning	Epistemological	Policy, Decision-Making, and Political	Management
<b>Context emphasized</b>	Political	Learning / Deciding	Scientific and Intellectual	Whole Policy	Whole Management
<b>Heuristic models / techniques</b>	Bounded Rationality	Mental and Cultural Models	Boundary Critique	Problem Mapping Interpretive/ Critical analysis	Social Learning / Experiment-alism
<b>Substance or Process?</b>	Process and Substance Inseparable	Understanding / Communication + Improved Process	Ulrich: Substance + Process; Midgeley: Process + Method	Mainly Process Oriented	Substance + Process in action

Since we are only at the beginning of our research, and have only begun to choose techniques and methods, and to develop our interview protocols, we have as yet collected no new data. We have, however, explored the retro-active case study that was developed in the proposal where it was hypothesized that:

I: Individuals formulate and understand environmental problems (including the assumption of spatio-temporal bounds to the problem) based on mental models that reflect their personal values and context.

II: Individuals who enter public debate about the management of resources in their area as members of an interest group are likely to share with their cohorts a cultural model that bounds the public management problem faced.

III: Choices of spatial bounds (as represented in mental models of participants and researchers) have profound implications for our understanding of the problems of interest: water management, urban sprawl, and brownfield redevelopment.

IV: "Sense of place" is observable both directly and indirectly, and may often not be related to the spatial bounding selected in problem formulation.

Between 1970 and 1990, Chesapeake Bay was transformed, not by natural forces or by human engineering, but through a collective act of "social learning." In the 1970s, spurred by an important EPA study and independent research, a scientific consensus emerged that, while local, point-source pollution remained important to the estuary, a more diffuse and difficult problem—

the over-nutrication of the Bay from non-point sources in farmer's fields and suburban lawns—constituted a greater threat to the Bay. What ensued was a transformation of scientific and cultural models of the Bay: the perspective of Bay area residents shifted to a larger geographic and temporal scale. Careful examination of this successful process of social learning, whereby the public, politicians, and policy makers adopted a mostly-shared, watershed-sized model of the Bay, can provide clues about both boundary-setting and social learning in the face of environmental problems.

This change in perspective and viewpoint in the Chesapeake region is a case of "macroscoping"—altering a problem by embedding it in a larger-scaled system. Macroscoping—and its opposite, Microscoping—involve shifts in scale and perspective, and are hence very important in the least understood areas of decision science—problem formulation. So, as a "retroactive test case, we did a preliminary test of whether, as one would expect if our hypotheses are true, there was in fact a measurable change in the "scale" discourse about pollution in the Chesapeake Region. We found, through a content analysis of the Annapolis newspaper, that by coding references to the scale of Bay (references to Bay itself, to Bay plus tributaries, and whole watershed), we could measure a significant increase in references to larger scales between 1976 and 2000. Similarly, references in newspaper articles showed that, while references to toxic pollutants were three times more prevalent than nutrification problems in 1976, nutrification was mentioned twice as often as toxics in 2000. These very preliminary results suggest that our hypotheses are sound; we are proceeding to apply what we are learning to more contemporary case studies, as researchers are (a) using spatial economics to examine boundary effects in environmental justice research, and (b) beginning to explore the role of values and perspective in ecological modeling exercises.

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### **John O'Loughlin, University of Colorado-Boulder**

The Dynamics of Civil War Outcomes: Bosnia and the North Caucasus  
0433927

#### **Overall Mission**

This research explores the situation produced by civil wars in Bosnia and in the North Caucasus area of Russia. Both regions experienced violent civil war in the 1990s as a result of the break-up of Yugoslavia and the Soviet Union. When major fighting ended in Bosnia in 1995, the country was divided by the Dayton Peace Accords into two federations and remains under the protection of international military forces, and ethnic cleansing is supposed to be reversed by guarantees of return migration. The civil war continues at a lower scale in the North Caucasian republic of Chechnya with continued displacement of hundreds of thousands of refugees in adjoining republics and frequent terrorist acts across the Chechen border.

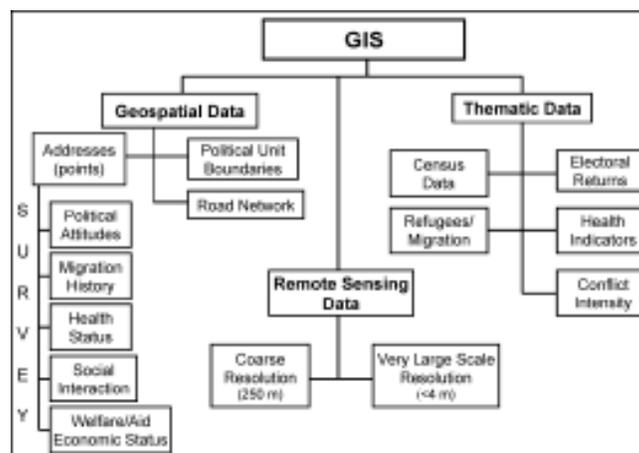
Four inter-related questions lie at the heart of the study:

1. What is the character and localized distribution of economic, social, political, environmental and health outcomes of the wars in the two conflict zones?
2. What factors explain these distributions?

3. How can the application of an integrated methodology of individual and aggregate data that relies on opinion survey, census, governmental, and remote sensing data collection be operationalized in a spatial analysis across a variety of scales?
4. Are postwar developments in the former conflict regions promoting or retarding interethnic harmony and democratic values, thus enhancing or reducing the prospects for longterm peace?

### Progress and Preliminary Outcomes:

The project builds a Geographic Information System for each study region that integrates three types of data (satellite imagery, census and other aggregate data, and survey data) at multiple scales as is indicated in the figure below.



a) Remote sensing data collection and preliminary analysis: Our initial work has collected a variety of satellite imagery at different scales for both landuse/landcover change classification and identification of possible shifts in agricultural activity from pre to postwar periods. The University of Maryland's Global Land Cover Classifications (GLCC) dataset was used to calculate percent forest and percent cropland for the 109 Bosnian *opstine* (counties). The data are available at multiple resolutions, but the most detailed 1km data were used in our study. These data are derived from NASA's AVHRR sensor and based on the computed NDVI (Normalized Difference Vegetation Index) values. To simplify the forest categories, evergreen, deciduous, and mixed forest types were spatially aggregated into a single forest category. Percent forest and cropland were then calculated for each *opstina*.

A more detailed land cover dataset was also used from the Food and Agriculture Organization of the UN, Sarajevo office. This dataset was derived using visual interpretation from Landsat 7 satellite data at 30m resolution. Since the Landsat data were captured after the conflict, they provide data for abandoned agricultural land related to war activity. *Opstina*-scale variables were derived from this land cover classification by combining the categories abandoned and predominantly abandoned land, forest and predominantly forest land, and arable and predominantly arable land. Examples of the resultant distributions are shown in Figure 1.

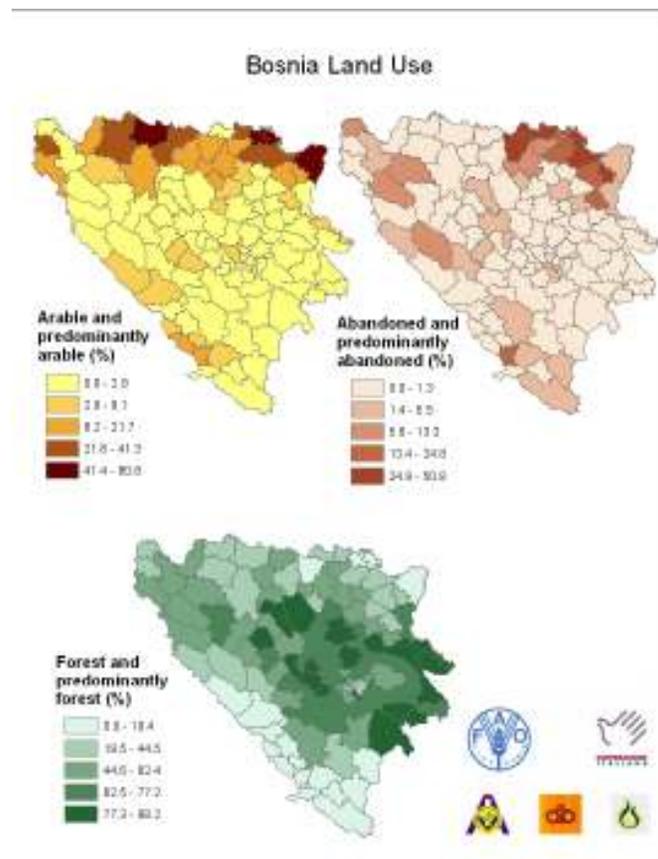


Figure 1: Land use categorization of Bosnian opstine in 1998 using FAO remote sensing data.

A similar remote sensing analysis is currently underway in the North Caucasus with a view to identifying pre- and postwar land uses and to making a choice of more detailed satellite imagery for the rayoni (counties) that are the sites of the opinion surveys of individuals and communities affected by the wars. This detailed imagery (scenes of pre-war, during the war and post war) will allow us to document microscale changes in agricultural and other economic trends at a scale of less than 30 meters.

b) Census and other aggregate data: The last population census in Bosnia was conducted in 1991 before the wars marking the breakup of Yugoslavia began. In Russia, a recent census in October 2002 has been slow to release data but the investigators have now acquired the key nationality and demographic data for the counties of the North Caucasus study region. As well as census data, data collected by other national and international agencies have been instrumental in helping to define the scope of the study and the key places for indepth analysis of the effects of the wars. Among these data are refugee data, data on elections, data on mines and other war materiel and damage, data on economic change and data on infrastructure. These data have been integrated into the respective GIS for Bosnia and the North Caucasus. Some examples of these maps are shown in Figures 2 -6.

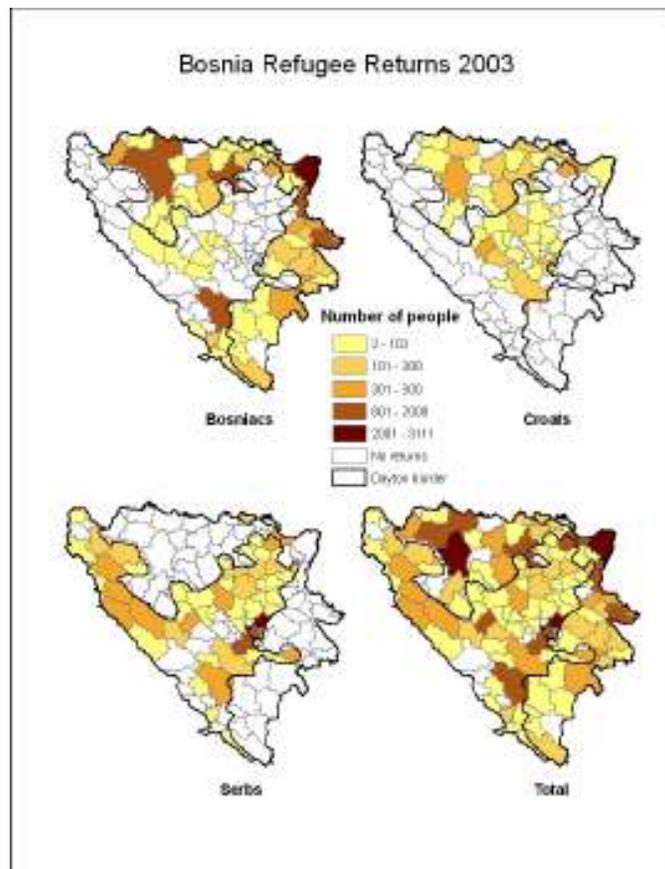
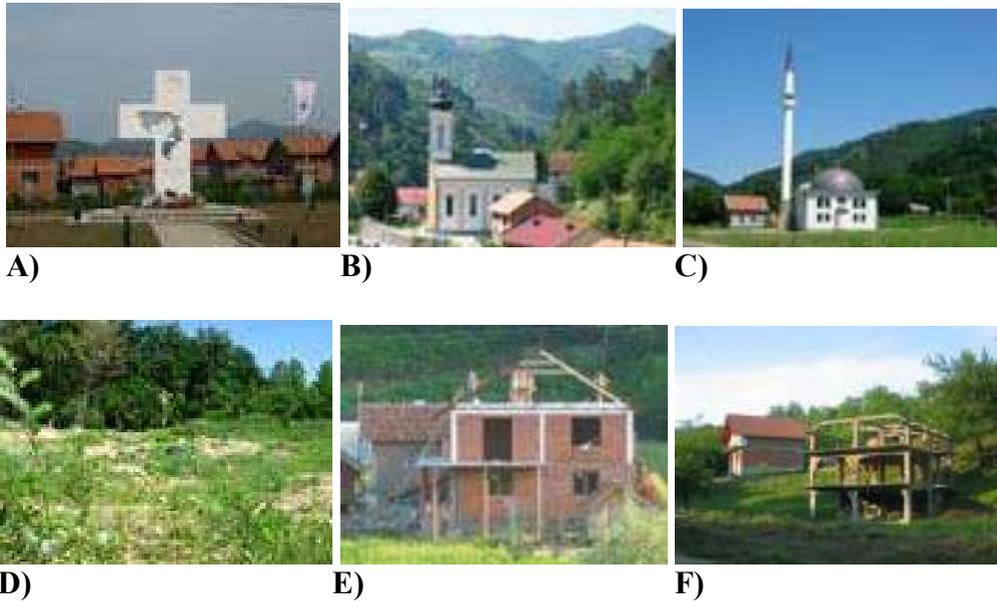


Figure 2: The distribution of refugee returns by ethnicity in Bosnia in 2003 according to *opstina*.

Data on refugee returns are collected monthly by international agencies and can be aggregated across all years. These data seem to show a high degree of success in reversing ethnic cleansing since the war produced over 2 million refugees, many of whom were “cleansed” from areas in which their group was a minority. This was particularly the case in parts of (what became) the Serb republic. While many of the refugees have claimed their property, the actual ratio of those who live in the reclaimed homes is much lower, as the PI and co-PI O Tuathail have seen in their Bosnian field work in June 2005. Many of the properties in the regions most affected by the war (NE Bosnia) for example are still abandoned, destroyed or in the process of being reconstructed. The photographs below, taken in the Zvornik area of the Serb Republic along the border with Serbia, indicate the nature of the current situation. Mosques and churches are being rebuilt, monuments are in effect reclaiming ethnic spaces, and housing is being reconstructed next to abandoned and pillaged buildings that date from the period of ethnic cleansing in 1992. While some mass graves have been excavated, others remain undiscovered. Typical examples are shown in Figure 3,a-e below.



- A) New war memorial to Serb dead in the Ekonomija settlement, Zvornik
- B) Reconstructed Serb Orthodox church, Srebrenica
- C) Recently completed mosque in the Serb republic of Eastern Bosnia
- D) The Crni Vrh mass grave (June 2005) where 1500 victims of the Srebrenica massacre were buried
- E) Rebuilding a war damaged house in Eastern Bosnia
- F) Looted Muslim property as evidence of ethnic cleansing Bratunac, eastern Bosnia

Bosnia agricultural and other land uses are still severely hindered by the presence of mines. The location of the war's frontlines (and the inter-ethnic boundary line today) can be easily determined by their concentration.

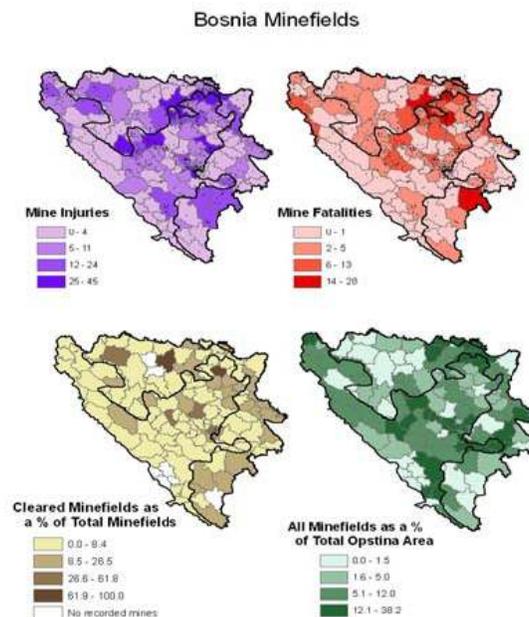


Figure 4: Landmines (including clearances) in Bosnia as % of opstina and cause of injury and death.

We are conducting a similar data collection and analysis of secondary (archival) material in the North Caucasus and will be engaging in fieldwork there in September-October 2005.

Opinion and Attitude Survey: One of the major foci of the collection of secondary data is to use this information to classify the territorial subunits of the study are for purposes of selecting typical representations of the types of communities present in both regions. Our surveying strategy is to stratify the approximately 110 counties in each study site by their aggregate composition (ethnicity, war experiences, refugee impact, economic change etc) and to select about 35 units for administration of the survey. We will collect opinion and attitude data from 2000 adults in both regions in surveys to be administered in early Fall 2005.

In Bosnia, for example, we used a clustering procedure to allocate the 109 opstine to 7 groups using the various aggregate data as inputs to the procedure. The resulting map (figure 5) shows some geographic clustering but the main emphasis is not on spatial contiguity but on opstina similarity.

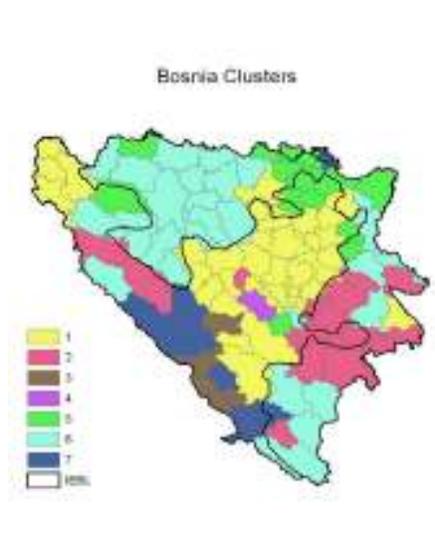


Figure 5: Clustering of the opstine of Bosnia into 7 groups using 25 input aggregate measures.

