From: Jocelyn Suero
To: Faust, John; Meehan, Laura
Date: 9/23/2010 10:55 AM
Subject: Fwd: Comments on "Cumulative Impacts: Building a Scientific Foundation"
Attachments: Huang_London_SJV_IGARSS_final.pdf

fyi....

>>> "Huang, Ganlin" <glHuang@ucdavis.edu> 9/23/2010 10:38 AM >>>

Dear Ms. Jocelyn Suero

My name is Ganlin Huang. I work at Center for Regional Change, UC Davis. Jonathan London is the director. One of the projects at our Center is about cumulative health impacts in the San Joaquin Valley, CA. We are very happy to see this draft report released by EPA and want to contribute some comments.

First of all, we are very glad to see a clear and comprehensive definition of cumulative impacts in the report. And besides pollutions, the definition also addresses health situation and population characteristics, which are often left behind in the past.

There are four things in the report that could be improved or addressed.

1) **Selection of indicators**: In Chapter 2, the five components (exposures, environmental effects, public health effects, sensitive populations, and socioeconomic factors) are defined and explained. In Chapter 3, the data source for each component is presented in Table 2 (page 33). I found that some important indicators that used to explain the components in Chapter 2 are not included in Table 2, Chapter3. I understand that it is challenging to find data covering entire CA for all the indicators. However, the following socioeconomic indicators should be easily available:

a. Access to healthy food
b. Educational attainment
c. Availability of parks and open space

The "exposure" component measures primarily air quality for now. To describe more aspect of the environment/pollution condition, I encourage to include pesticide data (available as roughly 1 square mile grid), heat exposure data (available as land surface temperature at 60 meter square resolution), and if available, water quality data.

2) **Overlap/Correlation among "Exposure", "Environmental Effects", and "Public Health Effects":** These three components could be related to one another. For example, a spill would be counted in "Environmental Effects" as itself. It may impact certain air quality measurement and be captured as "Exposure". Finally, its impact on the residents around will be counted in the "Public Health Effects". Such overlap needs to be addressed in the model.

3) **Analysis unit of the model:** In Table 4 (page 38), community was used as the analysis unit. I guess it means census block group or tract, but the boundary of the unit and scale of the analysis needs to be clarified. Furthermore, data come on different scales. For example, census data comes as by block group or tract, air data comes by each air basin or monitoring station, and toxic release inventory data comes as points. How data at different scale are merged together needs to be explained in the report.

4) **Calculating each indicator:** As indicated on page 36, a score is given to a community by dividing the entire dataset into equal subgroups. In this way, the distribution of the data is not considered, which could make a huge different. I encourage the work group to look into the distribution of the data and take this into consideration when dividing them into subgroups.

Cumulative impacts in a complex issue. It is very challenging to collect all the data and incorporate them into one model. Center for regional change and myself would like to contribute or share our own experience on building models to measure cumulative impacts. I attached a paper on modeling cumulative impacts to this email, which we presented at International Geospatial and Remote Sensing Symposium in July. Please feel free to contact me if there is any question.

Best,
Ganlin
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CUMULATIVE ENVIRONMENTAL IMPACTS AND SOCIAL VULNERABILITY IN THE SAN JOAQUIN VALLEY, CALIFORNIA

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ABSTRACT

Researchers in environment justice (EJ) are concerned with the differential distribution of environment hazards and benefits based on race or class. Quantifying the spatial distribution of cumulative impacts from multiple environmental hazards and social vulnerability of communities based on socioeconomic and demographic characteristics would provide valuable knowledge for EJ advocacy work, policy discussion and the academic community. In this context, our paper developed and mapped (1) a cumulative environmental hazard index (CEHI) and (2) a social vulnerability index (SVI) in the San Joaquin Valley, CA. A correlation analysis was conducted between the two indexes. Results showed that (1) CEHI and SVI are significantly correlated indicating that areas that are more socially vulnerable are impacted by more environmental hazards. (2) Areas close to the highways tend to be more socially vulnerable and impacted by more environmental hazards.

