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**OAK RIDGE
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Environmental Assessment and
Social Justice

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DEPARTMENT OF ENERGY

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ABBREVIATIONS AND ACRONYMS

BGAD	Blue Grass Army Depot (KY)
CD ROM	Compact Disc Read Only Memory
CFR	Code of Federal Regulations
CSDP	Chemical Stockpile Disposal Program
CSEPP	Chemical Stockpile Emergency Preparedness Program
EPA	Environmental Protection Agency
FEMA	Federal Emergency Management Agency
GB	Chemical nerve agent (Sarin)
GIS	Geographic Information System
H, HD, HT	Chemical vesicant agents (mustard)
NEPA	National Environmental Policy Act (1972)
NRC	National Research Council
PL	Public Law
SARA Title III	Superfund Amendments and Reauthorization Act (1986); Title II requires public disclosure of chemical release information and development of emergency response
SES	Socio-Economic Status
STF1-A	Summary Tape File 1-A (Census)
TIGER	Topologically Integrated Encoding and Referencing
VX	Chemical nerve agent
U.S.C.	United States Code

ABSTRACT

Determining quantitative methods for measuring social justice has challenged environmental professionals interested in strengthening decision making that must include consideration of social justice. To date, most social scientists have addressed the topic using qualitative research techniques. This paper describes a method of integrating census demographic data and TIGER Line File geographic data to develop quantitative measures for concepts dealing with social justice that are replicable as well as comparable across populations. Two case studies that used the method are presented for discussion.

1.0 INTRODUCTION

Recent presidential mandates have led to a formal need to address environmental justice issues. Executive Order 12898 of February 11, 1994, "Federal Actions To Address Environmental Justice In Minority Populations And Low-Income Populations," mandated that all federal agencies address equity issues for any action with the potential to impact certain disadvantaged populations.

Historically, the debate over environmental justice has been philosophical, theoretical, descriptive, passionate, or some combination thereof. Often studies begin with a priori judgments that inequities exist (often related to structural social problems) and then attempt to garner proof by means of case studies that richly document the injustices. Little of the work has been empirical in nature, despite a strong tradition in the social science of empirical research on the related topic of the quality of life (Andrews and Withy, 1976; Atkinson, 1982; Mulis, 1992).

Social scientists are often in a quandary on how to quantify measures (indicators) that empirically reflect the economic well-being and socioeconomic status (SES) of groups of individuals or communities when siting a hazardous material, chemical, landfill, or other noxious facility. Increasing costs associated with liability suits have forced many otherwise "good neighbor" industries to locate facilities in remote or rural, non-incorporated areas, placing further burdens on small communities unable to fend off intrusion.

Legal mandates are often the principal stimulus for conducting impact assessments (Soderstorm, 1981). The impetus to study the human consequences of federal actions is mandated through the National Environmental Policy Act (NEPA). Section 102 of NEPA requires that agencies :

- (A) utilize a systematic, interdisciplinary approach [to] insure an integrated use of natural and social sciences in planning or decision making,
- (B) identify and develop procedures [to] insure appropriate consideration [of] presently unquantifiable environmental amenities and values in decision-making along with economic and technical considerations.

While the mandate is clear and the methodological issues identified, the employment of these assessments has not necessarily been embraced by federal agencies (Soderstorm, 1981). The concept of social justice follows logically from traditional NEPA impact analysis. However, what has been lacking is a standard methodology to screen a proposed project for indications that equity issues may be involved. In the majority of instances, social and cultural impacts have rarely played a decisive part in the actual NEPA process, even though social

questions are often the primary focus for political debate about a controversial project (Warner, 1980).

This document presents a methodology for quantifying measures that can be used with available (often on-line) census data to address equity concerns. Although individual localities may disagree with some aspects of the census data, the majority of the census data have been collected without bias. The methodology is easily replicated and provides a basis for comparison among units. Two case studies are presented to illustrate how such measures have been used to analyze environmental equity issues. We emphasize that the methodology does not specify mitigation measures to address the inequities identified.