One of our aims is to conduct multilevel modeling in which we hypothesize that the attitudes, opinions and behavior of residents of war zones are not only conditioned by the usual socioeconomic predictors (age, ethnicity, education, gender etc) but also by the nature of the community in which they live. Thus, as might be expected from a joint geography-political science investigative team, we want to check to see if the more general relationships between predictors and outcomes are also affected by the type of environment in which the respondent lives. To do this, we need to gather enough samples in each community to allow the use of the multi-level modeling procedure – we will have at least 100 surveys for each community and the sampling strategy allows proportional response rates according to the size and ethnic composition of the communities.

In Bosnia, for example, we have selected 35 places for the survey which will be conducted according to the random route method (the same procedure is being used in the North Caucasus).

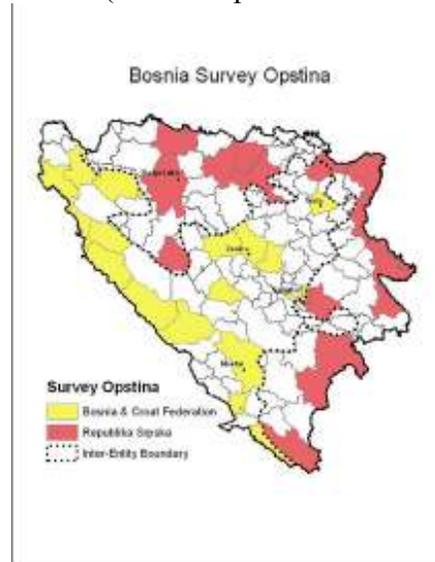


Figure 6: The selection of opstina for opinion surveys in Bosnia-Herzegovina

The survey that we have developed has 75 questions divided into about 15-20 sociodemographic (or predictor) questions and the rest of the questions probe attitudes to own and other ethnic groups, war and after-war experiences, migration history, interaction with members of different groups, and personal status, including physical and mental health status. A notable feature of the survey is the use of “vignettes” that tell a short story and ask the respondent to interpret it. Results from the vignettes allow the adjustment of survey responses across different cultures, in this case, to make the responses of the two samples comparable. About 20 questions of the 75 will be specific to the situation in each study site and the rest are the same. The survey has been translated into the respective languages and contracts have been signed with the respective survey firms to carry it out. Preliminary results will be available by the end of October 2005. In our statistical analysis, we will match the survey responses to the aggregate data and to the high-resolution remote sensing data that will be purchased in Fall 2005. The main statistical methods will be social network analysis and multi-level modeling.

**Broader Impacts:** The research deepens the empirical analysis of underlying factors of possible future conflict in the Islamic republics of the North Caucasus of Russia and in Bosnia. It also gauges the prospects for peaceful relations between nationalities in the two regions and provides answers to key questions about the nature of community conditions in former war zones as local, national and international agencies try to cope with the aggregated disruptions to peoples, economies and environments over the past 15 years. The PIs, a collaborative team representing five US universities and local research partners in Russia and Bosnia, ascertain the scope of structural and personal damages, the separate and cumulative effects of forced and voluntary population movement, the differential impacts across localities and communities of war dynamics and the depth of national, religious or ethnic-based consciousness.

**John Padgett, University of Chicago & Santa Fe Institute**

Co-evolution of State and Market: Renaissance Florence  
433006

## **Background and Overview**

This project assembles a cross-disciplinary (physics, sociology, statistics and history) and international (United States, India, Australia) team to analyze the social production of organizational innovation in Renaissance Florence. The project is built upon the empirical foundation of a powerful, indeed unprecedented historical data set – economic, political and kinship social-cum-organizational networks, traced over a two-hundred-year time span (from 1284 to 1500 A.D.). This data set, coded from original archival documents by Padgett (with significant help from McLean) over a span of fifteen years, will be described below. Under the sponsorship of the Santa Fe Institute, technical experts in social-network statistics (Pattison), in autocatalytic network dynamics (Jain), and in agent-based modeling (Sallach) will be assembled to assist substantive experts (Padgett and McLean) in the production of network models of organizational genesis, fitted to the Florentine data. The technical innovations demanded by the historical materials involve (changing) catalytic and regulatory feedbacks across the reproduction and development of multiple types of social networks.

Renaissance Florence was among the most innovative centers in Western history in its creation of new organizational forms. In the domain of economics, international finance and double-entry bookkeeping was invented in Northern Italy and came to be centered in Renaissance Florence (de Roover 1966, 1974, Goldthwaite 1993, Padgett 2001, Padgett and McLean forthcoming). In the domain of politics, republicanism reemerged in a few of the most prominent northern Italian city-states (Genoa, Florence, Venice), with Florence being particularly creative in its exploration of new electoral mechanisms (Najemy 1982). These Florentine electoral mechanisms later were to become important in the founding constitution of America (Pocock 1975). In the domain of extended family, dowries and the emergence of republican clientage had significant consequences for the restructuring of social elites, social status and social mobility (Brucker 1969, 1977). Such social restructuring created the competitive motivation for now-famous innovations in the production of new art (Baxandall 1988), new political philosophy (Baron 1966), and arguably new psychology (Burckhardt 1878).

Unexplored in the otherwise thorough secondary literature on Renaissance Florence are the causal connections among these extraordinary innovations. Were these simply a remarkable set of historical coincidences or ‘conjunctures’? Or did some sort of heretofore poorly understood ‘social innovation cascade’ occur within this particular city and time, across multiples domains? Padgett’s previous publications on this topic have documented the empirical plausibility of the second conjecture for the two domains of political-party formation (1993) and financial-market formation (2001, forthcoming). Specifying multiple-network feedbacks and possible organizational-form cascades analytically, and then empirically testing the resulting dynamic network models with Florentine data, is the research goal of this project.

Possible parallels between biological and human social evolution need to be approached with caution, skepticism and discipline indeed (Maynard Smith and Szathmary 1995, Lewontin 1992). However, the possible phenomenological similarity between extraordinary outbursts of human creativity like Renaissance Florence and ‘macro-evolutionary’ events like the Cambrian explosion (Gould 1989, Morris 1998) has not escaped our attention. Sanjay Jain (with informal help from other SFI external faculty Doug Erwin and Ricard Sole) will explore the insights, as well as the limitations, that existing macro-evolutionary models in biology offer to understanding the Florentine case. No doubt major modeling extensions eventually will be required, especially in the direction of multiple-network feedbacks, but developing a common dynamic-network formal framework will be the first analytic step, already partially attained.

### **Sergio Rey, San Diego State University**

An Exploratory Space-Time Data Analysis Toolkit for Spatial Social Science Research  
0433132

#### **Objectives**

The study of regional economic growth, inequality, divergence and convergence attracts considerable interest across multiple social sciences. By definition, these analyses rely on data that are spatially referenced. Only a few very recent studies, however, have given attention to the role of spatial dependence and spatial heterogeneity in the empirical analysis of regional economic evolutions. Research in the fields of geographical information systems (GIS), spatial statistics, and spatial econometrics has generated new methods designed to treat these spatial effects, but these methods do not address the dynamic dimensions of regional economic change. A truly integrated social science requires a toolkit that integrates both the spatial and temporal dimensions of socioeconomic phenomena. The objectives of this research project are to develop such a toolkit by (1) examining the implications of spatial clustering and spatial heterogeneity for the application of exploratory data analysis (EDA) techniques in a dynamic context; (2) developing new statistical methods for exploratory space-time data analysis (ESTDA); and (3) implementing these methods in an Open Source package for exploratory space-time analysis of social processes. The methods to be used include exploratory spatial data analysis (ESDA), exploratory temporal data analysis (ETDA), Monte Carlo simulation studies of the empirical properties of the new ESTDA methods, object-oriented programming, and dynamic geovisualization.

The toolkit Space-Time Analysis of Regional Systems (STARS) is an open source package designed for the dynamic exploratory analysis of data measured for areal units at multiple points in time. STARS consists of four core analytical modules: [1] ESDA: exploratory spatial data analysis; [2] Inequality measures; [3] Mobility metrics; [4] Spatial Markov. Developed using the Python object oriented scripting language, STARS lends itself to three main modes of use. Within the context of a command line interface (CLI), STARS can be treated as a package which can be called from within customized scripts for batch oriented analyses and simulation. Alternatively, a graphical user interface (GUI) integrates most of the analytical modules with a series of dynamic graphical views containing brushing and linking functionality to support the interactive exploration of the spatial, temporal and distributional dimensions of socioeconomic

and physical processes. Finally, the GUI and CLI modes can be combined for use from the Python shell to facilitate interactive programming and access to the many libraries contained within Python.

### **Activities and Accomplishments**

Research on the project has focused on four areas of activities. The first concerns a set of methodological advances developing new statistical methods for exploratory space-time data analysis. These include the development of two new tests for spatial autocorrelation in dynamic series (Rey, Janikas, and Smirnov, 2005 and Rey and Janikas 2005b), and a spatially explicit approach to analyzing the evolution of income gaps between economies in a regional system – so called spatial sigma convergence (Rey and Dev, 2005).

The second component of the research effort has been to continue to enhance the STARS package in a number of dimensions. First, we have refactored the data import component of STARS by removing a dependence on shapelib (a c-library for reading shapefiles). As a result a single version of STARS runs on all supported platforms (Windows, Mac OS X, Linux). This component has also been redesigned to improve the “user-friendliness” of data import. The user interface has also been enhanced to incorporate context sensitive help dialogs guiding the user through the options of each analytical method, as well as incorporation of example data sets, graphical tutorials (QuickTime Movies) and a user guide.

In addition to the enhancements of the user interface, STARS has also been extended to include the new analytical methods described above. A key component of this effort has been the development of novel methods for geovisualization. An example screenshot is shown in Figure 1. The user has selected the state of Illinois on the map via a mouse click (lower left). This highlights the associated observations in the three remaining views, each giving a different spatial or temporal perspective. In the upper right view the Moran Scatter Plot depicts each state’s income against that of its geographical neighbors. Illinois is seen to have above average income, yet its neighboring states have incomes below the national average.

In the lower right panel, a Conditional Scatter Plot shows that the dynamic relationship between incomes and Illinois and its neighboring states (red line) is markedly different from the overall trend (black line). Finally, the TimePath view in the upper left portrays the co-movement of income for Illinois and its regional neighbors. While Illinois initially had an income substantially above the national average in 1929, it has moved towards the national average over the century. The neighboring states, however, have tended to remain in the same relative positions in the income distribution. The TimePath itself was dynamically created by the user issuing a control click on the Illinois point in the Moran Scatter Plot.

The third area of activity has been the application of the toolkit to substantive research problems in a number of social sciences including regional economics (Yamamoto, 2005; Janikas and Rey, 2005; Rey and Janikas, 2005a), and spatial epidemiology (Getis, 2005; Anselin, et al 2005).

The final area of activity has been outreach, first through interaction with ESRI to explore potential transfer of the new methods to commercial GIS software (Rey, 2004) and second with

other open source spatial analysis projects. The latter has resulted in the establishment of a collaborative project (Anselin and Rey, 2005) to develop common spatial analysis functions in a shared library for use by STARS and other projects (PySpace, GeoVista) as described in (Anselin, et al 2005)

## Broader Impacts

This project will make significant contributions to the practice of spatial social science, the modeling of human dynamics, and to basic understanding of the nature of regional growth and inequality. The incorporation of space and time into models of regional inequality and growth will provide more comprehensive and accurate descriptions of human social and economic behavior. The project will develop an exploratory space-time toolkit that will be Open Source and accessible to a broad array of social science researchers to enhance the analysis of human and social dynamics. As such, this research is expected to have implications in areas such as studies of urban segregation patterns, space-time epidemiology and public health, criminology, housing market dynamics, socioeconomic inequalities, among others. From a policy perspective, the development of new spatially explicit measures will provide planners and analysts with capabilities to design policy interventions targeted at key individual geographical areas. By taking spatial spillovers into account, this spatially focused strategy will leverage the impact of such policy programs across the boundaries of a single area, thereby increasing the effectiveness of the policy.

**Project Website** <http://stars-py.sf.net/>

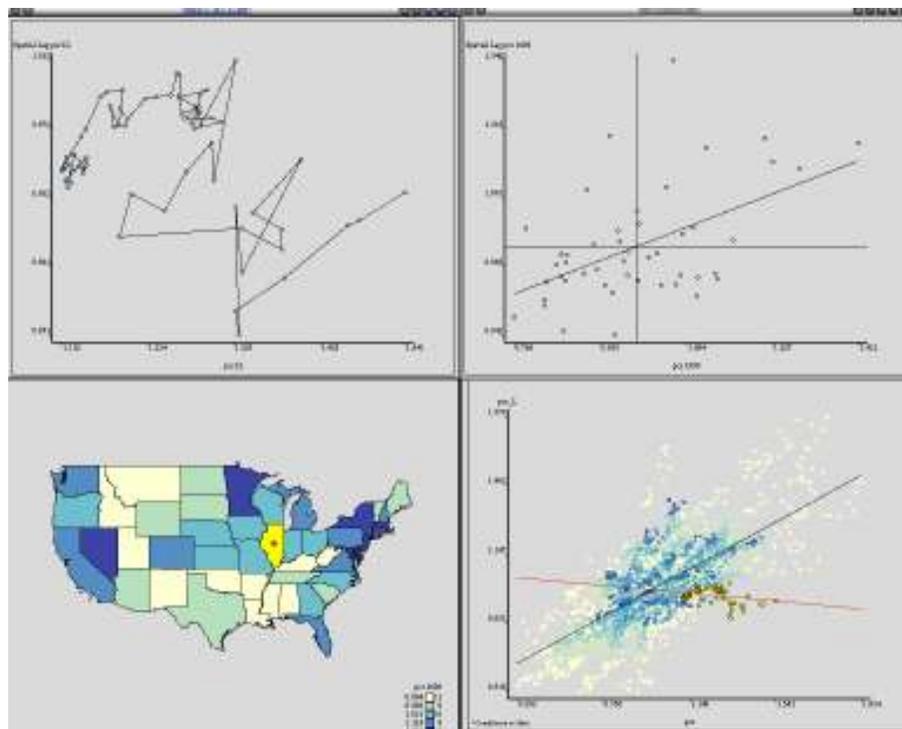


Figure 1. Example multidimensional views of spatial dynamics.

**Andrew Rosenberg, University of New Hampshire**

Modeling the Synergistic Effects of Social and Ecological Change in the 19th-Century North American Cod Fishery

0433497

Today, rapid resource depletion and deterioration of the natural environment threaten many human societies. Communities dependent on open access to natural resources are vanishing as resources become scarce. They take with them intimate knowledge about the natural world gleaned through generations of experience. Nowhere is this more evident than in commercial fisheries. Declining fish stocks, ineffective management policies, and increased marginalization of fishermen worldwide imperil coastal fishing communities, marine ecosystems and critical food resources. Understanding long-term interactions between fisheries and the marine ecosystem is essential to saving them, but few baseline studies exist describing human engagement with marine ecosystems in the past.

Recent studies have shown that overfishing is not new, but existed long ago. In the 19th-century, halibut stock in the northwest Atlantic collapsed, forcing Gloucester fishermen to venture as far as Iceland in search of the valuable fish. In the 1860s and 1870s, anadromous fish runs declined precipitously after weirs and pound nets multiplied. Public outcry led to the creation of state fish commissions and the US Fish Commission, a forerunner of NOAA, was formed in 1871. Even 150 years ago, New England's cod fishery experienced regional downturns due to declining catch. This federally subsidized, but unrestricted fishery offers an excellent model for examining social and environmental variables surrounding resource depletion, and how fishermen responded to them.

Archival records of New England cod fishing vessels between 1852 and 1866 present a data set suitable for modeling human behavior in the hook and line fishery, and investigating the synergy between social and ecological change. Logs can report daily catch, vessel location, depth of water, and the condition of the sea floor, as well as family affinities among the crew and communications with vessels fishing nearby. Fishing agreements list vessel size, homeport, crew names and residences and total catch weight after drying. The combination of daily catch statistics, observations at sea and geographic location with social, cultural and demographic data discloses communitarian knowledge systems, information networks and decision-making processes operating within ecological and social contexts. This interdisciplinary project, undertaken by environmental historians and marine scientists, correlates ecological change on cod fishing banks in the mid 19th-century with choices made by New England fishermen plying their trade with hook-and-line from wooden boats. Stained with saltwater and fish oil, written in smudged ink or faded pencil, occasionally embellished with drawings of fast schooners under full sail, the logs are more than sources of data (Fig. 1). Entries ranging from cryptic and illegible to clear and poetic reveal the stories of men steeped in the natural language of the marine environment.



Figure 1. Log book illustrations from the cod fishery, 1852-1866, courtesy of the National Archives and Records Administration, Waltham, MA.

Data from archival manuscripts are being extracted, entered into databases, and analyzed historically to identify affinity groups, fishing patterns, knowledge systems and trends in human demography. Work underway on the inshore Gulf of Maine fishery complements earlier work on the Scotian Shelf. Over 36000 daily records from 300 fishing logs of vessels sailing from the Frenchman's Bay, Maine, Customs District between 1860 and 1865 have been entered into preliminary databases for quality control, and transfer to an online MYSQL database is underway; 2500 fishermen have been entered into a separate database for identification in census, probate, and town records, and other historical sources. Global Information Systems (GIS) software enables tracking changes in the distribution of catch, fishing patterns, and human demographics over time. The geographic distribution of fishing vessels will be correlated with homeport, familial and social affinities, and biological indicators for cod stock generated by fisheries stock assessment models. Discrete choice modeling identifies and ranks variables that influence behavior and signal changes such as adopting new technologies, altering fishing strategies and accepting greater risk in a dangerous business.