Index Terms— Cumulative environmental impact, environmental justice, social vulnerability index, San Joaquin Valley

1. INTRODUCTION

Environmental justice (EJ) refers to the differential distribution of environmental risks and benefits based on race, class, ethnicity, gender or age [1]. Researchers and policy-makers concerned about EJ argue that some communities, i.e. low-income communities and communities of color, face a higher frequency and magnitude of impact from environmental hazards while have less resource, i.e. time, money, education, health care, to minimize the potential health impact.

Traditional EJ studies usually focus on the distribution of single pollutant based on race or class [e.g. 2-3], which does not meet the EJ advocates' need working in the communities suffering from multiple pollution sources. At the same time, it also raises the question of content validity in the academia world due to the lack of a full range of environmental indicators [4-6]. To address this issue, several indexes of cumulative impacts were developed and applied to various regions [6-8]. However, due to data availability and methodology challenge, the cumulative impact studies usually include one type of pollutants such as air pollutants or point source pollutants. The index of cumulative impacts is still far from describing every pollution source in the community.

As the measurement of environment hazard is moving from including single pollutant source to multiple ones, the socioeconomic status of communities are mostly described by race, ethnicity, income and poverty. In many EJ studies and projects, these socioeconomic indicators were used to divide communities into categories by percentage of people of color, income or poverty rate. Then the magnitude of environmental burden on communities in each category was summarized and compared [e.g. 2-3]. These socioeconomic indicators provide a straightforward way to indentify disadvantaged communities, but as single pollutant measurement does not give the full picture of environment hazards, these socioeconomic indicators do not present the full spectrum of social stress.

Recognizing the importance to measure social stress and resource in various aspects, social vulnerability index (SVI) was proposed and applied in several researches and EJ projects. Cutter [9] constructed a comprehensive SVI for the entire US using county-level socioeconomic and demographic data. Another study [10] examined the spatial pattern of social vulnerability and the risk of natural disasters associated with climate change in the southeast US.

As a contribution to innovations in community-university partnerships on cumulative impact research, a UC Davis team has collaborated with San Joaquin Valley Cumulative Health Impact Project, a coalition of environmental justice and environmental health organizations. This collaborative effort has developed a cumulative environmental hazard index (CEHI) and a SVI

to bridge the two data gaps discussed above in the San Joaquin Valley, CA. This paper presents the methods used to develop CEHI and SVI and the spatial patterns of them.

2. METHODS

The eight-county San Joaquin Valley is the southern expanse of California's 450-mile-long Central Valley (Figure 1), which is well-known for its bountiful agricultural production with reaches to statewide, national, and global markets [11]. Besides the large magnitude of pesticides applied in the San Joaquin Valley [12-13], the valley has also been associated with some of the worst air quality in the nation [14].

Figure 1 San Joaquin Valley, CA.

Census block group was used as the unit of analysis in this research. Six datasets describing environmental hazards were included (Table 1). Except for the pesticide dataset which was attained from CA Department of Pesticide Regulation, all the environmental data were from US EPA. These data are based on different measuring units, including locations of point source pollution (i.e. toxic release inventory sites), amount of agriculture pesticide application by square mile, and cancer risk based census tract.

Table 1 Environmental hazard datasets and indicator/index

Indicator/Index	Datasets	Time
Point source pollution index	Toxic release inventory sites	2006
	Refineries	2006
	Hazardous waste treatment, storage and disposal facilities	2006
	Chrome platters	2006
Pesticide density	Total amount agri. pesticide application per 1 mile^2	2007
Total risk of cancer	National-scale air toxic assessment	2002

2.1. Cumulative environmental hazards index

Datasets describing point source pollution include toxic release inventory sites, refineries, hazardous waste treatment, storage and disposal facilities, and chrome platters. These four datasets were merged into one file in ArbGIS^{TM} 9.3. Then a 1-mile radius buffer was drawn around the points (Figure 2). Percentage area of each block group falls within the 1-mile buffer was calculated as point source pollution index.