The document is organized as follows. The first section describes the Executive Order 12898 and the issue of social justice in light of the equity issues raised by researchers on the siting of noxious or hazardous material facilities. The next section discusses quantitative measures that can be used to examine the SES of groups within a population to determine the baseline distribution. Essentially this step is describing the existing environment in terms of social variables. The next section describes a methodology integrating existing census data with geographic information systems (GIS) to produce a profile of quantitative measures or indicators. The next section describes two case studies in which the methodology was used to establish whether in fact the project could result in increased social inequality among the population studied. The final section examines the findings from the methodology suggested and the implications for future use in NEPA documents.

1.1 NEED TO QUANTIFY CONCEPT

Executive Order 12898 of February 11, 1994, set forth broad agency responsibility for addressing equity issues in conjunction with federal activities. The executive order stated:

To the greatest extent practicable and permitted by law, and consistent with the principles set forth in the report on the National Performance Review, each Federal agency shall make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations in the United States and its territories and possessions, the District of Columbia, the Commonwealth of Puerto Rico, and the Commonwealth of the Mariana Islands.

The two arenas that are most likely to be affected by the executive order are Federal projects requiring NEPA assessments and Federal activities falling under SARA Title III.

Section 3-302 of Executive Order 12898, titled "Human Health and Environmental Data Collection and Analysis," states:

To the extent permitted by existing law, including the Privacy Act, as amended (5 U.S.C. section 552a):

- (a) Each Federal agency, whenever practicable and appropriate, shall collect, maintain, and analyze information assessing and comparing environmental and human health risks borne by populations identified by race, national origin, or income. To the extent practicable and appropriate, Federal agencies shall use this information to determine whether their programs, policies, and activities have disproportionately high and adverse human health or environmental effects on minority populations and low-income populations.
- (b) In connection with the development and implementation of agency strategies in section 1-103 of this order, each Federal agency, whenever practicable and appropriate, shall collect, maintain and analyze information on the race, national origin, income level, and other readily accessible and appropriate information for areas surrounding facilities or sites expected to have a substantial environmental, human health, or economic effect on the surrounding populations, when such facilities or sites become the subject of a substantial Federal environmental administrative or judicial action. Such information shall be made available to the public, unless prohibited by law; and
- (c) Each Federal agency, whenever practicable and appropriate, shall collect, maintain, and analyze information on the race, national origin, income level, and other readily accessible and appropriate information for areas surrounding Federal facilities that are: (1) subject to the reporting requirements under the Emergency Planning and Community Right-to-Know Act, 42 U.S.C. section 11001-11050 as mandated in Executive Order No. 12856; and (2) expected to have a substantial environmental, human health, or economic effect on surrounding populations. Such information shall be made available to the public, unless prohibited by law.

In summary, the executive order requires federal agencies to ascertain that proposed actions or on-going activities will not adversely impact minority or low-income groups disproportionately. Furthermore, attempts must be made to inform those populations regarding proposed projects or activities. How individual agencies will interpret the order is unclear, and probably will likely require clarification through the legal system.

1.2 ENVIRONMENTAL EQUITY AND NOXIOUS FACILITIES

Previous research has documented many different types of equity issues as they relate to environmental issues (Dunlop and Metig, 1992). Documentation of civil rights violations has strengthened the move to make environmental quality a basic right of all individuals (Bullard and Wright, 1987a, 1987b, 1992).

A study of migrant farm workers in the fruit and vegetable growing areas of the San Joaquin Valley, California found workers were frequently exposed to pesticides, often by misapplication or through lack of proper protective equipment (Beasley, 1990). It is alleged in the study that, as a result, the predominantly Hispanic farm workers suffer from undo health effects including cancer, birth defects, headaches, dizziness, skin rashes, cardiac arrest, and death from pesticides. Beasley (1990) argues that pesticide regulations are frequently overlooked and not enforced. Furthermore, results of the study indicated that enforcement agencies tend to ignore the farm workers' complaints.

Another investigation documents how Native American communities around the country are being singled out for the siting of hazardous waste. Over 42 of the 360 tribes in the United States have been approached by waste disposal companies and 30 have rejected the proposals (Ruben, 1991).