The logs reveal fishing patterns very different from the Beverly, Massachusetts, cod fleet, the focus of our previous study. While two thirds of Beverly vessels fished the Scotian Shelf and vessel size correlated to choice of fishing ground, 91% of Frenchman's Bay vessels fished inshore grounds regardless of size. For instance, in 1861 the 120 ton ORATOR of Surry in Blue Hill Bay fished in roughly the same region as the 8 ton UNION of Ellsworth, up the Union River at the head of Blue Hill Bay. Small boats fished hard. The UNION caught four times more cod

per ton-of-vessel than the ORATOR, a general trend suggesting that a reverse economy of scale was in effect.

Logs identify fishing banks by name. Landmarks and compass bearings, not navigational coordinates, determine course. Names are often local and idiosyncratic. The Frenchman's Bay inshore fleet fished a well-defined zone from Isle au Haut in Penobscot Bay to Grand Manan (Fig. 2). Fishing banks (Goode 1887, Rich 1929) were mapped in Geographic Information Systems (GIS) and coordinate with the MYSQL database. Aggregation of catch per day per bank is ongoing as further data is entered.

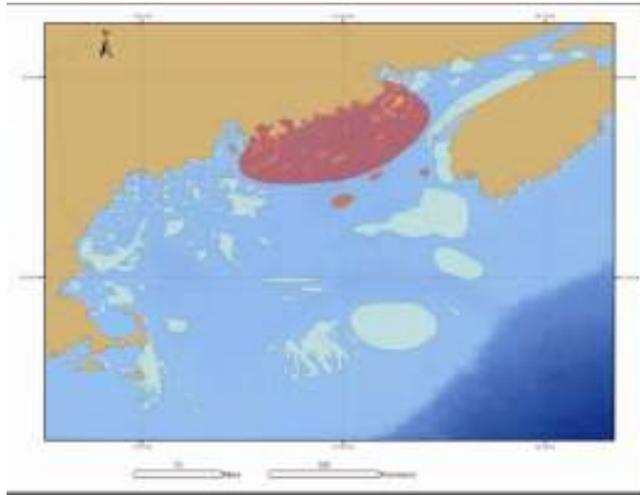


Figure 2. GIS map of the Gulf of Maine showing fishing grounds identified by Walter Rich of the Bureau of Fisheries in 1929. The region where 91% of the vessels from Frenchman's Bay, Maine, fished for cod from 1860 to 1865 is identified in red.

Vessel size influenced fishing patterns within the Gulf of Maine. Small boats fished in bays and tidal rivers and unloaded catch every few days to be dried by a shoreman. Larger schooners fished east to west along the coast and farther out to sea. Eighty percent of Frenchman's Bay vessels under 40 tons appear to have been operated by two or more members of the same family. Seventeen vessels were captained by men under 21, one by a 15 year old boy. Alvah Doliver, a girl of 13, fished with her father, and evidence suggests that boys as young as 6 were on board some vessels.

Frenchman's Bay skippers used tub trawls to land the same amount of fish quicker, not to land more fish in the same amount of time, as was the case in Beverly. Nevertheless, preliminary figures for overall catch show that, in 1861, 81 small schooners caught 5180 mt of cod between Isle au Haut and Grand Manan, an area almost devoid of cod today. This is nearly as much as the entire Gulf of Maine yielded in 1999 and 2000 combined.

The biomass estimate for Scotian Shelf cod in 1852 has already influenced scientific and public notions of past species abundance. Biological indicators such as this dispel the myth of low productivity even as they raise the possibility of a regime shift towards lower trophic levels in the marine ecosystem. Profound shifts in abundance of keystone species like cod can serve as

indicators of ecosystem health. They raise the bar for rebuilding productivity by orders of magnitude. Nineteenth-century records of cod landings in the Gulf of Maine promise further evidence of startling abundance distributed throughout shallow bays, up tidal rivers, and on fishing grounds covering just a few acres. Frenchman's Bay vessels fishing at anchor provide ecosystem data in much finer detail than modern trawl surveys. Evidence of bait fishing in cod logs shows how the demersal fisheries affected other species populations in the inshore ecosystem, and indicates productivity on lower trophic levels.

By identifying modes of traditional behavior among mid 19th-century New England cod fishermen, analyzing the factors influencing them and charting trends in their behavior, this project contributes a behavioral baseline for an important modern fishery currently in freefall. Establishing a historic range of responses to ecological and economic crises may suggest more options in today's highly polarized management debates. Acknowledging 19th-century fishermen as accurate observers of the environment encourages a dialog between contemporary scientists and fishers on the state of the marine ecosystem. Better management policy may eventually result from such a dialog. Our interdisciplinary analyses contribute to an understanding of humans as architects of the natural world, and of nature as an agent of social change even as they expand the potential for interdisciplinary education in the sciences and humanities.

The Gulf of Maine Cod Project (GMCP) at the University of New Hampshire trains graduate and undergraduate students in all aspects of historical ecology as they work with original documents, modern statistical modeling and GIS. As part of the Alfred P. Sloan Foundation's History of Marine Animal Populations (HMAP) program, UNH partners with national and international colleges and universities. Besides participating in and hosting workshops and conferences sponsored by HMAP, a PhD candidate from the University of Southern Denmark studied historical and statistical analysis at UNH in 2004. Fulbright scholars from the European University in St. Petersburg, Russia will be in residence in 2005 and 2006 collaborating on the analyses of historic North Atlantic cod and Atlantic salmon fisheries.

GMCP staff regularly participate in regional conferences and workshops, and give public lectures. We have advised local museums, and local, National and Canadian Public Television on aspects of our work. Recently, Stellwagen Bank National Marine Sanctuary joined with us to begin reconstructing the changing ecology of the sanctuary region from historical records. Its detailed focus on all species in one small part of the Gulf of Maine over hundreds of years compliments the Cod Project's focus on one fishery region-wide in the mid 19th century. Sanctuary officials are interested in the potential of historical ecology to engage public imagination. Our project is serving as a pilot for other National Marine Sanctuaries interested in a historical component. Records of fishermen from the 1860s show how closely these men were connected to their ocean environment. The data is inextricable from their narratives and stories. These histories hold the promise of connecting science to people, and making the ocean a meaningful human space.

### The Causes and Consequences of Urban Expansion 0433278

This research project is designed to investigate the causes and the consequences of the expansion of land in urban use in a global sample of 120 cities stratified by size, geographic region, and level of economic development. This investigation is of central scientific and policy importance at this time, particularly for cities in developing countries, where the urbanized population is expected to double, from 2 billion to 4 billion in the next 30–35 years. With increasing incomes in the developing countries, the consumption of land by their cities will likely double in the next 25 to 30 years. These growth rates imply that in the developing world a new city with more than 1 million inhabitants must be built every week for the next four decades. Confronting and managing this massive expansion in an efficient, equitable, and sustainable manner is a serious global challenge. In a related study, financed by the World Bank, the research team has undertaken to construct the sample of 120 cities and to collect census data and satellite imagery for two time periods, corresponding to the two most recent censuses, for each city in the sample. The location of urban areas in the sample is illustrated in Figure 1.

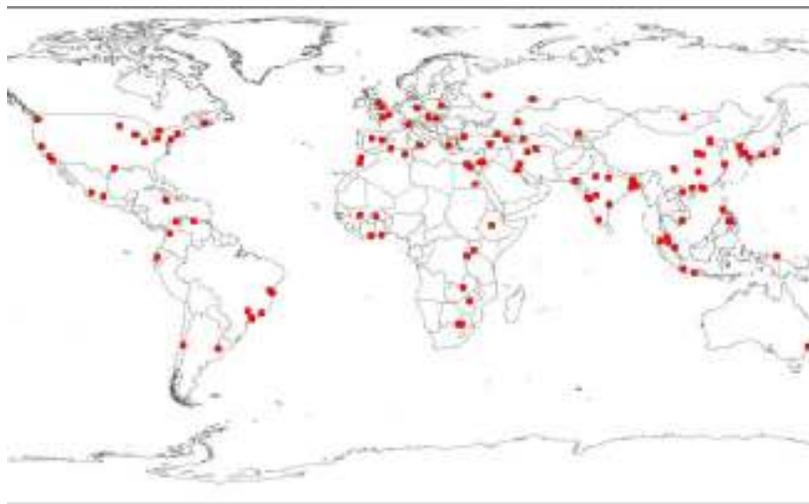


Figure 1

The proposed research will use the data collected for these 120 urban areas as a foundation for more extensive examination of the impact of local conditions — especially local planning and regulatory regimes — on urban expansion. This will permit exploration of the consequences of different levels of urban land consumption for human welfare in general, and for urban poverty in particular. These explorations require data collection at the individual city level. The proposed research will undertake to:

1. Collect local data using local surveyors in each urban area
2. Improve and assess the land cover classification currently underway for the sample
3. Measure the social and economic impacts of urban expansion
4. Model the effects of local policies on urban expansion.

The data collected and evaluated in tasks (1) and (2) will serve as inputs to the analysis undertaken in tasks (3) and (4). The data collected will further serve as an essential resource for scholars and policy makers in developing and testing hypotheses concerning the process of urban expansion, and will be made widely available. The analysis undertaken in tasks (3) and (4) will be the first to use a global sample to explore the relative importance of factors such as population growth, income, transportation costs and infrastructure, economic structure of the urban area and local regulatory policies on urban expansion. The analysis will also be the first to evaluate, in a global context, the impacts of urban expansion on housing affordability, access to sanitary and transportation infrastructure, and conditions in the most impoverished areas of cities.

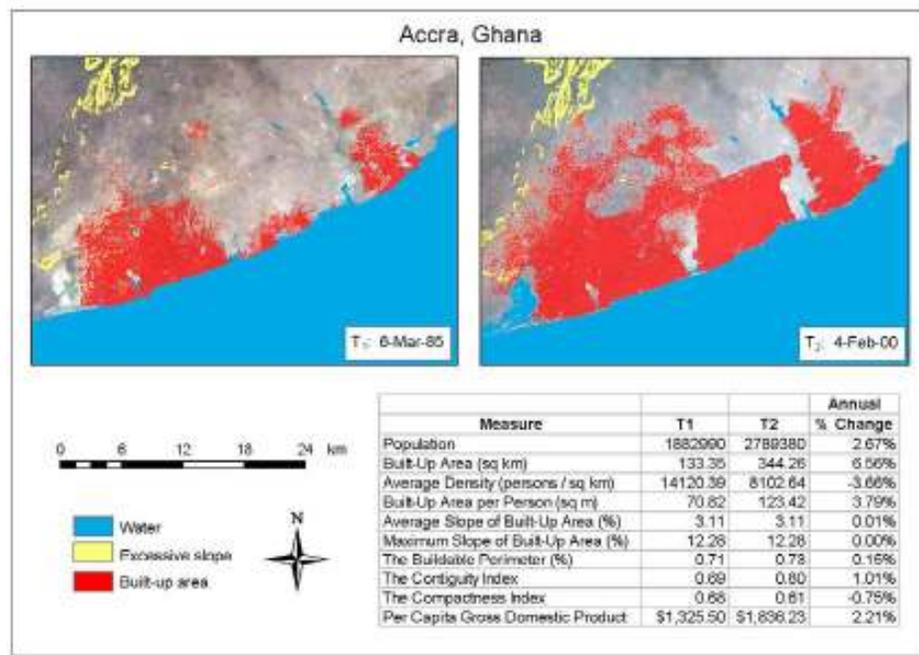


Figure 2

As a first step, summary maps are being prepared for each urban area in the sample, providing summary measures of the magnitude of urban expansion and the density of human settlement. Maps are presented that illustrate the amount of urban expansion based on our analysis of satellite images. The dates for each image are given, and the levels of population and per capita

GDP are adjusted to these dates for comparison. An example for Accra, Ghana and surrounding urban area is illustrated above in Figure 2.

More detailed data for use in modeling the economic and physical determinants of urban expansion are currently being collected by field researchers. As of August 2005, data had been submitted from researchers in 47 different urban areas, and data collection was underway in a total of 104 urban areas. Field researchers are being recruited for the remaining 16 urban areas so that data collection can be complete by the summer of 2006.

The research has generated interest within both the scientific and policy communities. The World Bank, UN Habitat, and the UK Department for International Development have expressed interest in the research and contributed additional resources for collecting data relevant for both scientific analysis and evaluation of important objectives such as the Millennium Development Goals (see <http://www.un.org/millenniumgoals/>), particularly Goal 7, Target 11 (see <http://www.unhabitat.org/mdg/>).

The research team has been invited to present preliminary results of their analysis at the Allied Social Sciences Associations meetings in Boston (January, 2006) and the UN Habitat Conference, to be held in Vancouver, BC (June, 2006). A paper reporting on the satellite image classification techniques being developed and used in the research was presented at the meetings of the American Society for Photogrammetry and Remote Sensing (ASPRS) in Baltimore, MD (March, 2005).

**Project Website** <http://www.williams.edu/Economics/UrbanGrowth/HomePage.htm>

### Dynamics of Human Behavior Emphasis Area

**Yiannis Aloimonos, University of Maryland and Ken Nakayama, Harvard University**

The Grammars of Human Behavior

0433136

Have you ever thought what goes on inside your head when you look at someone performing an action and you understand it? Or how about when I show you a dance and you look at me and you are learning the movements? And what about the case where you think of an action that you did yesterday or that you will do tomorrow? We do these things so effortlessly that we hardly ever think how we accomplish them. These scenarios show that when these behaviors are exhibited, we are relating different action representations to each other. The action representational system is not monolithic, but rather occupies a spectrum of informational structures at hierarchical levels corresponding to different behavior "spaces": (a) the mechatronic space used in movement planning and production, i.e when we actually perform an action (b) the cognitive space, involving representations for action recognition, analysis, and evaluation; (c) the visual motion space, which encodes and organizes visual motion caused by human action; and (d) the linguistic motion space, comprised of conceptual/symbolic action encoding.

Our theoretic, computational, and experimental efforts seek to clarify and formally describe both the nature of the representations in these spaces and, crucially, the mapping of representations across spaces. Notably, we explore a candidate action representation, referred to as a visuomotor representation, which, in facilitating the understanding of observed actions, may recapitulate and resonate with the actual motor representations used to generate movement. Moreover, we present a promising approach for obtaining this representation from discrete action elements or anchors.

This endeavor spans a number of research domains, both basic and applied, including Human and Computer Vision (e.g., automated action recognition in digital video, surveillance, security), Cognitive and Social Psychology (e.g., robust social judgments given degraded biological motion), Kinesiology and Motor Control (e.g., analysis/modeling/training of movement profiles, as in athletics or pathology/rehabilitation), Artificial Intelligence and Robotics (e.g., control of anthropomorphic robots and symbol grounding), and Computer Science and Animation.

The Intellectual Merit of our proposed work derives from its principled development and empirical evaluation/refinement of a novel formal theory of the mental representations and processes subserving action understanding and planning; our work provides a compact but powerful and extensible computational approach to the analysis *and* synthesis of complex actions (and action sequences) based on a very small set of atomic postural elements ("keyframes" or "anchors") and the corresponding probabilistic, grammatical rules for their combination. Thus, in a sense, our probabilistic "pose grammar" approach to action representation is similar to state of the art techniques used for speech recognition (e.g., hidden Markov models), but with key postural silhouettes taking the place of phonemes; such augmented transition grammars also nicely reflect sophisticated new control-theoretic techniques in Robotics for robust anthropomorphic movement.

There are two promising thrusts of our work, one scientific and the other technological. Our studies on human action reveal a structure similar to language, as they both (action and language) have a recognitive and generative aspect (I understand what you say and I can also produce language; I understand with my vision what you do and I can do a similar action). Like in language, human action has nouns, adjectives, verbs, adverbs and prepositions. We are collecting empirical data on thousands of human actions and we are learning a grammar that produces all these actions. We think that this grammar of action will play a fundamental role in understanding the ideas surrounding Chomsky's Universal Grammar. The technological thrust comes from software that can automatically recognize human actions in video. Although many researchers work on this problem, our approach is unique in the sense that we use both visual representations (that we extract from images) and motor representations that we learn from measuring human action.

**Project Website** <http://www.cs.umd.edu/~karapurk/nsfhsd/index.htm>

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### **Delphine Dahan, University of Pennsylvania**

Temporal Dynamics of Phonological Expectations in Language Comprehension and Development  
0433567

### **Overall objective and preliminary outcomes**

Imagine a situation where your task is to evaluate some information in order to guide a decision, but the information is ambiguous, noisy, and keeps changing. How could you ever perform this task? Amazingly, this situation captures the challenge we face when we perceive and interpret what someone is saying. Speech is a continuous, highly complex, and rapidly changing signal. A spoken word is a temporal sequence, which becomes available only gradually. Contrary to

written language, where the stimulus usually remains in view, speech is transient. Because humans' sensory memory is limited, speech must be evaluated and interpreted incrementally. Speech is also a noisy and ambiguous signal. For example, the same acoustic detail in the signal can mark the presence of different speech sounds (e.g., *g* or *d*), depending on the nature of the sound that precedes or follows it (e.g., *l* or *r*). As a result, the recognition of spoken words requires the on-line management of a continually shifting set of expectations, to work out an interpretation in the face of substantial ambiguity.