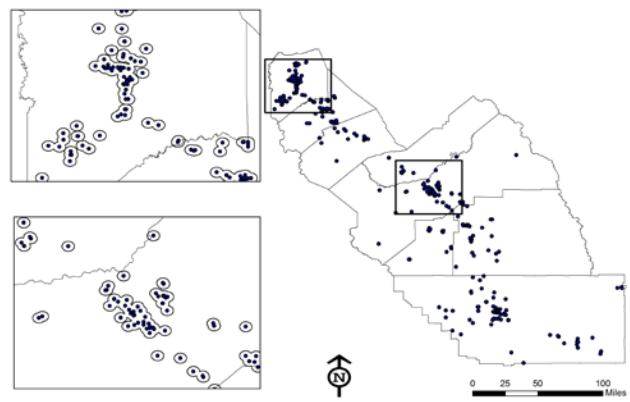

Figure 2 Locations of point source pollutions and its 1-mile radius buffer zone.

Pesticide density, defined in this study as total amount of agricultural use pesticide application per square mile was generated based on pesticide use reporting data and the Public Land Survey System (http://www.nationalatlas.gov/articles/boundaries/a_plss.html), which typically divides land into 1-square-mile sections. In this study, each 1-square-mile section was then divided into 16 units with a rough size of 100m x 100m each. Then pesticide density for each block group was calculated in ArbGIS^{TM} 9.3 as the mean value of that from the 100m x 100m units included more than 50% in a block group.

National-scale Air Toxic Assessment (NATA) provides estimates of the risk of cancer and other serious health effects from inhaling air toxics. It uses census tract as estimate unit, which is one level higher than block group. In our study area, one census tract contains 5.5 block groups on average. We assign the risk estimates of a tract to all the block groups that were contained within it.

Finally, we normalized pesticide density and total risk of cancer from NATA and then calculated the mean value of point source pollution index, pesticide density and NATA as CEHI.

2.2. Social vulnerability index

Social vulnerability index was calculated as mean of the four indicators derived from census 2000 [15]: percent of household below federal poverty line, percent of people older than 25 years who do not graduate from high school, percent of people of color, and percent of households that are linguistically isolated.

2.3. Correlation analysis

Two analyses were done in PASW Statistics 18 to examine the relationship between cumulative environment hazard index and social vulnerability index. First, we conducted a correlation analysis between the two indexes. Then, we divided social vulnerability index into five categories by quantile and compared the distributions of cumulative environment hazard index of each category.

3. RESULTS

Our result shows that CEHI and SVI are correlated at the confidence level of 99% with a coefficient of 0.222. It indicates that the block groups having a high CEHI, which are the areas impacted by point source pollution facilities, more pesticide use or air toxic pollutants, tend to have a high SVI, which means more residents living there are people of color, in poverty, linguistically isolated, or do not graduate from high school.

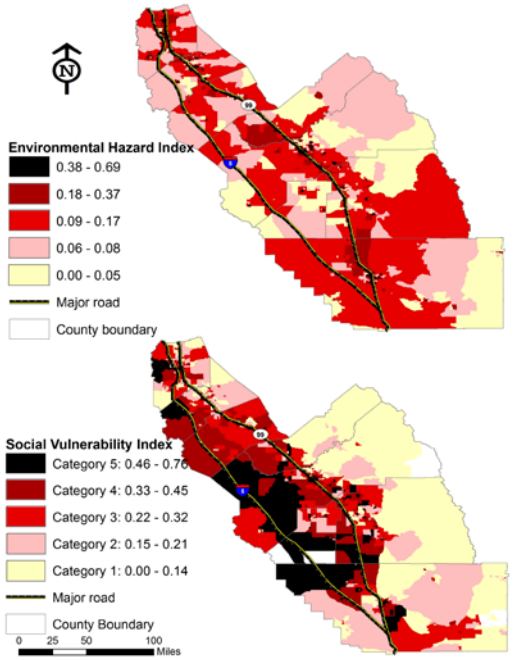

Figure 3 Spatial distributions of cumulative environmental hazard index and social vulnerability index