Grossman (1991) studied Atgeld Gardens, a housing project on the Southeast Side of Chicago with about 10,000 predominantly African-American residents. The project is in close proximity to chemical plants, a paint factory, several steel mills, and lagoons filled with contaminants. It is estimated that over 30,000 tons of toxic substances were emitted by those industries into the air each year. Environmentally caused diseases, such as cancer, brain tumors, respiratory problems, birth deformities, blindness, and deaths allegedly exceed normal levels within the study area (Grossman, 1991) .

Dumping in Dixie: Race, Class, and Environmental Equity (Bullard, 1990) is an in-depth study of environmental justice in black communities in the South. The researchers used a case study approach to examine problems of predominantly black communities in preventing exposure to hazardous materials. The study documents social movements carried out to protest landfills, incinerators, toxic waste, chemical industries, salvage yards, and garbage dumps. The study showed that strategies used by the communities to prevent actions included demonstrations, presence at public hearings, lawsuits, the election of supporters to state and local offices, meetings with company representatives, and other similar approaches designed to enhance public awareness and accountability.

In Hazardous Waste Sites: The Credibility Gap (Greenberg and Andersen, 1984) the authors document how waste seems to flow to low income areas. Greenberg and Anderson (1984: 222-223) note:

“...the worst abandoned sites tended to have populations that were relatively poor, and contained a greater proportion of younger, older, and black residents.”

In analyzing environmental equity with respect to risks from industrial hazards in Allegheny County, Pennsylvania, Glickman (1994) used a GIS to calculate the percentage of non-whites and poor residents inside and outside the close-proximity region of 62 facilities having extremely hazardous substances on their premises. The study found that using a worst-case chemical accident scenario introduced a bias because nonpoor whites are affected at further distances from the facility than minorities closer to the facility. The study concluded that smaller releases (under average case scenarios) affect those living close to facilities - the poor nonwhites. This study is important because it indicates that initial decisions regarding the spatial characteristics used for analysis may well determine the outcome for affected minority populations.

1.3 MYTHICAL EQUALITY: MEASURING SOCIAL ECONOMIC STATUS (SES)

Even though most Americans think American society has become egalitarian, empirical evidence suggests otherwise. The distribution of income remains skewed toward a small wealthy population, and poverty appears to be increasing among some minority and elderly groups. Because of structural economic changes in the last decade, lack of employment opportunities for low-income urban minorities has increased the numbers of families living near or below the poverty level (NRC, 1993). Although there has been substantial increase in racial equality since the 1950's, the reality of racial discrimination, particularly in the access to resources, continues to exist but in a more subtle manner.

While flagrant discriminatory activities, such as the 'redlining' of real estate districts that result in unequal distribution of housing for minority groups, have been generally curtailed, the outcome of such previous activities remains structurally embedded in the physical infrastructure of many communities. To examine whether these groups continue to be burdened with additional discrimination (i.e., siting of waste sites), it is necessary to have a methodology that effectively screens for such impacts, is predictive when possible, has varying levels of geographic detail, and is adjustable over time.

While we recognize that some goods or resources (such as political power) cannot be obtained simultaneously by all groups within a population, the question of distribution is essential to determining equity. The question of equity thus focuses on the beneficiaries, those who will bear the costs and/or resulting risks, and how conflicts can be resolved. The three value principles - the principle of equality, the principle of utility and the principle of freedom do not imply the presence of each other but rather are independent of each other.

1.4 DEFINING SOCIAL JUSTICE

Like other latent concepts in NEPA documents (such as risk), social justice has migrated into the environmental equity literature via a largely unintentional route, but one consistent with NEPA analysis. That such analysis should be directed toward the distribution of impacts (instead of a general analysis which may overlook specific pathways) follows logically given the NEPA mandate for discussion of cumulative impacts.

The definition of social justice depends on the assumptions provided by a discipline's paradigm. We agree with the two points of EPA's working definition of environmental equity (EPA, 1994):

- that all people should be given equal treatment under environmental laws, and
- that environmental policies should be enforced equitably without discriminating on the basis of race, ethnicity, culture, economic status, etc.