The objective of this project is to understand the nature of the expectations that adult and infant listeners bring to the task of interpreting speech, and how these expectations change to reflect listeners' continuous adaptation to the information they have accumulated. In order to assess listeners' interpretations, we monitor their eye movements to potential referents of the spoken stimulus. Adults or young children hear spoken instructions referring to one of a set of objects displayed on a computer screen (e.g., "*Look at the cat!*"). Listeners' eye movements to an object upon hearing a spoken name are taken to reflect the degree to which the object is thought to be the named target. Thus, eye movements serve as an index of listeners' interpretation of the target's name. Previous research from our labs and others has established that eye movements provide a useful measure of speech interpretation over time. For instance, if adult listeners are asked to "*click on the beaker*" with the computer mouse, by the end of the word *beaker*, they are more likely to have launched an eye movement to the picture of a beaker (the target) or a beetle (which sounds like *beaker* at first) than to the picture of, for example, a baby carriage. This demonstrates that (1) people process speech incrementally and generate hypotheses about the identity of the spoken word they hear before they have received complete information, and (2) eye movements to visual potential referents can reflect this incremental process.

We examine how evidence from the acoustic signal, combined with prior expectations, is evaluated and integrated over time by both adults and very young children. Evidence that children as young as one year of age continuously monitor the speech signal and can revise an interpretation based on new information is scarce. Our first study aimed to establish continuous uptake and evaluation of phonetic information in the signal by one-year olds. Children between 14 and 20 months of age and their caregivers were invited to the lab. During testing, the child was sitting on his/her caregiver's lap, facing a large monitor. On each trial, two familiar objects were displayed, and one was named using a correct pronunciation (e.g., *Where's the dog?*) or mispronunciation (e.g., *Where's the tog/dawb?*). A concealed video camera recorded the child's face, and infants' eye movements were coded as being directed to one or the other of the two displayed pictures. Each child heard correct pronunciations and onset or offset mispronunciations of known names of objects (as assessed by parental reports). The mispronunciations were natural recordings, created by changing one phonetic feature to the first or last consonant of the original name. Overall, children looked at the referent less when its name was mispronounced than when it was correctly pronounced. Importantly, the timing of this difference reflects where in the word the mispronunciation occurred. This result demonstrates that even very young children continuously evaluate the speech signal with respect to a mental representation of the referent's name, and that eye movements can capture this dynamic process. This opens the way to testing the perception of artificially modified pronunciations that are even more subtle, for which different theories make different predictions.

A second line of research focuses on adults' ability to adapt to the characteristics of a talker, and the processing consequences of this adaptation. In some American English dialects, the vowel *a* before *g* (as in *bag*) is raised to a vowel approaching *e* (making *bag* sound almost like *beg*). Importantly, this "raising" phenomenon does not occur before a *k* context (so *back* does not sound like *beck*). This phenomenon in effect reduces the phonetic overlap that exists in standard American English between (e.g.) *bag* and *back*, because with raising of *bag*, *bag* and *back* no longer have the same vowel. We took advantage of this dialectal phenomenon to study listeners' adaptation to speaker differences. In this study, participants saw four written words on a computer screen (e.g., *bag*, *back*, *dog*, *dock*) and heard a spoken word. Their task was to indicate which word they heard. Participants' eye movements to the written words were recorded. First, participants in the "raising" group heard *bag*-like words containing the raised vowel *e*; participants in the "control" group heard *bag*-like words containing standard *a*. Then, acoustically identical *back*-like words were presented to both groups. Participants in the "raising" group made fewer fixations to the competitor *bag* than control-group participants did. This result indicates that (1) prior exposure to raised realizations of *bag* has changed the pronunciation of *bag* that listeners expect from this talker, and (2) this knowledge is involved when evaluating the initial portion of the spoken word *back*: The evaluation of the vowel *a* in *back* predicts *bag* to a lesser degree for the raising-group participants than for the control-group participants, even though both groups are hearing the same "standard" pronunciation of *back*.

Adult listeners evaluate speech with respect to expectations. This is often modeled as Bayesian inference. This study's main contribution is showing that the computation of "likelihood" (the probability of the signal, given a hypothesis) is context- and talker-dependent. Incoming data from the speech signal are used for two purposes simultaneously—as input to be interpreted, and as input to processes that modify the perceiver so as to optimize future interpretation.

### **Broader impacts**

The project promotes teaching and training by involving undergraduate students in the laboratory. Under the direction of the PI and co-PI, several undergraduate students have participated in all phases of the research effort, from assisting in the design and creation of experimental stimulus materials, to testing participants and analyzing results. Some of these students have participated as part of Research Experience courses that the PIs offer annually.

To date, all of the undergraduates who have participated in the research this way have been women, and a high proportion have been from underrepresented groups. Given that nearly all of the students who have worked in our labs have then gone on to seek higher education or employment in research careers, the present project may be viewed as a springboard for young researchers with promising futures in science.

Because the research participants in the infant studies can be anyone in the community who is raising a native speaker of English, the studies have an impact outside the University and, most likely, outside the range of much exposure to science. Minority group participation in these studies has been encouraging. All parents who participate are then placed on our mailing list for the infant lab newsletter, which presents our research and other scientific research studies of

early development in understandable terms. In this way, parents can place their own participation in the broader context of incremental scientific progress.

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**Marco Janssen, Arizona State University**

The Dynamics of Rules in Commons Dilemmas

0432894

Various social sciences have contributed to understanding how humans make decisions in a given rule set of experimental games, such as social dilemmas, coordination, and bargaining. However, the rules of the games are not fixed in real-life settings. Not many systematic studies have been performed on the question of how humans are able to change the rules in commons dilemmas. From field studies it is well known that people invest significant effort in crafting new rules. This project will study what causes individuals to invest in rule development, and which cognitive processes explain the ability of humans to craft new rules.

The main research combines experiments and modeling. We use three types of experiments which we will discuss briefly:

**Laboratory experiments.** We are developing an artificial environment where a group of 5 human subjects share a renewable resource (Figure 1). The human subjects can derive monetary rewards by collecting tokens by moving their agents around on the screen. We have a number of different treatments. In one of them the subjects can vote on a restriction on their harvesting opportunities by allocating private properties. In the other treatments the private property rule is imposed, or there is no opportunity to include private property. Those who break the rule have a chance to be caught and pay a penalty. We will test a number of effects including the impact of experience on the behavior of the subjects, and whether imposed rules lead to different behavior than chosen rules.

**Field experiments.** Paper and pencil experiments are designed for the field in Colombia and Thailand. We design three types of games related to the resources irrigation (how much to contribute to a public good and how to allocate the public good), forest (how much to take from a renewable resource), and fisheries (when to harvest where). We test these three types of games in three types of communities: irrigation dominated, fishery dominated, and forestry dominated. The subjects can make choices which type of rule (lottery type, rotation type or property rights). We are interested which type of rule communities chose, whether this relates to their own experience with governance, and the difference between imposed and chosen rules.

For both laboratory and field experiments we will develop agent-based models and test on the data which type of behavioral models best explain the data.

**Role games.** The field experiments provide a starting-point to perform a companion modeling exercise. This means that specific queries on rule crafting for each community is used to perform role games to solicit more understanding how the particular communities

develop and adapt institutional rules. The resulting models are socially validated by the communities.



Figure 1: A screenshot from the experimental environment. The green tokens are resources, the yellow dot is the agent of the human subjects, while the blue dots are the other subjects. The white lines define the property boundaries of the yellow agent.

The different types of experiments and modeling relate to each other (Figure 2). Different types of experiments have different level of control. During the first year of the project we focused on the design of the experiments due to these differences, and to increase the likelihood that the different activities have synergetic effects. The main bottleneck we faced were the different traditions in doing experiments and role games, which led to discussions which path to follow when we want to align the different types of activities. For example, the role of subject payments was an important concern. We decided to use monetary incentives, but for some communities in the field we may decide not to pay subjects in monetary units — but in other valuable assets — if monetary units have no meaning for the subjects. The designs of the experiments provide us the opportunity to test and compare the results of different levels of control and context. Laboratory experiments provide detailed information of many real time decisions. Experiments in the field provide less control but include some context of real resource users. In the role games the focus is on the context of the particular communities. Due to the different focuses we aim to develop a number of models that are consistent to each other and provide some core findings how people invest in rule creation.

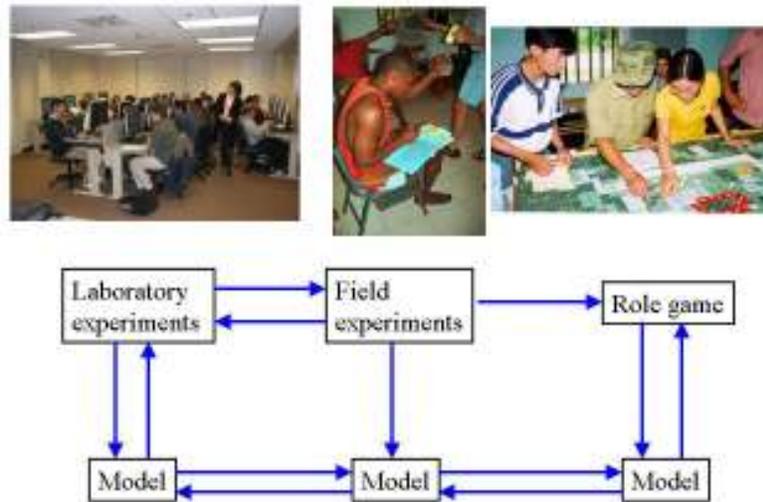


Figure 2: The relation between different types of experiments and the modeling activities.

Based on the experiments in the laboratory and the field, we will develop a software available as downloadable educational tools, with which students all over the world will be able to experiment with rule-crafting in commons dilemmas.

This project will contribute to the methodological development of agent-based models by combining laboratory and field experiments, and role games, and to the empirical testing of alternative behavioral models. It may have a broad impact in political science and ecosystem governance by deriving an understanding of what factors affect the ability of resource users to change institutional rules effectively. The project will strengthen the collaboration on experimental research and agent-based modeling between Asia, Latin American and the USA.

**Project Website** <http://www.public.asu.edu/~majansse/dor/nsfhsd.htm>

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**Henry Kautz, University of Rochester and James Rehg, University of Washington**

Creating Dynamic Social Network Models from Sensor Data  
0433637

### Overall Mission/Objective

People are social animals. Interaction with others underlies many aspects of our lives: how we learn, how we work, how we play and how we affect the broader community. In this project, our aim is to develop a sensor-based approach for understanding people's interactions and their social networks: how people communicate with and influence each other, how they build networks of social relationships, and how such social networks develop over time.

We are asking these questions using a new and, we believe, powerful set of interdisciplinary tools, drawn from Sociology and Computer Science. Sociologists have developed a rich set of

theoretical tools for studying social networks, such as methods for measuring people's prominence within social groups, and for quantifying people's tendency to interact with others who are similar. However, it has been difficult to collect data that are as rich as the theories. The only methods available have been either impractically laborious, such as directly observing people for hours on end, or potentially unreliable, such as asking people to answer questionnaires or to write diaries.

Methods from Computer Science can transform the data collection process, by making it possible to automatically record detailed aspects of people's social interactions, for hours and days on end. This is achieved by having the data collected not by people, but instead by computers. These computers are wearable, meaning that they are carried around on the bodies of the study participants: lightweight, small and unobtrusive, worn just as one might wear a watch, a necklace or a belt. These wearable computers incorporate sensors to record various aspects of the immediate environment, such as sound, movement, and geographical location.

Wearable computers are already becoming part of our lives: iPods, cell phones, and runner's heartmonitoring watches are all forms of wearable computer, although they lack the wide variety of sensors built-in to the wearables in our study. Wearable computers can collect data in several ways that humans cannot. First, they can record continuously with fine time-resolution, e.g. hundreds of recordings per second. In addition, they can record uninterruptedly, for long periods of time. Perhaps most importantly, a large number of people can wear such computers simultaneously, making it possible to study the social interactions not only between individuals but also within and between groups. We have already used such devices to record the social interactions between twenty-three people over a period of two weeks, and we are currently starting a study to investigate the formation and evolution of social networks in a large proportion of the incoming class of University of Washington

Computer Science graduate students, over the course of an academic year. These types of data sets will many times more richly detailed than hand-collected data about social networks, which, for face-to-face interactions, is all that has been available until now. Such datasets will enable us to investigate a host of important sociological questions. For example: how do social networks change over time, over short and long time scales? Do individuals sharing relations tend to be similar in attitudes, and behaviors? Do we choose friends who are similar to us, or do we become more similar to our friends? How does the physical environment affect the social networks of people who live and work there?

It is one thing to collect a mass of data, and quite another thing to understand what the data might be telling us. We are building computational models that can find structure in the masses of noisy sensor data that get collected. In particular, these models should be able to infer people's roles and relationships, and describe how individuals influence one another. Probabilistic models, e.g. Bayesian networks and Markov networks, are ideal for finding the underlying structure and dynamics of the social networks that led to the recorded person-to-person interactions. Because these computational models are probabilistic, they allow us not only to make sense of the raw sensor data, but also to handle the variations that are characteristic of human behavior.

### **Progress and (Preliminary) Outcomes:**

Our current project at the University of Washington grew out of a pilot study of twenty-three graduate students, who wore wearable computers with sensors during business hours, over a period of two weeks. Computational and statistical modeling of the collected data yielded several interesting preliminary results. For example, it was found that people mostly stuck within their own groups, but that there were a few individuals who mixed between groups, thereby functioning as the community's social connectors. We also found that the people who were the most socially connected in the community were also those who tended to have the greatest influence on other people's styles of conversation. These findings, although promising, were limited by the relatively small scale and short duration of that study.

To look at larger-scale and longer-term trends, we are right now starting a new study with the incoming class of University of Washington graduate students at the Department of Computer Science. Thirty custom designed wearable computers have been constructed for the students to wear, with each device containing the following sensors: audio, WiFi (wireless internet), GPS (satellite global positioning system), accelerometers (to detect motion), temperature, light, humidity and air-pressure. At the present time (August, 2005) enrollment is in process, and datacollection will commence with the start of the 2005 Fall Quarter. The participants will be wearing the devices for one week per month, throughout the 2005-2006 academic year. Standard sociological surveys have also been developed and will be conducted periodically throughout the duration of the study. The survey data will give us preliminary measures of fixed characteristics (e.g. ethnicity, language, etc.) and variable characteristics (e.g. research interests), so that we can analyze how such characteristics and social networks co-evolve over time. We can then correlate the findings with behavioral measures obtained from sensor data. This study will create the first opportunity to study in detail how networks of social interactions develop in a large group, from the starting point of individuals who are meeting mostly for the first time, and then continuing over the course of a year during which social and work relationships are born and grow.

It is important to emphasize that we are taking great care to protect the personal privacy of the study participants. The collected audio is processed only to distinguish between periods of speaking and not-speaking, with no recording of intelligible speech or extraction of the words actually spoken. All recorded data will be anonymized and encrypted.

### **Broader Impacts**

We expect that our study will have broad impact, both within and beyond the scientific community. As described above, our study will be able to address long-standing questions in Sociology at a far greater level of detail than was possible before, due to our automatically collected large-scale data set. Moreover, we are also developing statistical and computational models in order to understand the structure of the data.

We will be making our newly collected data sets available to the broader scientific community. Previous manually-collected data sets, although sparse and data-poor in comparison to what fully our automated methods make possible, have nonetheless been analyzed and re-analyzed by sociological theorists. We therefore anticipate that there will be substantial interest in the datasets

that we generate, and that new theoretical insights into social networks will emerge not only from our own computational analyses, but also from other researchers investigating our data.

The new understanding of social networks that, we believe, will emerge from our work is likely to have many potential applications in the real-world. Large businesses have long been interested in the flow of information within the organization, as the difference between their success and bankruptcy could depend on how well information flows between different groups of employees. Another real-world problem in which social networks play a central role is the spread of disease. An infectious outbreak in a self-contained village community would spread in a completely different way from an outbreak in a busy metropolitan city. Knowing the social networks in these communities can have enormous practical benefits. For example, the social network structure can help to predict the rate of spread of a disease, and also where it will spread to next.

These examples are just two of the possible applications of social network research. Many other domains could also be impacted, covering areas as diverse as marketing campaigns and urban planning. The wealth of new data made accessible by our new methods will, we expect, open up many more new questions than it will answer. We hope that it will also inspire further collaboration between the disciplines of Sociology and Computer Science. Our work will, perhaps, help to serve as a connector between the social networks of those two fields.

**Project Website** <http://www.cs.washington.edu/ai/socialnetworks/>

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### **James Kitts, University of Washington**

Disseminating Computational Modeling in the Social Sciences  
0433086

#### **Objective**

The social world that we observe reflects a web of interdependent processes, with macro-level social structures emerging in nonobvious ways from micro-level behavior. Unfortunately, most empirical social science research has focused on estimating and interpreting correlations in cross-sectional data, giving us limited insight into the underlying generative processes. Our failure to consider dynamics and interdependence has been partly due to the relative paucity of longitudinal and multi-level data and partly due to the supposed intractability of theoretical problems involving complex dynamic systems. But the progress being made in the natural and physical sciences using computational models makes it clear that our commitment to static lenses is now more a function of habit than need.

Computational modeling frees social scientists from constraints of analytical tractability and data availability, allowing us to rigorously consider emergent behavior of dynamic systems specified by theory. It also adds another approach to the production and analysis of data, one more in keeping with a laboratory than an observational study. We may use computational experiments to directly investigate social dynamics in “artificial worlds.” The patterns we observe in this setting, by manipulating inputs and analyzing the results, can help elucidate theoretical debates and inform empirical research. The discipline of formal modeling requires us to specify our

theory and identify our assumptions explicitly. Formalization closes the gap between theory and methodology. More than anything else, this is essential to the coherence and advancement of a field.

Even as these innovative tools mature and proliferate, however, the audience for computational modeling remains largely confined to a small community of modelers. Although a handful of interdisciplinary centers advance these tools, only a handful of disciplinary social science programs currently offer training in computational modeling. Most B.A. and Ph.D. students thus graduate without learning to be critical consumers of research using these innovative tools, let alone use the tools in their own research. Unsurprisingly, relative to peers in the physical and natural sciences, most social science journals have poorly-developed standards for evaluating research employing computational models.