The spatial patterns of CEHI and SVI are presented in Figure 3. It shows that the areas along the highways tend to have higher values for both indexes. A boxplot was generated to present the distributions of CEHI within the five categories of SVI (Figure 4). The boxplot presents the five statistics (minimum, first quartile, median, third quartile, and maximum) within each category. Outliers were also pinpointed in the chart. There were 8 outliers within the first category and 1 outlier within the third category while each category contains about 450 cases. The result shows a clear increasing of the median and third quantile of CEHI when the SVI moves across the five categories from low to high.

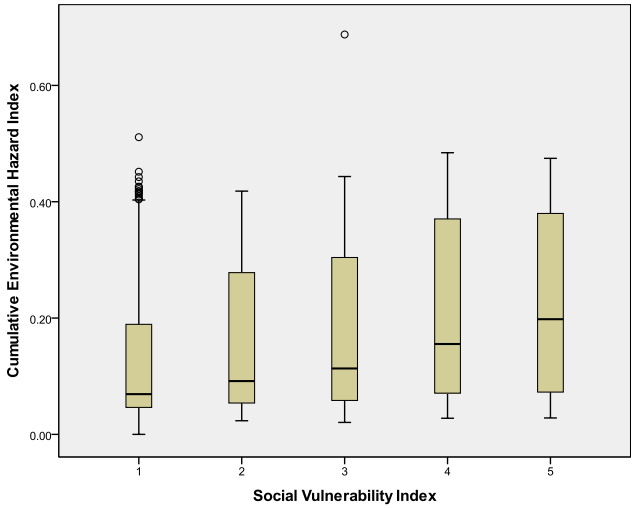

Figure 4 Cumulative environmental hazard index and social vulnerability index

4. DISCUSSION AND CONCLUSIONS

In this study, we developed an index of multiple environmental hazards including those people are most concerned with in the San Joaquin Valley: various point source pollution facilities, agricultural use pesticides application and toxics in the air. It provides an example of combining data based on various units (i.e. point, square-mile grid and census tract) together to generate one index measuring overall risk from environmental hazards.

We also developed an index to measure how vulnerable people are when facing with the potential health risk and other problems brought by the environmental hazards. Our results showed significant positive correlation between the two indexes. It indicates that areas are impacted by most environmental hazards are those have the least resources to minimize the potential harm. This finding is consistent with other EJ studies.

There are several limitations of this study. First, both CEHI and SVI are calculated as mean values of their sub-indicators. Such an additive approach does not take into

account the possible interactions between indicators. Second, limited by data availability neither CEHI nor SVI measured all relevant aspects. For example, dairy is another potential pollution source people concern about in the region but was not included in this study due to data availability. Third, to make best use of the available data, data sets used in this study are from different years as shown in Table 1. The most recent census data is 2000. The most recent NATA dataset is from 2002 and the data for point source pollution and pesticide use are from 2006 and 2007.

In summary, this study measured cumulative environmental hazards and constructed an index based on point source pollutions, pesticide use and toxics in the air in the San Joaquin Valley, CA. It also examined the social vulnerability of communities in the region and built an index based on race, education, linguistically isolation and poverty. Our results showed the two indexes are significantly correlated indicating areas are impacted heavily by environmental hazards are more socially vulnerable. The spatial patterns of the two indexes were examined. Areas along the highways in the region are generally score high in both indexes, which indicating places suffering from more environmental impacts and more socially vulnerable.

6. ACKNOWLEDGEMENT

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