While the term 'justice' has long been associated with the law and law enforcement professions or policy analysts, the adjective 'social' has largely been missing from investigations that focus primarily on legal issues and individual rights of perpetrators and victims. The sociological concept of 'social' recognizes that an individual is inherently enmeshed in a complex network of social and economic relations that shape the prospects an individual has for health and happiness. Moreover, those networks are influenced by historical circumstances as well as temporal relationships related to age, gender, and ethnicity. Gaining information on these factors leads to an overview of the context in which to examine a population sub-group's environment and the distribution of resources within that environment.

Quantitative indicators of socially disadvantaged groups have pointed to three structural factors - low economic status, ethnic heterogeneity, and residential mobility. These economic, organizational, and social factors affect people's opportunities to participate in the distribution of resources, whether individually or at the group level. For example, employment status and income level influence the amount of resources purchased by a household unit. Other problems associated with lack of employment (whether chronic or long-term) are both physical (lack of resources, access to health care, etc.) and social, including the social- psychological factors such as feelings of anomie or hopelessness that affect human behavior.

Information from government surveys, including the census and periodic studies, is available to any researcher. Such information can be used to estimate the average income level of groups and to compare the results to other similar communities in the region, to the region as whole, or to a state or other entity with similar properties that can be aggregated. Some of the information can provide surrogate measures to indicate where further attention should be directed in determining equity among groups based on certain factors - age, income, minority status, etc. The analysis can be broken down spatially by jurisdiction or

other aggregate political unit or on a population cohort basis depending on the questions raised. For example, if the analysis indicates that a minority group in a certain area is thrice that of the state's average, then the analysis would indicate further assessment of the possible inequities associated with place (spatial) or population (social) should be done.

While we can compare housing characteristics for a population unit (density, size, renter, owner-occupied) from census data, other characteristics affecting distributional inequity are not as easily examined. Those include the physical factors directly affecting individuals within a population, such as the amount of emissions released during a specific period, the total number of industries with potential emissions in an area which could exacerbate exposure, or the rate at which components mix to increase the risk of individual emissions. The reason relates both to the methods of reporting such emissions and the characterization for such incidents on an individual level of tolerance. Moreover, since dose and duration are related to an individual threshold of tolerance and may differ significantly by age (Rodericks, 1992), estimates of risk to individual households are difficult to assess, much less average. Thus other surrogate measures are used - rate of morbidity for certain groups (called cohorts) having a statistical demographic factor in common, such as age, within the population at risk.

To maximize replication, assumptions for using a cohort measure must be clearly elucidated. For example, in determining evacuation time estimates, it is logical to assume that persons under age fifteen would likely be dependent on caregivers or other sources for transportation. In a community with larger than average cohort groups under age 15 (those ineligible for driving licenses), we assume that those groups would be dependent on others for transport. For example during school hours, students would require buses to reach evacuation centers. During non-school hours, students would likely evacuate via the family vehicle. Other dependency factors related to age might include impaired mobility, especially if institutionalized populations are identified as living in the area at risk.

Another equity issue focuses on resource consumption and exposure pathways. One of EPA's major concerns, for example, is the ingestion of contaminated food resources by largely minority or nonwhite groups that rely on subsistence hunting or fishing. The activity may be related to traditional practices or based on necessity. However, if certain population groups consistently engage in the activity, such as consuming fishing taken from contaminated waters, then agencies must attempt to prevent further degradation of the resource by critically analyzing impacts on those sub-populations.

1.5 ENVIRONMENTAL JUSTICE FRAMEWORK

Figure 1 describes our conceptual approach to the analysis of environmental justice. Our model does not assume defacto effects—it begins with some proposed action or intervention. This action or intervention can be something abstract such as a government policy or regulation or something fairly concrete such as the proposed siting of a waste

Figure 1 Environmental Justice Framework

facility or construction of a new highway. Such interventions can vary in scale, from extremely localized actions to global-scale interventions.

Each action or intervention poses some impact pathways. We have developed five broad categories of impacts: environmental pathways, economic pathways, social pathways, political pathways, and human health pathways. These are not mutually exclusive. A release of a toxic substance may disperse through the air and have long-term health effects as well as social and psychological consequences for the population groups affected. Building a highway may create physical barriers that affect social acceptance and relations that impact the way laws are enforced in segregated neighborhoods.