We aim to make research in social dynamics both more rigorous and more accessible by offering training resources in computational modeling. First, we are running development workshops at professional meetings to promote curricular reform and to foster disciplinary training standards.

Second, we are assembling a resource manual that will enrich coursework in computational modeling and also provide hands-on explorations of social dynamics for substantive social science courses. Lastly, we are developing a web portal with a repository of source code, exercises, and demonstration software, including an arena for interactive learning. The online repository will also aid in developing methodological standards and improve the integrity of computational modeling research by making source code and other supplementary materials available to the social science research community.

### **Project Progress**

We are currently developing a suite of materials for training social scientists in dynamic modeling, in tandem with model seminars that we have offered at the University of Washington and Cornell University. The web portal mentioned above is currently under development.

In line with our goal to transform disciplinary institutions, we recently conducted a development workshop at the 2005 annual meeting of the American Sociological Association; in 2006 we will offer a session at the conference for Chairs of Departments of Sociology, focusing on fundamental changes to graduate and undergraduate curricula in Sociology. We are also reaching out to scholars in other disciplines – many of which have been quicker to explore and adopt computational modeling – to coordinate dissemination of lessons in disciplinary training across the social sciences.

### **Broader Impacts**

The edited volume on computational modeling, online repository for source code and other materials, and the development workshops at professional meetings will assist faculty in designing courses on computational modeling and in integrating modeling into their existing course offerings. By enhancing teaching and curriculum development, our goal is to improve the integrity of students' applied training in dynamics within traditional social science disciplines. The short-term result should be a faster rate of adoption in disciplinary curricula and

improvement in training quality. This will contribute to a longer-term result of increasing emphasis on and integrity of modeling dynamics in the social sciences.

**Project Website** <http://depts.washington.edu/modeling/>

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**Daniel Levin, Vanderbilt University**  
Intentional Vision in Humans and Robots  
0433653

### **Overall Mission**

As computers become increasingly powerful, they will become progressively more and more integrated into the real world. This phenomenon is especially salient for the kind of humanoid robots that are currently being developed to fill real-world functions ranging from household chores to elder-care. Among the challenges these devices pose, perhaps the most difficult is the need for a two-way understanding between the robots and their human users. Not only do humans need to understand robot capabilities and representational states, but robots require the same understanding of humans. This is particularly true if robots are to have productive and flexible interactions with humans, a process that requires a careful alignment of understanding that is dynamic enough to coordinate a complex flow of changing circumstances, beliefs, desires, and intentions. The research proposed here represents an attempt to understand A) how people will construe the representational states of robots, particularly with respect to vision and B) the cognitive and perceptual basis for and effects of this construal.

An important issue underlying this research is that people have a specific set of expectations about how other people think about, and represent things in the world. These expectations are sometimes referred to as an "Intentional Theory of Mind", and they are applied to a wide range of tasks as people attempt to infer others' beliefs and desires based on the behaviors they produce. Previous research by the PI suggests that this intentional theory is sometimes the most readily available means people have of thinking about representations, so it is sometimes misapplied to representation-making systems (such as computers) for which it is not appropriate, and can even lead to mispredictions about human representations. On the other hand, it may be that people have some understanding of the difference between different kinds of representational systems, and that problems occur only when they fail to apply these understandings. Generally, we have been quite surprised to discover how little is known about people's expectations about the inner workings not only of robots, but of computers more generally, despite the large amount of research exploring human-computer interactions.

### **Progress and preliminary outcomes**

The activities funded by the grant have been organized into several specific projects. In the first, we have been exploring people's beliefs about the representations inherent to different kinds of living and mechanical systems. We have therefore been asking children and adults questions derived from basic research on concepts that are designed to assess the degree to which the mental functions of computers and humans are presumed to differ. For example, in an initial experiment on adults we found that subjects are willing to generalize novel mental properties

from people to computers, but only if they are nonintentional. To begin understanding the basis for these attributions we have been asking children about the mental, physical and biological properties of humans, computers, and robots. At age three, children successfully differentiate these three systems, and by age 4 they seem to apply subtly different notions of thinking and seeing to the systems. Also interesting is the finding that young children seem comfortable attributing both cognitive and mechanical (but not biological) properties to robots, implying that foundational concepts about living and nonliving things are sufficiently flexible to include anthropomorphic objects such as robots.

In a second project we have been exploring the degree to which concepts such as the ones described above affect people's interpretations of actions, their expectations about how different kinds of systems interpret actions, and how people perform actions. In one series of experiments, we have been asking subjects to demonstrate simple procedures (for example tying a shoe, or completing the Towers of Hanoi problem) for either a human or computer audience. We have found that subjects engage in systematically different movements and looking behavior for the two audiences. For example, subjects looked more at a picture illustrating a human audience than at a computer audience as they demonstrate the actions. On the other hand, subjects provided more visual emphasis for the segments of subactions when demonstrating for a computer audience. In addition, we asked subjects to mark action segment start- and end-points as they would be perceived by a computer or a person. Subjects consistently broke actions into smaller and more numerous segments for computers. Most interesting, this effect was strongest in subjects who responded that computers are poor at understanding human goals and intentions (as indicated in a post-experiment survey). Combined, these experiments show that people have specific expectations about how intentional and nonintentional systems perceive action, and our next experiments will begin to explore how the kinds of anthropomorphism inherent to robots affects these expectations. Finally, we are piloting experiments testing the effects of being observed while completing simple actions. These experiments will explore how being watched by a person, by a computer, or by a robot will affect hand movements as subjects touch covers that they have hidden an object under. This experiment will make use of a remote-control robot head adapted for this project. We hope to test the effects of different realistic (and nonrealistic) robotic eye movements on observed actions.

In a third project, we have been exploring how people move when they demonstrate these actions. Initial work has focused on tracking hand and head movements while people demonstrate actions using both video analyses, and magnetic tracking of hand movements through 3-D space. We have successfully developed a color- and texturebased video tracking system that processes action demonstration videos to locate the actor's hands, their head direction, and the objects they are handling. These will be used to correlate detected motions with actions segments provided by human subjects. In addition, we have been analyzing directly-recorded 3-D positions for breakpoints as defined by directional changes, and have applied an "Isomap" analysis to the resulting segments to provide an automatic grouping of actions. We plan to use these analyses as predictors for action breakpoints, and as a means of objectively distinguishing action demonstrations for different audiences, and purposes.

### **Broader Impact**

This research will not only enrich the existing collaborations between the cognitive science and engineering communities at Vanderbilt, but it will also have a broader educational impact. Testing these ideas in the context of a humanoid robot will also provide a compelling context for both graduate and undergraduate students to consider basic questions of representation and mind, and Vanderbilt undergraduates have been playing an important role in this research. In addition, the project will be featured in a video created by the Learning Sciences Institute here at Vanderbilt. This video covers a range of projects in the learning sciences, and based on the filming we have already done for our short segment, we plan to create a longer video on this project, intended for a broader nonacademic audience.

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**Peter Lindert, University of California - Davis**

Global Prices and Incomes, 1200-1950 - First Stage  
0433358

How well or badly did people live around the world in centuries past? When did the North Atlantic countries pull ahead of other countries, or were they always ahead? What were the underlying causes -- agricultural changes, industrial changes, wars, diseases, population pressures, or commercial dominance? How can scholars find out more about these perennial concerns?

Such fundamental questions call for fresh thinking, fresh archival research, and a new technology for diffusing the quantitative historical record of what happened to people's income levels and the prices they paid. The project offers all of these.

In addition to pushing the data frontier back several centuries for several countries, the project is designed to tackle the even tougher task of comparing prices, incomes, and productivity across places and regions for each early date. The team has begun to make headway on the key task of converting all measures into modern metric units with partial adjustments for quality differences. Our early findings confirm some long-believed patterns, and reveal some new ones. Northwestern Europe was a zone of peculiar grain scarcity, relative to non-food goods, suggesting that its advantages in agricultural productivity were exceeded by its advantages in other sectors, particularly capital goods and knowledge goods.

To supplement the earlier abstract, this one features four breakthroughs we have made since our Stage 1 started in January.

(1) Conversion of the world's pre-metric measurements into metric. Past scholars have been frustrated by the inability to compare across regions in centuries past, owing to the eclectic mix of local units of measurement in a very divided world. Our team has already harvested many of the fruits of the field of metrology around the world. We can now compare, for example, the prices of labor or grain or nails or writing paper in southern Korea, Istanbul, Amsterdam, Moscow, Peru and many other places in the eighteenth century.

(2) New findings on real incomes in East Asia. Starting around January, a five-member team from within our group has produced a stirring new paper on real wages in China and Japan since the eighteenth century (“Wages, Prices, and Living Standards in China, Japan, and Europe, 1738-1925” by Robert C. Allen, Jean-Pascal Bassino, Debin Ma, Christine Moll-Murata, and Jan Luiten van Zanden). The results tentatively depart from Kenneth Pomeranz’s (2000) pioneering work on the great divergence between Europe and China. The five-author team will also produce other papers extending this Eurasian comparison to include Korea, Java, and India.

(3) New archival discoveries in Beijing. This spring and summer, team member Debin Ma, helped by a Beijing scholar (Mr. Yuan Weipeng), has discovered large sets of private merchant books covering the period c1800-c1850. These give prices of many things in copper, with copper-silver conversion rates. The merchant books can even be used to figure out the implicit interest rates around Beijing in that period. Other team members are launching similar explorations in the archives in Latin America, Istanbul, Spain, Korea, Vietnam, and the Dutch East Indies company.

(4) Data supplying web site. As promised, a centerpiece of Stage 1 and later stages will be the development of a vast supply of historical data downloadable as Excel files. There will be hundreds of such files, once we have carefully edited them and made the necessary conversions of ancient units to metric. We have just begun. Please visit the web site, remembering that it is still in progress and that most data files are not fully edited yet, and thus not clickable. We will also unveil the site soon on such wide-reaching sites as eh.net.

Our new research group is the Global Price and Income History Group (GPIH Group). Its current members are:

Robert Allen (Oxford, UK),  
Jean-Pascal Bassino (Japan),  
Gregory Clark (California – Davis),  
Metin Cosgel (U. of Connecticut),  
Martin Cuesta (UADE, Argentina),

John Devereux (CUNY - Queens),  
Philip Hoffman (Caltech),  
David Jacks (Simon Fraser),  
Seong Ho Jun (Sung Kyun Kwan University, Korea),  
James B. Lewis (Oxford),

Peter Lindert (California - Davis),  
Debin Ma (GRIPS, Japan),  
Paolo Malanima (Napoli),  
Christina Moll-Murata (Utrecht),  
Boris Mironov (European University St. Petersburg),

Sevket Pamuk (Bosporus University),

Bas van Leeuwen (Utrecht),  
Jan Luiten van Zanden (Utrecht and IISG, Netherlands),  
Marianne Ward (Loyola College, Maryland)

**Project Website** <http://gpih.ucdavis.edu>

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**Michael Macy, Cornell University**

Network Topology and the Dynamics of Collective Action  
0432917

**Overall Mission/Objective.**

What do flocks of birds, traffic jams, fads, forest fires, riots, internet search engines, and residential segregation have in common? The answer is self-organization. There is no leader bird who choreographs the dance-like movement of a flock of geese. There is no supervisor in charge of a riot. There is no librarian in a back room at Google headquarters who is busily classifying all the internet websites in a digital version of the Dewey decimal system. There is no conspiracy of banks and realtors who are assigning people to ethnically homogenous neighborhoods.

Traditionally, sociologists have tried to understand social life as a structured system of institutions and norms that shape individual behavior from the top down. In contrast, a new breed of social modelers suspect that much of social life emerges from the bottom up, more like improvisational jazz than a symphony orchestra. People do not simply play parts written by elites and directed by managers. We make up our parts on the fly. But if everyone is flying by the seat of their pants, how is social order possible?

New and compelling answers to this question are being uncovered by social theorists using an innovative modeling tool developed in computer science and applied with impressive success in disciplines ranging from biology to physics -- agent based computational modeling (ABCM). It is *agent-based* because it takes as a theoretical starting point a model of the autonomous, yet interdependent individual units (the “agents”) that constitute the social system. It is *computational*, because the individual agents and their behavioral rules are formally represented and encoded in a computer program such that the dynamics of the model can be deduced by step-by-step computation from given starting conditions.

Can social scientists learn something from models of self-organized behavior developed for understanding computer networks, bird flocks, or chemical oscillators? We believe they can, for three reasons. First, ABC models show how simple rules of local interaction can generate highly complex population dynamics that would be difficult (if not impossible) to model using traditional methods. Second, these models show how “social facts” can emerge *sui generis* at the population level, even when these properties do not exist at the level of the individuals. Third, these models can be used as virtual laboratories, to reveal the micro mechanisms responsible for highly complex social phenomena.

**Progress and Preliminary Outcomes**

Our research has led to several important discoveries about the diffusion of innovation and beliefs, including the spread of participation in collective action. Diffusion over social and information networks displays a striking regularity that Granovetter (1973) called “the strength of weak ties.” As Granovetter put it, “whatever is to be diffused can reach a larger number of people, and traverse a greater social distance, when passed through weak ties rather than strong.” The strength of weak ties is that they tend to be long – they connect socially distant locations. Recent research on “small worlds” shows that remarkably few long ties are needed to give large and highly clustered populations the “degrees of separation” of a random network, in which information can rapidly diffuse. We test whether this effect of long ties generalizes from simple to complex contagions – those in which the credibility of information or the willingness to adopt an innovation requires independent confirmation from multiple sources. Using Watts and Strogatz’s original small world model, we demonstrate that long ties not only fail to speed up complex contagions, they can even preclude diffusion entirely. Results suggest that the spread of collective actions and risky innovations benefit not from ties that are long but from bridges that are wide enough to transmit strong social reinforcement. Wide bridges are a characteristic feature of spatial networks, which may account in part for the widely observed tendency for social movements to diffuse spatially. Balance theory shows how wide bridges might also form in evolving networks, but this turns out to have surprisingly little effect on the propagation of complex contagions. Of greater importance is a threshold effect with a critical mass of lowthreshold nodes.

### **Broader Impacts**

Using our research program as a template, we are developing a curriculum for an innovative interdisciplinary social science seminar at the graduate level that will train students in agent based computational modeling. The goals of the seminar are three-fold. First, we want students to see how models of dynamical systems can inform theoretical research on collective action. Second, we want them to develop intuitions about how aggregate properties, such as network typology, can interact with individual decision making to affect the dynamics of propagation. And third, we want them to appreciate the importance of modeling propagation within structured networks, not in fully (or randomly) connected populations. Accordingly, the seminar introduces graduate students in political science, economics, and sociology to computational modeling, network analysis (focusing primarily on cascades), and collective action theory (including game theory). Students will also acquire sufficient hands-on training to understand and extend our JAVA libraries.

We have also created a public web site with examples of models. These models have intuitive graphical interfaces and will allow users to observe the effects of changing structural and behavioral parameters on the spread of collective action. This approach to formal modeling is far more accessible to novices than conventional analytical techniques that use systems of equations to describe population dynamics. Moreover, the application to problems of collective action (such as protest movements, panic behavior, and global warming) is far more compelling and engaging than highly abstract game-theoretic representations. We therefore anticipate a broad target audience for the web site, including graduate and undergraduate students of the computational and social sciences.

The third outreach component is a two-day international workshop on Games, Networks and Cascades, to be held at Cornell University in October, 2005. The workshop is bringing together physicists, computer scientists, economists, sociologists and political scientists from Europe and the United States. We are working in a newly emerging field where progress will accelerate rapidly if we can overcome institutional, intellectual, and physical boundaries that obscure mutual awareness of theoretical and methodological advances. We plan to publish the proceedings of the workshop on-line and to include these in the graduate seminar.

**Project Website** <http://hsd.soc.cornell.edu/index.html>

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### **Stephen Mezias, New York University**

The Strength of Social Influence as a Determinant of Organizational Change  
0433280

#### **Overall Mission/Objective:** Gaining Insight into Organizational Change

*At 11:50am the quiet cacophony of buzzing, creaking, ticking gadgets that adorning the cafeteria is drowned out by a group of women discussing their daughters' boyfriends and the best place to buy Splenda in bulk. Yet, woven seamlessly into conversations that might otherwise be characterized as idle, a different kind of conversation is being constructed. It is a conversation about 'what really seems to work in the new reading curriculum'; how to get materials for 'everyday math', 'tips to get Kendrick motivated', 'what would really happen if the school didn't make Adequate Yearly Progress.' In the in-between conversations and personal exchanges held in the social spaces that structure their professional interactions the thirty-member teaching staff of a small school in Staten Island, New York sets the process of organizational change in motion.*

Despite assertions of predominant organizational change models which rest on making boundedly rational assessments of performance against aspirations (Cyert & March, 1963), change in many organizational contexts likely evolve from much more emergent processes. This is particularly true in complex, uncertain and ambiguous environments (e.g. Perrow, 1982) where absent and/or contested external standards, feedback lags, organic technologies and diverse stakeholders complicate the assumptions of more traditional models. Our work investigates a model of organizational change based on social dynamics and emergent decision processes.

#### **Project Development: A Model and Investigation of Sociocognitive Processes**

*The Model.* The model we investigate presumes change stimuli, in the form of salient and ambiguous information enter the social network through one or multiple persons (MacDonald, 1995). Individuals make initial assessments of the stimuli as a function of their individual backgrounds, predispositions and historical social network experiences. Yet, faced with the ambiguous nature of the information and what should be the appropriate response, members turn to others to complete their assessments (e.g. Festinger, 1954) and individual assessments enter

into the local network through formal discussions, natural conversations, stories, gossip around the water cooler, etc. (e.g. Boje, 1991).

These social interactions filter and structure information resulting in individual assessments that are updated and changed by the assessments of other network members even as those assessments are changed and updated by the assessments of the first actor. These recursive assessments generate a collective understanding of the need for change based on two strategic and institutional criteria. Specifically, these considerations include whether the resources of change are known and available (Levinthal and March, 1981; Dutton and Duncan, 1987; Milliken, 1990), whether increased performance in key areas can be expected at a relatively low cost (Cyert and March, 1963; Oliver, 1991); whether stakeholders accept the adapted form as a better way to do business (Oliver, 1991) and whether there is time and social pressure to implement changes (Dutton and Duncan, 1987; Strebel, 1998).

*The Industry Setting.* The current study examines the social and cognitive dynamics of change in six New York City public schools, which differ in their institutional and organizational propensity to change. Specifically, the school sample is stratified into three groups based on their five-year average performance history and their current regulatory constraints. Two schools are from the highest performing third of NYC schools and are exempt from the regulatory initiatives of the federal, state and local governments (e.g. No Child Left behind (NCLB), the Mayoral “Children First” initiative and the NY State Registration Review process). Two schools are from the middle third of performers and operate with the most typical set of regulatory constraints as they are imposed by the federal and city government. The final two schools are from the lowest third of performers and face the most stringent constraints being mandated to change by all three governing agencies.

*Data Collection & Analysis.* The first phase of data collection began with a five month ethnographic pilot in two NYC schools that served as exemplars for differing institutional and organizational propensity to change (two schools randomly selected from the 2003 list of schools currently added to or recently removed from the State Registration Review list). Analysis of data collected during the 60-plus hours of observation 27 half-hour to forty-five minute interviews with staff supported refinement of the theory and generation of context appropriate survey measures for the ongoing study. The current twenty-page instrument (administered three times a year for three years beginning in April 2005) attends to a number of organizational, social and individual decision characteristics revealed to be central to sociocognitive network dynamics, including, 1) work schedules, 2) tenure and training, 3) friendship and advice ties, 4) work roles and routines, 5) professional aspirations, 6) status and perceptions of relative deprivation. As a measure of change, we collect data on participants’ reported use of twenty-five different instructional strategies that are among the improvement strategies most commonly proposed by the local, state and federal departments of education. We also collect classroomlevel data on students’ standardized test score performance and employ a longitudinal multilevel model to assess the relationship between individual decision influences (e.g. tenure, training, aspirations, and perceptions of relative deprivation), social and structural characteristics (e.g. friendship and advice ties, work schedules, roles and routines) and action at the individual and organization level (e.g. choice of instructional strategy and ‘unit’ performance, respectively).

### **Early Findings and Broader Impacts: Issue Selling and Social Spaces**

Lessons revealed from the pilot study reveal the importance not only of professional community interactions but of how change-relevant issues are framed and ‘sold’ (Dutton and Ashford, 1993) to organizational members, given their past experiences. Our research also suggest that organizations underutilize existing social capital by isolating members, poorly structuring formal interactions and missing opportunities to establish new norms through active participation of the organization’s leadership. These are lessons which suggest the importance of effective organizational design – a topic which will be further explored in on-site workshops planned at each school site at the conclusion of the project.

**Project Website** <http://w4.stern.nyu.edu/management/academic>

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### **Francis Quek, Virginia Tech**

Embodiment Awareness, Mathematics Discourse and the Blind  
0451843

Humans are embodied beings. When we speak, our embodied behavior of gesture, gaze, posture, and facial expression are brought into the service of the communicative process. The communication of mathematical concepts seems especially to engage such co-speech behavior. The extent to which one’s interlocutor is aware of such embodied behavior and utilizes it to maintain the interaction and comprehend the material conveyed is still an open question. Our research is grounded in psycholinguistic theories of multimodal human communication. One path from multimodal behavior to language is bridged by the underlying mental imagery. This spatial imagery, for a speaker, relates not to the elements of syntax, but to the units of thought that drive the expression (vocal utterance and visible display). Hence, gestures reveal the focal points of the accompanying utterance, and relates to the meaning of the newsworthy elements of the unfolding discourse. We advance the concept of ‘embodiment awareness’ by which one’s interlocutor accesses the situated communication, maintains the communicative context, and comprehends the material conveyed. We use the loose sense of ‘aware’ not to indicate one’s ability to derive information from the behavior, whether one is fully conscious of the behavioral carrier of the information or not.

We focus these theories on math discourse. Mathematical reasoning is rich in spatial imagery that is revealed in gesture. Furthermore, gesture has the capacity to create images of the math concepts that serve as ‘objects of contemplation’. When a graphic/illustration is available for math instruction the discourse stream is typically situated with gestures of spatial reference into the graphic. Research with individuals who are blind suggest that they have remarkable capacity for visual imagery, memory, and conceptualization. However, students who are blind tend to lag sighted students in mathematics education. We posit that a significant impediment to math instruction for students who are blind lies in the lack of visual access to the embodiment of the instructor. We have in such students, a population that is able to access the graphical content (through tactile image technology) but are not visually aware of the embodied behavior of their interlocutor. Hence, we propose a research approach to understanding the role of embodiment

awareness in maintaining situated math discourse and understanding by enabling blind students a sense of embodiment awareness.

We propose a set of augmentation approaches that employs tactile devices to provide elements of embodiment awareness. We will perform a series of ‘perception and action’ experiments to assess the efficacy of these devices. Once the capacity of these devices to convey spatial information is known, we shall engage in a series of experiments with blind and sighted students in mathematics instruction. The students who are blind will undergo two six-week of similar math curricula with and without the augmentation. The sighted students will receive instruction on the same curricula. We will capture these instruction/learning sessions on stereo calibrated video, and analyze these data to support coding and analyses. We shall code the video data for embodied behavior for each teacher and student, and perform a pre- and post- test for each six week session for each student. Our analyses will assess the quality and quantity of imagistic content both conveyed by the teacher and by the student in the course of the instruction. We will correlate these with the pre- and post-test scores to determine the relation between embodied communication and uptake with the formation of math conceptualization.

We have assembled a multi-disciplinary team to address our clearly cross-disciplinary research. The fields represented are computer science (computer vision, multimodal interaction and human computer interaction), psychology (perception and action research, and psycholinguistics), education (special education and mathematics instruction), and disabilities research/services. Each participating field contributes to the overarching research, and advances its research. In fact, the preparation of this proposal has already given the participants a broader understanding across the fields, and raised questions to be addressed within each field.

The broader impact of our project accrues in three areas. First, the strong inter-disciplinary nature of our project provides good opportunities to train students in such cross-disciplinary research. Students in Computer Science, Psychology and Special Education will be made aware of each others’ research and learn to conduct research that cross the traditional disciplinary lines. Second, understanding of the channels for embodiment awareness is of great significance to the design distance learning systems for mathematics and science. The augmented embodiment awareness strategies we will investigate will provide insights on how to provide embodiment cues to students in internet-based instruction in mathematics and science. Third, our research has direct impact on inclusive mathematics instruction for the visually disabled. The research directly impacts the National priorities embodied in the “No Child Left Behind” and “Individuals with Disabilities Education Act – IDEA” legislation. The provision of a sense of embodiment awareness to students who are blind has not hitherto been studied, and has the potential for enabling such students in science and mathematics. Furthermore, it permits access to inclusive instruction in K-12 instruction through college.

**Project Website** <http://vislab.cs.vt.edu>

### On Long-Term Consequences of Selfish Behavior: A Game Theoretic Approach to Host-Pathogen Co-Evolution

0433253

#### **Overall Mission/Objective**

Optimal management strategies constitute underlying themes of conservation ecology and economics, and exploring the junction between these two disciplines is both important and of broad interest. Humans, as well as other social species, face trade-offs between self and group “interest”, with efficient cooperation often critical for long term survival. An interesting case of this problem is that of human-disease interactions, since not only must we, as humans, manage our natural enemies, but these enemies must also manage us.

Such coevolutionary dynamics can be described by a multi-layered game, with strategic interactions between the individual hosts, as well as between the hosts and their pathogens. Despite the advantages the hosts derive from contact with one another, there are also costs in the form of exposure to infectious diseases, and so, the (Nash) noncooperative equilibrium level of contact between selfish host individuals will necessarily be greater than the level that would maximize the group fitness/welfare. What is more, these higher levels of contact are hypothesized to influence the evolution of the pathogen, bringing us to the other dimension of this game: optimal virulence. Fitness-maximizing levels of virulence depend on the levels of contact between the hosts, which in turn, are partly determined by the virulence of the pathogen.

Such dynamics may result in significantly higher levels of infection, and higher rates of mortality for infected individuals, than would be selected for if the hosts were to cooperate. The method by which modern rational humans may enforce cooperation is through public health policies that facilitate avoiding infection, and the ultimate objective of our analysis is to suggest improved policies that account for the long-run consequences of these health authorities’ actions.

We have thus proposed to develop models of host-pathogen coevolution that combine variants of the classical S-I dynamic model with the structure of game theory. This may allow us to predict the welfare effects of various public policies.

Our research agenda has two main stages. The first stage lays the theoretical groundwork for the coevolution of host social behavior and pathogen virulence. This stage has been completed and the results are currently in press in the science journal *Evolution*. Our second stage will build from some of the theoretical work in the first stage, but will focus specifically on a human-malaria game.

#### **Progress and (Preliminary Outcomes)**

Higher disease prevalence can induce greater sociality; a game theoretic coevolutionary model (Bonds, M.H., D.C. Keenan, A.J. Leidner, and P. Rohani, 2005) *Evolution*, in press.

There is growing evidence that communicable diseases constitute a strong selective force on the evolution of social systems. Indeed, it has been suggested that infectious diseases may determine upper limits of host sociality by, for example, inducing territoriality or early juvenile dispersal.

Here, we used game theory to model the evolution of host sociality in the context of communicable diseases. Our model was then augmented with the evolution of virulence to determine coevolutionarily stable strategies of host sociality and pathogen virulence.

We show that, as generally hypothesized, exogenously increasing disease prevalence from initial low values results in a decrease in the evolutionarily stable rate of contact. However, for a large range of the parameter space, the optimal contact rate increases as prevalence rises past a threshold level. In other words, though the disease never causes sociality to rise above the disease-free optimum, higher disease prevalence can actually induce greater sociality. This result is similar to that of van Baalen (1997) who finds that the optimal investment in immunity rises and then falls as infection probabilities rise. The reason for both of these results is that the costs of the host's response to the disease, in terms of higher mortality, eventually overwhelm the benefits of those responses when infection is sufficiently difficult to evade. In our model, this means that the host would then evolve greater sociality at high levels of disease prevalence. An exception to this relationship is when the pathogen is sufficiently virulent to eliminate the value of contact after infection (Figure 1). In this case, the optimal contact will fall monotonically as prevalence rises.

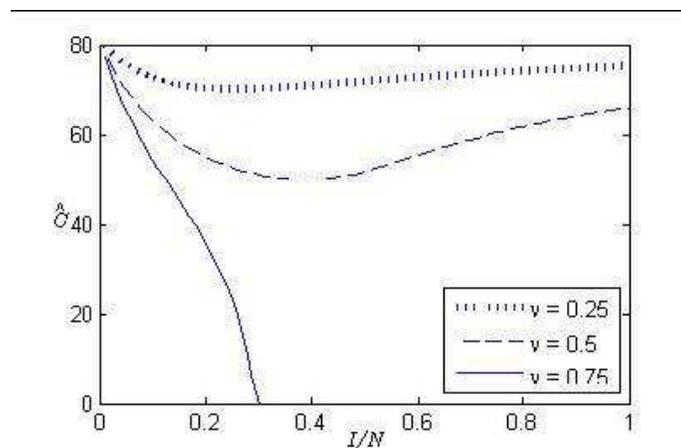


Figure 1 The optimal contact rate is presented over a range of exogenously determined rates of disease prevalence, with different values of pathogen virulence. At relatively low levels of virulence, the ES contact rate responds nonmonotonically to disease prevalence. At high levels of virulence, the ES contact rate responds negatively to disease prevalence

Finally we considered pathogen coevolution. We show that lower contact increases pathogen virulence, counter to Ewald's (1994) hypothesis. This is because, as contact rates fall from the disease-free optimum, so does host survival, lowering the benefits for the pathogen of preserving the host, and increasing the advantages of being transmissible. As we alter various parameter values, we continue to find a U-shaped relationship between the CoES level of host sociality and the equilibrium disease prevalence (Figure 2). We also find a U-shaped relationship between the CoES level of host sociality and pathogen virulence.

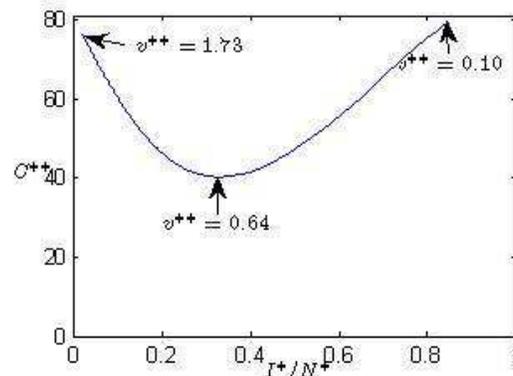


Figure 2 The coevolutionary relationship between contact and disease prevalence is U-shaped across background mortality rates.

### *Evolution of a disease-driven poverty trap*

One billion people in the world currently live on less than \$1 per day, which is considered “extreme poverty” and has special economic consequence. \$1 per day places people on the edge of the ability to sustain their lives. And living on such an edge precludes saving for the future. In the absence of saving, resources (specifically “capital”, in economic jargon) cannot accumulate, greatly confounding the prospects of raising standards of living. As a result, one sixth of all humans are roughly as poor today as their ancestors were thousands of years ago. How is that possible? A plausible explanation is that the world’s poorest individuals are stuck in a disease-driven “poverty trap” (Sachs, 2005). The basics of this idea are simple. Both the economy and public health serve as essential positive determinants of each other: economic activity requires healthy labor, and disease prevention and treatment require economic resources. So when an infectious disease spreads throughout a population, the effective labor force shrinks, which further debilitates the ability of the population to afford measures to fight off diseases. What makes things even more complex is that both income and health are determined not just by the behavior of the individuals, but also by their geographic and social context (remember, it is infectious diseases – those that are transmitted by neighbors – that are the chief villains). Thus, sustaining income growth for one individual requires sustained health of his/her community. The most glaring modern example of this is AIDS in Africa where rural communities are commonly known to have lost the entire core of their local economies – working-age people. But historically, the biggest culprit of the poverty trap may well be Malaria. (Sachs, 2002).

To date, the disease-driven poverty-trap has been treated mostly as an economic question (Sachs, 2002). But diseases are not static forces that can be thrown linearly into economic growth models. The transmission of malaria, for example, is determined by the population dynamics of an animal – the Anopheles mosquito – which is itself involved in an evolutionary relationship with the disease that it carries. What makes this topic especially interesting is that human behavior has predictable consequences for the evolution of both the mosquito and the pathogen. Furthermore, the relationship between this behavior and economic growth is predictable. Due to basic interventions such as glass windows and bednets (to name a few), wealthy people tend to be less exposed to the transmission of vector-borne diseases. This lower exposure is analogous to a decrease in host “contact” and we can therefore rely on the theoretical framework developed in

the first stage of our project. Further development of this economic-growth malaria “game” constitutes our research for the remaining duration of the grant.

**Broader Impacts; teaching, training, and learning** Our research budget has been almost entirely allocated towards the development and training of our graduate research assistant, Matthew Bonds, and to a lesser degree, an undergraduate research assistant, Andrew Leidner. Under our close supervision, Matt has been delegated the primary responsibilities of developing the project. Matt has presented our project at the 2005 Ecological Society of America conference in Montreal, Quebec, as well as at the 2005 Southeastern Ecology and Evolution Conference, in Athens, Georgia, where he received an award for the best oral presentation. He also assists in managing our undergraduate assistant Andrew Leidner, who works with us for 15 hours per week. Since joining our group, Andrew has learned to program simulations of disease evolution in C++ and is a coauthor of our article in *Evolution*.

Finally, we are currently arranging for Matt to visit Andrew Read at the University of Edinburgh in Scotland where he can learn directly from Read’s malaria experiments. While in the United Kingdom, Matt also plans to visit other prominent scientists who work on pathogen evolution. These scientists include Steve Sait of the University of Leeds, Mike Boots of the University of Sheffield, and Julia Gog of the University of Cambridge.

### Decision Making, Risk, and Uncertainty Emphasis Area

**Susan Cutter, University of South Carolina and John Wilson, University of Southern California**

Place-Based Decision Support for Spatial and Temporal Transference of Risk and Hazards  
0433158

Vulnerability science is an emergent multidisciplinary field focused on what makes people and places vulnerable to environmental threats from natural, technological, or human-induced hazards. Our current knowledge base is fragmented and insufficient to advance understanding of many key social, environmental, and methodological issues in vulnerability science. This project examines one of the least understood aspects of hazard vulnerability—the role of inequality. Specifically, the research proposes to develop new methods and spatial models for measuring the differential susceptibility and impacts of risks and hazards on people and places and how this in turn affects the resilience of these places to extreme events and chronic risks.

#### **Overall Objective**

The project examines three basic research questions: (1) What is the role of current practice and public policy in facilitating the relocation of risk either spatially or temporally? This question examines the argument that risk may be increased or simply moved from one place to another by various types of interventions or other societal trends. (2) How does spatial bias amplify or attenuate risks and hazards and at what scale are these most evident? This question recognizes the special characteristic of particular places and the larger number of inter-related factors that influence risk. (3) Can we anticipate inequities in the distribution of vulnerabilities and how can

this be lessened through improved decision-making with respect to hazards mitigation and response?