Finally, these pathways help us to assess justice considerations. How do these pathways lead to spatial patterns of impacts among certain populations? How do the pathways lead to distributional impacts with respect to socioeconomic variables? How do the pathways result in broader societal impacts? And finally, how are these pathways extended from generation to generation?

1.6 METHODOLOGY

To be useful, a methodology must assist in problem definition, the first step in impact analysis. The methodology chosen must be systematic, applicable to a variety of situations, and replicable to satisfy the information needs of all parties.

To examine the spatial proximity of population to a particular action or intervention, a method of spatial analysis is needed. Geographic Information Systems (GIS) provide one tool for conducting such analyses. A GIS is composed of 3 basic components: a database for storing attribute information, a user interface for accessing and displaying information, and a set of tools or functions for manipulating and analyzing data.

For this effort we used MapInfo—a commercially available GIS product. It was chosen for cost, functionality, and ease of use. Other GIS packages are available which also could be used to conduct the analyses performed.

1.7 SOURCES OF DATA

Census data used in our analysis comes from two sources: the Census on Population and Housing, 1990: Summary Tape File 1 on CD ROM (STF1-A) and Census of Population and Housing, 1990: Public Law 94-171 on CD ROM (PL94-171). The STF1-A contains basic demographic data including population, households, age groups, race/ethnicity, and housing characteristics. Population data are cross tabulated by age, race, Hispanic origin, or sex. Housing data include occupancy/vacancy status, tenure, contract rent and value of housing unit. Housing data are cross tabulated by race or Hispanic origin of householder or by tenure. The PL 94-171 contains a count of all persons and all housing units in the geographic area and data on race and ethnicity. The greatest difference between the two

sources is in spatial aggregation of data. The STF1-A breaks data out by state, county, census tract, and block groups. The PL 94-171 breaks data out by the above-mentioned levels as well as by block level—the smallest geographic unit in the census files.

Both the STF1-A and PL 94-171 provide the basis for identifying racial groups. The Census racial statistics uses five basic racial categories; American Indian or Alaska Native, Asian or Pacific Islander, Black, and White. The 1990 census race question also included an "Other race" category with provision for a write in entry. The concept of race reflects the self-identification by respondents and is not intended to reflect any biological or anthropological definition. Persons of Hispanic origin are identified as an ethnic group and may be of any race. In the 1990 census, persons of Spanish/Hispanic origin categories were asked to classify themselves in one of the specific Hispanic origin categories—Mexican, Puerto Rican, Cuban, or Other Spanish/Hispanic origin. The 1990 census also provided respondents a write in entry for the last category (U.S. Dept. of Commerce, *Statistical Abstract of the U.S. 1993*: 4-5).

Geographic data come from the Census Bureau's automated geographic data base, the Topologically Integrated Geographic Encoding and Referencing (TIGER) System, a digital (i.e., computer-readable) map database that automates the mapping and related geographic activities required to support the census and survey programs of the Census Bureau. The Census TIGER/Line files, available on CD-ROM, are an extract of selected geographic and cartographic information from the TIGER database.

The TIGER/Line files provide digital data for all 1990 map features, the associated collection of geographic area codes (i.e., 1990 census block numbers), and the codes for the January 1988, political areas on both sides of each line segment for all mapped features. The files cover the United States, Guam, Puerto Rico, the Virgin Islands of the United States, American Samoa, the Northern Mariana Islands, and the other Pacific territories for which the U.S. Census Bureau aids in the census taking process.

The TIGER/Line files include information on 1990 census geographic area codes, feature names, and address ranges in the form of six "record types": 1) basic data records (i.e., individual feature segment records); 2) shape coordinate points (i.e., feature shape records); 3) additional decennial census geographic area codes; 4) index to alternate feature names; 5) feature name list; and 6) additional address range and ZIP code data. For segments that are not straight, the shape records provide coordinate values which describe the shape of the feature. For some areas, the TIGER/Line files do not contain address ranges or ZIP codes.

The TIGER/Line files contain all the physical and political boundaries needed to define census blocks, block groups, tracts and counties. The files also contain information on highways, streets, waterways, and rail lines. Therefore, the TIGER files allow us to show the location of the intervention with respect to the community infrastructure and the thematic distribution of population attributes.