Two place-based case studies will serve as test-beds for linking the theory, concepts, methods and models in a decision support system—the greater Los Angeles area and the Charleston, South Carolina metropolitan region (Figure 1). These test-beds were chosen based on the mix of common and unique hazards in each, a range in scale-dependent complexities based on physiography, size, wealth, demographics, the nature of the built environment and the prior experience and local place-based knowledge of team members. The research team is working on developing place-based integrated hazards assessment models, starting initially with two “design events” (seismic in Southern California; hurricane in South Carolina).

When completed, this project will advance hazards and disasters research and decision-making through improved data, methods, models and analytical techniques. It provides a protocol for gathering information to guide and advance knowledge of the changing distribution and nature of hazards vulnerability, in addition to a scalable metric that could be employed in decisions regarding preparedness, planning, and response.

### **Progress and Broader Impacts**

The challenge for multi-disciplinary, multi-institutional projects is one of communication and continuity. To facilitate the research the Lead Investigators have met with both research teams in face-to-face meetings during the year. A project intranet (wiki) has been set up for both research groups as a means for record keeping, protocol sharing, and updating on the progress of the research. The demographic change protocol is nearing completion with the creation of a social vulnerability index for Charleston at the census tract level (downscaled from the county level) for the decadal periods 1960-2000. A similar index is under construction for the Los Angeles region. A companion built environment index for Charleston is nearing completion as well for the same 1960-2000 period. Work continues on the development of the hurricane and seismic design events. Historical building code policies are being developed for the Los Angeles region for this time range, which will be used to modify the existing building inventory for specific code adoption periods. Building code policies refer to the code adoption, which determines the design level, and construction quality. Sensitivity analyses will initially be conducted using HAZUS to examine the role of various hazard and structural parameters in vulnerability and loss estimations.

A presentation on the project was made to the National Science Foundation at the Human and Social Dynamics FY 2005 Roll-Out Meeting on December 9, 2004. A poster presentation at the Natural Hazards annual workshop in Boulder, CO (July 2005) highlighted the project as well. The Natural Hazards Workshop provides a venue for academic researchers to interact with the emergency management practitioner community in the application of new knowledge and understanding in the social, natural, and engineering sciences to support the emergency management and disasters practitioners.

Three graduate students and one undergraduate student were supported on the project (South Carolina) for the first project year from four different academic departments--Geography,

Statistics, Marine Sciences, and Civil Engineering. One graduate student, one education outreach program manager (SCEC), and one research faculty (Co-PI) from the departments of Geography, Earth Sciences and Civil Engineering, respectively (California), were also supported for the first year of the project.

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**Baruch Fischhoff, Carnegie Mellon University**  
Integrating Risk Analysis and Risk Communication  
0433152

### **Overall Mission/Objective**

The project aims to develop and apply the emerging methodology of *integrated assessment* to using the social, behavioral, and economic sciences in addressing complex social problems. The approach recognizes that formal models provide a unique form of insight into complex, unfamiliar settings. In order to be trustworthy guides, such models must be “behaviorally realistic.” They must reflect current science about the focal behaviors and capture the substance and extent of expert judgment. If they achieve such realism, these models can then serve as templates for targeted risk communication instruments. The approach aims to extract the most relevant science and assemble it into the disciplined structure of an integrated assessment (an interdisciplinary assessment that simultaneously considers different domains of a problem and their feedbacks and interactions). Throughout the assessment development process, communication with the target audience ensures that the analysis is relevant to their concerns, its assumptions transparent to their view, and its results understood, in terms of their implications and robustness.

The need for behaviorally realistic analysis arises in many domains. This project is pursuing such analysis in the context of three relatively unrelated risk domains: (a) radiological emergencies, (b) adolescents’ safety and violence, and (c) animal vectors spreading disease to humans. These domains include risks of more commonly experienced forms (e.g., waste disposal, bullying) as well as events associated with terrorism. This research considers one case study within each of these three domains, each corresponding to terror-related threats. In addition to their timeliness and public interest, these domains have features that stretch the methodology: They can evoke powerful emotions. They require contributions from multiple disciplines. They often raise difficult value tradeoffs. Their complexity and unfamiliarity defy simplistic communication strategies. The focus on specific problems allows selecting results that really matter, from the wealth of research that any field could potentially contribute.

Working out the interfaces between domains can be challenging, in ways that advance the participating disciplines. As an exercise in *applied basic* research, integrated assessment tests existing theories, by seeing how well they perform in new contexts, as requiring the development of auxiliary assumptions, interpreting theories in context, so that they can be tested at all. As an exercise in *basic applied* research, the process can identify new theoretical problems, different than those that might have developed endogenously, through normal scientific evolution.

### **Progress and Preliminary Outcomes**

(1) Radiological emergencies. The 25th anniversary of the Three Mile Island accident recently brought occasion to reflect on the severe social and economic impacts that radiological emergencies can have, even when radiological health damage is not detectable. As the U.S. fleet of commercial nuclear power plants continues to age, and as the era of terrorism opens new possibilities for large releases of radiation, it is prudent to examine the radiological emergency from a broad behavioral perspective. Similar questions arise whether it's another nuclear power plant accident or a terror-inspired attack with a radiological dispersion device. In the immediate aftermath of the event, how well will officials understand their situation and communicate it to first respondents, healthcare officials, the news media, and residents? How will citizens respond, in order to protect themselves, their families, their homes and businesses? What contamination levels will they accept in choosing to return to homes or workplaces following an evacuation? What factors influence the ability of citizens to trust official information on the extent of radiological contamination? Managing this risk includes modeling the physical processes associated with dispersal of radioactive materials, as well as the cognitive processes of both officials and citizens. To explore this risk management problem in detail, we are conducting an integrated assessment of a radiological terror event in an urban area. This case study requires a strong engineering basis for including both elements of short-term reaction (including communication and behavior), and long-term clean-up decisions.

In addition to representing relevant factors of a radiological dispersion device, such as the type and amount of radioactive material, the weather conditions contributing to spread of radioactivity, and relevant human behaviors, this event is also compared to other possible radiological attacks such as potential explosions around or near waste materials. Comparisons include current and potential barriers to terrorist actions, short-term and long-term impact on population health, and psychological impact of terror events.

(2) Adolescents' Safety and Violence. All people face threats to their personal safety. These threats often exact a price even when they do not occur, by imposing stress and costs for protective measures (including restricted action). Sexual assaults are one such class of threats. Adolescent violence is another, restricting teens' activities, limiting their ability to concentrate on school and work, constraining social relations, and troubling parents. Although adolescents are often perceived as viewing themselves as invulnerable to risk, emerging evidence shows them to be similar to adults or even possessed of special vulnerability to premature death. School shootings are low-probability, high consequence events, seemingly on the mind of many teens and adults concerned with their welfare. We are continuing to refine an integrated assessment of these threats, as they vary by school and are affected by preventive measures such as metal detectors on school grounds and psychological profiling of students, as well as parent reactions to the threats including changes of school venue or transportation. That assessment, and the subsequent communications, deals with complex social and emotional processes, as well as high levels of uncertainty.

We are currently subjecting our integrated assessment to ongoing scrutiny from various experts to further refine the defined variables and their relationships to one another. Next we will embark on a thorough analysis of the existing literature on school violence, including psychological and physical, representing all known correlational and causal relationships in terms of our integrated

assessment. This step will further inform the assessment and will provide a rubric for integrating diverse findings on school violence into an integrated tool that will allow the review to present more than the sum of the individual studies.

(3) Zoonotic risks. Many diseases spread from animals to humans, including relatively new ones such as SARS, West Nile, and Avian flu. They represent possibly severe threats to health and security, if they begin to spread more easily in the human population. For this project, we will take, as a prototype, intentionally released bubonic plague spread through fleas on rodents and domestic animals. This scenario is not beyond imagination. During World War II, the Japanese army air-dropped clay containers of plague-infected fleas and grain to attract local rodents over China, thereby condemning thousands of civilians to a gruesome death. Bioterrorism incidents can create severe psychopathology, making the task of communicating clear instructions to the public, who are frightened for the safety of their children and terrified of their pets, a delicate one. Effective communication could provide a form of psycho-prophylaxis. Our integrated assessment combines biological and behavioral science in a general form, adaptable to a variety of mammal-flea complexes, to identify critical choices and informational needs from both the institutional and individual perspectives.

The integrated assessment models a hypothetical release of plague at a crowded stadium, following likely sequelae at multiple levels. It distinguishes between different forms of plague, including bubonic (transmissible from flea bites), pneumonic (transmissible through coughing) and sylvatic (transmission between wild animals). It incorporates what is known about the biological mechanisms of the disease with anticipated and varied public and government reactions.

**Broader Impacts** This research is expected to have broad impacts. Combining these diverse, interdisciplinary approaches, across these three critically important risk domains, the research team will produce an enhanced version of integrated assessment, documented in such a way as to promote other researchers using it and applying it to other domains. Our research team's collaborative approach will allow us to address new, emerging risks in an innovative fashion, and formulate a detailed plan for addressing such risks in these and other domains as they arise.

**Project-Related Website** <http://sds.hss.cmu.edu/risk/>

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### **Eric Hamilton, US Air Force Academy**

Measuring and Increasing Complex Reasoning Performance in National Security Domains  
0433373

### **Introduction**

The nation's security requires the continuous expansion of the problem-solving capabilities of its military and civilian defenders. The failure to prevent September 11 has often been called a failure of the imagination. How we respond to rapidly evolving threats to our security will increasingly require greater creativity and capacity to anticipate and analyze complex and interconnected situations and to craft robust solutions that exhibit strategic sense and wisdom.

This research is part of the quest to elevate human performance in the specific area of complex problem solving.

### **National and USAFA Undergraduate Trends in Intellectual Development**

King and Kitchener (1994) present findings suggesting that over the course of a college education, undergraduates, on average, start at a relatively low position (around stage 3) and do not progress significantly from there. This finding is consistent with the *Greater Expectations* report of the American Association of Colleges and University (AACU 2002), which prominently emphasized concerns that undergraduate education does not provide sufficient opportunities for college students to develop sophisticated and advanced critical thinking for the global information and technology age. These national concerns are of intense local interest at the US Air Force Academy (USAFA). On instruments such as the King and Kitchener's Reflective Judgment interviews, increases in stages of intellectual maturation between first and fourth year cadets were negligible. Administration of the *California Critical Thinking Dispositions Inventory* produced similar results. While USAFA's academic program is considered exemplary, it has not solved a problem challenging the broader postsecondary community, to significantly advance the intellectual maturity of undergraduates.

### **Goal and Objectives of This Exploratory and Education HSD Project**

The main goal of this project is to produce more strategically capable problem solvers who can ably tackle complex scenarios in two contexts that loom large in national security and homeland defense: geospatial awareness and decision-making, and response to terrorist threats. A secondary goal involves advancing research in the cost-effective measurement of a key proxy of complex-problem-solving ability (intellectual development). Our instrumental, empirical, and theoretical objectives are to:

- Use an established class of mathematics-rich problems, called model-eliciting activities (MEAs), to create a bank of scenarios appropriate for officer training
- Test and refine an experimental tool (Cogito®) for measurement of reasoning level
  
- Empirically explore the link between sustained effort in complex reasoning and intellectual development
- Ongoing refinement of the theory of intellectual ability by factors that affect problem solving cognition, including social dynamics of team problem solving, affect, creativity and wisdom

### **Social Dynamics in Problem-Solving**

The collaborative social dynamics of team problem-solving extends well beyond the aggregation of skills from competent problem-solvers. Our conjecture is that engagement in team problem solving will deepen the reasoning skills of individual problem-solvers. In that regard, we pursue an interesting line of inquiry. The Perry and RJ scales produce scores for individuals rather than groups. Ironically, part of William Perry's original interests in formulating an intellectual development scale focused on an individual's capacity to integrate perspectives of others or external frames of reference. The analysis emerging from this study may help set the stage for analog measurements of a group's capacity to tackle a complex problem.

## Scenario Domains

The table below describes some of the scenario areas that are appropriate for this project, in the two areas of geospatial awareness and terrorist network modeling. Because GeoBase is an operational concept across the Air Force, is adaptable outside of the Air Force, and integrates so many disciplines, it is a useful, real-world context for building scenarios. Command of geospatial dynamics in a crisis or battle situation that is either anticipated or has arisen is an absolutely essential component of what the military refers to as the situational awareness. Command of those dynamics involves interpreting and integrating a complex array of variables from domains such as geology and geography, engineering, biology, chemistry and mathematics.



**Figure 1: Sample “Smart Map” from Okinawa Base** *Depicts and immediately updates geospatial decisionmaking variables. This particular simulation shows plume and cordon boundaries of a toxic gas leak.*

**Violent Non-State Actor (VNSA) modeling** VNSA modeling involves the interdisciplinary application of tools and approaches from engineering design, systems theory, social behavior, and neuroscience to help understand how the complex social system that supports terrorist group formation evolves over time. These tools have been used to produce a systems level simulation tool that models of terrorist growth and recruitment. Initial development of VNSA modeling has been led by two of this project’s Co-PIs (Casebeer and Bartolomei) and is promising. The model has been used to successfully retrodict (i.e. produce valid predictions concerning past events) the Sendero Luminoso terrorist activity in Peru. The underlying theory about the nature of terrorist organizations involves treating them as biological entities which change over time: such groups have a genesis point, grow, mature, and eventually transform. These processes occur at the intersections of environmental variables and facts about individual and group psychologies. VNSA is gathering fast-moving recognition as a significant tool in modeling the social network dynamics of the primary threats in the current national security and socio-political landscape.

<p>Natural Disasters requiring humanitarian assistance, domestically or abroad</p> <ul style="list-style-type: none"> <li>• Hurricane, Typhoon, Drought, Tornado, Earthquake, Volcano</li> <li>• Off Base/On Base Fire (example: oil fields in Iraq and Kuwait)</li> </ul> <p>Attack on Air Base</p> <ul style="list-style-type: none"> <li>• Assets (e.g., Personnel, Aircraft, Airfield, Fuel Storage, Munitions, Storage, Water,</li> </ul>	<p>Terrorist Attack</p> <ul style="list-style-type: none"> <li>• Water Supply Poisoning</li> <li>• Synchronized Bombings</li> <li>• Chemical Attack</li> <li>• Anthrax or other biological agent attacks</li> <li>• Attack on upstream dam or reservoir (or general failure) “Dirty Bomb” Nuclear Attack</li> </ul> <p>Military or Civilian Aircraft Crash</p>
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Communications)	
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Examples of Contexts for Structuring GeoBase and/or VNSA related Problem Scenarios For This Project

## **What Performance Dynamics Are Expected To Emerge and Improve?**

Lesh's Model Eliciting Activity (MEA) framework outlines some of the competencies that have been found to characterize successful problem-solving teams and that we expect will emerge and expand using the GeoBase and VNSA MEAs. Lesh and Lehrer (2003) have found that rather than simplify an overall task by the construction of a powerful representational tool highlighting aspects of a problem, the task pathways become deeper and more sophisticated because the problem solvers are able to dispense with its computational or surface structures. This is exactly the kind of modeling practice we hope to stimulate among cadets: **the capacity of a team to readily plumb the deep structure of a new and complex problem by rapidly crafting conceptual tools that dispense with its closer-to-the-surface layers.**

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## **Anthony Leiserowitz, Decision Science Resource Institute**

The Socio-Cultural Dynamics of Risk Perception  
0433385

### **Overall Mission/Objective**

Risks and risk management occur within a rich and complex socio-cultural context, in which groups of individuals are predisposed to select, ignore and interpret risk information in different ways. This exploratory project is part of a broad program to understand the socio-cultural dynamics of risk perception, decision-making and behavior. Specifically, this research will attempt to identify, describe and explain the existence of discrete "interpretive communities of risk." clusters of individuals who share mutually compatible risk perceptions, connotative meanings, worldviews, and sociodemographic characteristics. Results from this study will contribute to emerging theory on the roles of affect and emotion, symbolic meaning, worldviews and socio-cultural context in risk perception and decision-making.

Early research on public risk perception found important discrepancies between expert and public risk assessments, with the public often highly concerned about some low-probability hazards (e.g., nuclear accidents), yet relatively unconcerned about other high-probability hazards (e.g., natural disasters). Subsequent research found that this discrepancy between expert and public risk priorities could not simply be blamed on public ignorance (e.g., the "information deficit model"). Numerous studies have subsequently demonstrated that knowledge about risks, while important, is not sufficient to explain risk perceptions and behavior. Further, scientists, decision makers and risk communicators are increasingly aware that providing more detailed and accurate scientific information, while important, is not sufficient to generate appropriate public concern for some risks or to allay public fears about others.

Subsequent research within the "psychometric paradigm" identified the subjective profile of various risks, finding that certain risks (e.g., nuclear accidents) scored very high on two underlying dimensions – dread risk and unknown risk – while other risks (e.g., smoking) scored very low. This research helped to explain why the general public often perceives risks like nuclear accidents as extremely serious (despite the fact that nuclear accidents are very rare and

have killed relatively few), while everyday hazards like smoking are perceived as relatively low risks, despite the fact that thousands die each year from smoking-related diseases. The psychometric approach, however, did not examine or explain why some sub-groups of the public perceive particular risks as extremely serious while others do not.

Thus, we still know relatively little about how the characteristics of the risk perceivers themselves influence public risk perceptions. To address this, recent research has focused on the broader sociocultural and cultural context of risk perception, examining how sociodemographic factors like sex, race, income and education, and cultural factors like trust, social values and worldviews influence risk perception. Thus, researchers are increasingly asking not just “What does the public perceive as a risk and why?” but “Who perceives risk and why?”