1.8 CREATING DATA FILES

Census Files

The database manager FoxPro was used to extract information from seven of the ten STF1-A files at the block group summary level for each county associated with a site. STF1-A files 0, 1, 5, and 6 were used to obtain population data. STF1-A files 7, 8, and 9 were used to obtain occupied and vacant housing data. This gave us seven files, each containing data at the block group level for each county associated with the site. These county data files were then joined together to create one block group level file for a site. A similar process was used to extract data from the PL94-171 CD ROMs to create the block level data files.

TIGER/Line Files

The geographic information as distributed in the TIGER/Line files requires software to display the data in a map format on a computer screen. ORNL developed several programs for the Chemical Stockpile Emergency Preparedness Program (CSEPP) that read TIGER/Line Files and create MapInfo Exchange Format Files that can be directly imported into MapInfo for displaying the information in graphic form (Greider 1992; Roland 1993). These programs include: TIGERNEG.EXE--a program used to generate line segments with negative longitudes for the western hemisphere representing water, rails, highways, streets, and other features; TGRPKEY.EXE -- a program used to generate census block group boundary geography; and TBLKKEY.EXE, a program used to generate census block boundary geography. Also, the programs were used to employ the capabilities of MapInfo to create point and thematic displays of demographic information.

Linking Files

A key field, unique to each census block, was created in both the population/housing tables and the map files. All files (both census and TIGER) were exported to MapInfo. Through the GEOCODE function in MapInfo, this key field was used to link population and housing data tables (i.e., tabular data) with graphic data for simultaneous display.

1.9 SPATIAL ANALYSIS

In MapInfo, "Workspaces" were built to link various tables. A workspace is defined as a saved configuration of open MapInfo tables and windows. It preserves the setup from one session to another to avoid having to re-assemble (i.e., re-open one by one) each of the tables in the display window. For example, to display block level population data by the centroid of the block in conjunction with geographical features, a workspace was built consisting of the block population table, street table and highway table. The population table was set to display the population data field for each block while the street and highway tables were used to label

the features with the name of the street or highway listed in the tables. When finished with the session a workspace allows you to save the current setup so when you start your next session each table being used in the last session will automatically be opened. Therefore, you will not have to rebuilt your display window one table at a time.

To assess the distribution of an ethnic group or race we manipulated the block level population file by creating a new field defined as the total population divided by the number of blacks field, resulting in the percent black field. Similar fields can also be created at the block or block group level for other categories of interest such as age, sex, or other variables in the census.

Several methods can then be used for displaying the data. First, we generated summations or averages by geographical area defined as a discrete polygon or by a radius from a point. It is also possible to generate summations along a corridor or a combination of geometrical shapes. Secondly, we displayed values as point sources for the centroids of the areas they represent. Finally we created thematic maps to show patterns in the data. By using all three methods it is possible to develop some conclusions about spatial distribution of certain populations with multiple attributes.

1.10 CASE STUDIES

We present two case studies in which the methodology was incorporated to examine if potentially detrimental impacts would unequally accrue to certain population groups. The first case study is based on a methodology used to examine population characteristics in eight communities around military installations storing aging chemical agent munitions. The second case study involves possible energy development in Hawaii.

2.0 STORAGE OF CHEMICAL WEAPONS

2.1 BACKGROUND

The Chemical Stockpile Disposal Program (CSDP) was initiated in response to the 1986 Congressional mandate (by Public Law 99-145) to destroy the United States stockpile of the aging chemical munitions by the year 1992. These munitions, located at eight army depots around the country, contain the chemical nerve agents VX and GB and the blistering agents H, HD, and HT (commonly called mustard gas), all of which are highly toxic to humans upon inhalation or skin contact. After a thorough examination of the risks involved in the transporting and disposing of the stocks and in response to the congressional mandate to protect the public, the Army decided to build incinerators at each of the eight installations.