This project is guided by the following research questions: Can we identify distinct interpretive communities of risk among the American public? If so, what are their distinguishing characteristics? Are these interpretive communities dynamic and in constant flux, or are they relatively stable, transcending particular risks? In other words, do interpretive communities that are substantially different in character form around different kinds of risks (e.g., health vs. security risks), or are there groups who consistently perceive and interpret a wide variety of risks in similar ways? Finally, why do some interpretive communities perceive particular hazards as extreme risks, while others perceive these same hazards as very low or non-existent risks?

### **Progress and (Preliminary) Outcomes**

To explore these questions, we designed and implemented a nationally representative survey of the American public (n = 815) in June, 2005. This survey measured public risk perceptions regarding nuclear power, global warming, legal abortion, genetically modified food, terrorism, homosexuality, the Iraq War, gun control, marijuana, and pesticides. Respondents were asked whether they think these items are good or bad (affect), how great of a risk each is for the United States, and how much they worry about each of them. Respondents also provided the “first thought or image” that comes to mind when they think of each issue. Respondents were also asked a series of questions designed to measure value orientations toward egalitarianism, individualism, hierarchism, fatalism, and cultural relativism. Finally, respondents were asked a series of sociodemographic questions, including measures of media behavior. Analysis is currently on-going, but preliminary results indicate that distinct interpretive communities of risk can be identified, in which members share similar risk perceptions, connotative meanings, worldview and sociodemographic characteristics.

### **Broader Impacts**

This project should demonstrate the utility of affective image analysis for the study of diverse risk perception issues. This project will also promote graduate student training in risk perception theory, survey methodology and analysis. Finally, it will also provide invaluable information on the socio-political dynamics of public risk perception for risk managers and communicators. One of the first principles of communication is to “know your audience.” The communication of risk information will be greatly facilitated by a detailed understanding of what particular audiences (interpretive communities) are predisposed to believe or disbelieve, trust or distrust, support or not support. Identification of the salient connotative meanings held by the public for particular

risks should be invaluable for risk communicators who wish to design and test messages intended to evoke, correct or challenge these critical elements of risk perception. This research will also explore the role of social values and political ideology in risk perception. Risk management and communication efforts that ignore these socio-cultural dynamics will often fail or generate active opposition and even hostility. This research will contribute to our understanding of these dynamics.

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**Holly Taylor, Tufts University and Carl Renshaw, Dartmouth College**

Development and Evaluation of a Natural Hazard Interactive Laboratory for Improving Decision Making  
0433419

Given a wealth of data, varying background information and expertise, and social and emotional factors, how can people make the best decisions about natural hazards and related policy? This work examines the impact of a fully developed, interactive, computer-based, role-playing laboratory on decision making based on scientific data. The overall goal of the project is to examine educational design principles that promote higher-order cognitive and critical thinking skills.

*Eruption* is a role-playing simulation of a volcanic hazard. In *Eruption*, students take on different roles related to a volcanic eruption. Some act as scientists and gather scientific data from volcano monitoring instruments, using the information to predict eruption likelihood. Some act as policy makers deciding when and how much of neighboring villages to evacuate, taking into account monetary and social factors related to evacuation.

Our previous work showed the "proof of concept" of *Eruption* and its impact on decision making (Taylor, Renshaw, & Jensen, 1997). This work used an innovative evaluation strategy that incorporated cognitive science methodologies. The evaluation methodology examines stability in decision making based on available scientific data. In other words, it examines the extent to which such decisions remain stable in the face of other distracting, but irrelevant information. For example, work in Cognitive Science has shown that people make different decisions about the same data depending on whether the information is framed positively (e.g., survival rates) or negatively (e.g., death rates). Our previous work also allowed us to identify specific design principles that impact higher-order, critical thinking skills and increase the effectiveness of CAI laboratories (Renshaw & Taylor, 2000; Renshaw, Taylor, & Reynolds, 1998; Sinclair, Renshaw, & Taylor, 2004; Taylor, Renshaw, & Choi, 2004; Taylor, Renshaw, & Jensen, 1997). Incorporation of these principles into the fully implemented *Eruption* will increase its impact on higher-order cognitive skills such as decision making, problem solving, and critical analysis.

Work on this project began in June 2005. The first step, which is underway, is to program *Eruption* using the *Director/Shockwave* development environment. *Shockwave* and *Director* include standardized technologies for developing interactive content using web-based networking and 3D imaging. Including networking options significantly increases the complexity of both the use and support of CAI software. While we hypothesize that the increased

perspectives gained by including networking will increase the program's effectiveness, it remains an empirical question. Even if correct, the educational improvements must outweigh the increased difficulty inherent in adding networking. It may be that the increase in effectiveness is only slight and more than offset by the additional time and support needed to use a networked program. Consequently, evaluation of the effectiveness of the networked version of *Eruption* in developing higher-order skills relative to the effectiveness of non-networked versions of the program is essential. The next stage of the work, after development, will be evaluation with a feedback loop to re-design.

The completed implementation and coincident assessment will further inform the relationship between educational exercises and higher-order critical thinking skills. This work will also allow further refinement of our cognitive science based assessment methodology. By creating an objective measure of educational impact, we can identify specific design principles that increase the potential for reaching student populations with weaker math and science backgrounds and/or those traditionally under-represented in the sciences. Further, in fully developing *Eruption*, we plan to make the software more modular and separating the instruction components (types of volcanoes, description and theory of monitoring equipment, etc.) from the application component (the *Eruption* simulation). In our experience, separating the instructional components from the application components significantly increases the potential dissemination of the CAI laboratory.

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**Craig Trumbo, University of Vermont**

Hazard Proximity and the Perception of Cancer Risk: A Multi-Level Spatial Analysis  
0433410

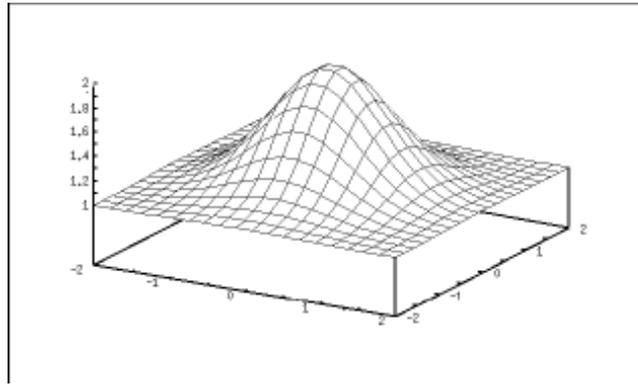
**Overall Mission/Objective**

This exploratory project examines the cancer risks people associate with environmental hazards through the application of geographic information systems (GIS). The goal is to advance fundamental understanding of the spatial dimensions of risk perception.

The relationship between hazard proximity and risk perception is under-examined but not ignored. For some time researchers have looked at the social and psychological problems associated with living near environmental pollution. For example, it has been shown that fear of cancer is more prevalent in communities located near toxic exposure sites. Recent work has brought the tools of spatial analysis to the task of understanding hazard proximity, which has been found to be a strong and independent determinant of risk perception. This literature also illustrates that the effect of proximity is not simple. Elements that need to be considered include economics, associated factors of education and race, and the characteristics of the hazard itself. Through the application of GIS tools, this project will afford an opportunity to look at the role played by a number of associated elements that together may influence how proximity affects risk perception.

The project involves adjunct analyses of existing data from surveys of some 20 communities that have requested investigations of local cancer rates due to concern over local environmental hazards. The analysis involves geocoding the survey data, combining the 20+ locations into one

‘virtual hazard site’ and expanding the data through linkage to a number of other data sets. The resulting enriched data set will then be examined through several spatial analysis techniques and visualized through the use of GIS software. The primary relationship to be explored is that of hazard proximity and health risk perception.



**Hypothetical Spatial Surface.** Li (Lee, 2001) models a spatially dependent bivariate relationship, for example between risk perception and cancer anxiety. The hypothesized surface (Diggle’s function) is theoretically centered on the set of hazards and visualized by a 3D Isopleth map of the values of Li for each x,y location.

### Progress

Work during the first nine months of this two-year project (through September 1, 2005) has emphasized the preparation of the survey data and the acquisition of GIS skills by the Principal Investigator. The PI has completed GIS instruction at ESRI and through online courses offered by Penn State University. One of the goals of the project is to provide the PI with some training and entry to the interdisciplinary field of GIS—this goal is being rapidly met. Progress has also been made in preparing the data for analysis. A preliminary study to finalize a measure of cancer anxiety has been completed and address fields have been prepared for geocoding. Analysis is expected to be underway near the end of the first year of the project with preliminary results available in January 2006.

### Broader Impacts

A significant amount of investigator education is embedded within this project. It is anticipated that completion of this research project will propel the investigator into further research in the spatial dynamics of risk. Further, it is clear that merging data bases such as the Toxics Release Inventory and Cancer Registries using the Web and GIS will be an important force in the future definition of concern over hazards and the manner in which individuals and society views risk. It is imperative that we continue to develop our scientific understanding of how laypersons view hazards and learn to communicate information to them effectively and responsibly. Such an understanding can certainly be generalized to contemporary circumstances involving terrorism.

This project will also satisfy additional criteria. With respect to intellectual merit within and across fields, this project applies a variety of social scientific theories to understand the perception and communication of risk. Like the broader area of risk research, this proposal is strongly interdisciplinary. It draws from perspectives in both the psychological and social traditions, as well as their confluence in the field of communication. These perspectives are further united through the application of GIS tools and spatial analysis. The outcome of this work

will be a quantitatively demonstrated model of spatial risk with sufficient rigor to serve as a foundation for ongoing attention to this problem by this investigator well as others in the research community across a range of disciplines.

### Infrastructure Emphasis Area

#### **Keith Kintigh, Arizona State University**

Enabling the Study of Long-Term Human and Social Dynamics: A Cyberinfrastructure for Archaeology

0433959

Scientific investigations of social and socio-environmental systems are seriously impaired by a lack of millennial- or centennial-scale data. In developing and testing explanatory models, we must do more than project recent observations—reflecting at most a few decades—into the past or future. Archaeology can provide the long-term data on societies and environments needed to illuminate such critical topics as demography, economy, and social stability. To date, efforts to recognize phenomena operating on large spatio-temporal scales have been crippled by the inherent complexities of archaeological data, the lack of data comparability across projects, and limited access to primary data. Nonetheless, the potential for archaeological insights to contribute to the study of long-term social dynamics is enormous; the fundamental challenge is to enable *scientifically meaningful* use of an expanding corpus of data.

#### **Project Objectives**

**Goal 1:** To develop a shared vision for a cyberinfrastructure of archaeology, to assess the major sociological, archaeological, and information technology challenges that must be confronted, and to outline for a long-term strategy for achieving that vision. This goal was attacked through a December 2004 workshop including 31 individuals representing diverse archaeological interests, computer scientists concerned with information integration and informatics, and scientists associated with informatics infrastructure projects ongoing in other disciplines. The workshop focused on the needs for information integration in archaeology and was hosted by the National Center for Ecological Analysis and Synthesis (NCEAS).

**Goal 2:** To develop a base ontology and schema for a limited segment of an archaeological data domain, to use that ontology to develop metadata for a modest variety of sample data sets; and to illustrate the flexibility and utility of this approach. This has been accomplished by a smaller working group of faunal analysts working intensively with project computer scientists on a concrete problem with actual data. The Faunal Working Group met once in the Fall of 2004 and will meet again early in 2006; initially to refine the problem and outline key ontology and metadata issues, and second to discuss and evaluate the application deriving from the first meeting.

**Progress & Preliminary Outcomes** A workshop entitled [The Promise and Challenge of Archaeological Data Integration](#) was held in Santa Barbara, California in December of 2004. The

report of the workshop concluded that new technologies in information integration will enable archaeologists to:

- work at scales not currently possible to answer pressing questions that cannot now be addressed due to a lack of effective access to existing data;
- foster the development of a new paradigm of integrative and synthetic research;
- scale and integrate archaeological data so that they can be used to address compelling questions in other disciplines; and
- sustain the scientific utility of existing digital data that are critically endangered by media degradation, software obsolescence, and inadequate data documentation (metadata).

The workshop concluded that to meet pressing research needs and to help stem the loss of existing information, it is essential that we embark now on the task of creating an infrastructure that will allow us to archive and make available integrated databases of archaeological data. Our intensive investigation of the information integration demands of archaeology has led both to a clear definition of the computer science challenges posed by a cyberinfrastructure for archaeology and the design of a technical approach that accommodates the unusual demands of the domain of archaeology. We conclude that these technical challenges cannot be met by a straightforward adaptation of existing information integration technologies. Needed are tools employing novel query-driven, ad hoc data integration techniques that allow archaeologists to register their data sets, and integrate them with already registered data sources to enable complex inferences. Such an architecture will allow researchers to extract a sensibly integrated and appropriately scaled database of analytically comparable observations from multiple datasets gathered using incommensurate recording protocols.

We are now refining a prototype application that we developed that implements the ad-hoc integration strategy for a limited problem domain relevant to an intellectual challenge posed by the faunal working group. This development was accomplished through close collaboration of project archaeologists and computer scientists and a team effort by one graduate research assistant in computer science and another in archaeology.

**Broader Impacts** Such an information infrastructure will enable researchers across scientific disciplines to substantially advance complex socio-ecological modeling efforts and to address large-scale and long-term questions with empirical support that has heretofore been unthinkable. Impacts extend far beyond the traditional boundaries of academia including critical needs of private, tribal and governmental archaeology programs. It provides a means to maintain the long-term utility and accessibility of irreplaceable primary data in the face inadequate metadata and rapidly changing technology.

The information integration architecture we have designed will have broad applicability in other science-informatics domains in which complex inferences need to be made over multiple heterogeneous, inconsistent, and context dependent sources. Specialists in other fields will gain direct access to intermediate-level archaeological knowledge as well as to primary data that are scaled and reconciled to match the scope of their inquiries. By providing scholars in diverse fields with meaningful access to long-term data on society, population, and environment,

archaeology can help explain the complex human and social dynamics that have constituted today's social world and have shaped the modern environment.

**Project Website** <http://cadi.asu.edu>

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**Steven Ruggles, University of Minnesota**  
International Integrated Microdata Series  
0433654

A vast body of raw census microdata covering much of the world over the past four decades survives in machine-readable form. The bulk of these data, however, remains inaccessible to researchers. This proposal seeks funding to create an integrated global database of over 150 censuses from at least 44 countries. The International Integrated Public Use Microdata Series (IPUMS-International) will be the world's largest public-use population database, with multiple samples from each country enabling analyses across time and space. These microdata and accompanying documentation will be freely available for scholarly and educational research through a web-based data dissemination system.

The project leverages NSF investment in a major social science infrastructure project now nearing completion, "International Integrated Microdata Access System" (SBR9908380). That project covered many of the costs of finding and preserving microdata and documentation, negotiating dissemination agreements, developing data cleaning and sampling procedures, creating data conversion and dissemination software, and establishing design protocols for data and documentation. As a result, creation of the new database will be highly cost effective.

Census microdata represent an extraordinary untapped resource for research and education in human and social dynamics. With over five hundred million records spanning four decades, the new database will offer far broader chronological scope and greater sample densities than any alternative data source. For most countries, censuses are the most representative source of population data available. The new database will allow investigators to analyze global change during a period of unprecedented economic, demographic, and political upheaval.

### **Progress Report**

We began work on the project in January 2005. We have two main goals for the first year of the project. First, we are working to preserve and democratize access to as much census microdata as possible; second, we are developing a comprehensive design for creating the database.

Our data preservation efforts have been remarkable successful. We have successfully executed dissemination agreements with 44 countries, and have acquired both the data (over one billion person records) and dissemination licenses which allow us to redistribute it. This represents the minimum number of countries we promised in the proposal, but our work on preservation continues. By the end of the project, we hope to have ensured the survival and usability of many additional microdata collections.

The development of a streamlined work plan is also proceeding well. The new plan represents a significant restructuring of the work processes we employed in the first phase of this research.

Our new approach improves scalability, speeds processing, and reduces the cost of database maintenance. Highlights of the work process include 1) full implementation of XML metadata standards, 2) elimination of metadata redundancies, 3) all new java-based data conversion software, with increased analyst control, 4) improvement of the data access tools. We will present a final version of the design at the annual meeting of our Advisory Board in April 2006.

### **Broader Impact**

This project will reduce barriers to international research and education by preserving datasets and making them freely available, converting them into a uniform format, providing comprehensive documentation, and implementing web-based tools for disseminating the microdata and documentation. The database will provide fundamental infrastructure for a broad range of fields in the social and behavioral sciences, including economics, geography, sociology, population studies, and environmental studies. Researchers in most countries do not presently have access even to their own national census microdata; IPUMS-International will democratize access to this vital scientific resource, creating unprecedented opportunities for global-scale research.

Most census data have traditionally been available only in aggregated tabular form. Census *microdata* provide information about individual persons, families, and households, and they allow users to interrelate any desired set of population and housing characteristics. The flexibility offered by microdata is essential for comparative research on social dynamics because the aggregate tabulations produced by national statistical offices are usually not comparable across time or between countries. In the few countries where census microdata covering multiple census years have been easily available to researchers, these data are the most widely used source for the study of large-scale economic and demographic transformations. Making integrated census microdata available for almost half of the world's population will allow researchers to describe the transformation of the world in far richer detail than previously possible. Even more important, these data will provide unprecedented opportunities to investigate the agents of change and assess their implications for human society.

Census microdata are an essential resource for studying large-scale transformational changes such as economic development, urbanization, fertility transition, large-scale migration, population aging, mass education, democratization, and growing international trade and capital flows. The availability of multiple censuses for each country lends historical depth, revealing the trajectories of change hidden in snapshots from the recent past. These data allow detailed study of the relationships of social and economic change to variations in climate, geography, and environment. They are also uniquely suited to assessing the human consequences of social, economic, and demographic transformations in such diverse areas as family structure, economic inequality, cultural diversity, and assimilation.

**Project Website** <http://ipums.org/international>