The law mandating disposal requires destruction in a manner that maximizes the health and safety of the public. The probabilistic risk analysis for the disposal program identified a number of credible accident scenarios that could result in potential fatalities. The Final Programmatic Environmental Impact Statement for the CSDP (U.S. Army, 1988a) found that emergency planning for an accident was inadequate in the communities surrounding storage sites. The Army's Record of Decision subsequently committed the Army to enhanced emergency planning (U.S. Army, 1988b).

The level of public knowledge about the storage and the potential risks involved in the continued storage was unclear when the U.S. Congress mandated the Army to dispose of the existing stocks of unitary chemical agent munitions in 1988. However, the Army's decision to incinerate the stocks of chemical agents at the existing sites brought about an equity issue as to whether the sites were being unfairly targeted for incinerators by the Army.

The Army, using FEMA as a interface with the communities, initiated and funded a Chemical Stockpile Emergency Preparedness Program (CSEPP) at each site. The CSEPP was intended to provide communities and states with resources in emergency response to reduce their risk in the event of an accidental release of chemical agent either during storage or during the incineration process. Under the guidance of the planning subcommittee of CSEPP, a planning guidance document was prepared (Oak Ridge National Laboratory and Schneider Engineers, 1990). The planning guidance provides general guidelines for implementing CSEPP. Program standards have been developed to provide more detailed planning requirements. Currently the Army and FEMA are preparing Emergency Planning Guides for each site. As part of this process ORNL is developing demographic data and displays for all eight CSEPP sites. This case study is derived from that effort.

2.2 ANALYSIS

As part of the CSEPP emergency planning process, we were initially interested in determining the number of people at risk at varying distances from the facility. Distance

provides a measure of the degree of risk. The nearer the facility, the greater the risk from an accidental release of agent because of the lack of time between a potential release and arrival of the toxic plume.

Secondly, we were interested in determining whether or not minority groups (in this case black populations) are disproportionately at risk. (The same could be asked for other groups such as the elderly or those with low incomes). The issue of social justice is important if activists ever accuse the Army of furthering discrimination against minority groups because of the existing populations around the installations. The question is structural in nature - are the number of minority groups around the eight military installations higher than for the population at other levels of geographic organization? Thus we were interested in empirically determining if, by building the incinerators at the existing sites, the Army was furthering the low status and placing at risk minority groups.

We employed the methodology discussed above to examine this issue and determine whether further analysis was indicated. Table 1 presents the initial findings from one site, Blue Grass Army Depot (BGAD) in Richmond, Kentucky.

2.3 DISCUSSION

The findings indicate (Table 1) that the proposition that blacks are at disproportionately higher risk was not supported with data from the 1990 census files. In fact, the number of black household units in the area nearest the facility that would be affected by an accident is less than both the county and the state averages as a whole. The fact that the analysis is systematic and replicable provides a solid basis of evidence that can be used to assess claims of social inequity. On the other hand, if the findings had supported the proposition that the Army was perpetuating discrimination, further assessment of the problem would have been warranted.

Table 1. Distribution of Black Populations Surrounding BGAD Incinerator Site

Area	Total Population	Black Population	Percent Black
3 mile radius	3,592	122	3.4
5 mile radius	9,271	697	7.5
10 mile radius	43,573	2,554	5.9
Madison County	57,508	2,920	5.1
All CSEPP Counties (region)	150,245	5,073	3.4
State	3,685,296	Not Available	7.0

This methodology also provides a basis for fine-tuning the comparisons for other population characteristics. For example, the table shows the greatest proportion of blacks in the 5 mile radius of the site. In order to determine what is causing this difference, we used MapInfo to prepare a thematic map of the distribution of black populations. Figure 2 displays the distribution of black population in Madison County.

From the map we find that most of Madison County has a very low black population. This largely corresponds to rural agricultural areas. The black populations in Madison County are found in the two urbanized areas-- Richmond and Berea. Figure 3 shows that the highest concentration of blacks are in a 16 block neighborhood about 3.6 miles from the incinerator site. This neighborhood is surrounded by areas with black population ranging from less than 1% to 2%. Thus the presence of one section of a city with a high percentage of blacks provides little support for the proposition that minorities are at greater risk.

3.0 ENERGY DEVELOPMENT ON HAWAII

3.1 BACKGROUND

Unlike the first case study where the risk to community residents stemmed from an existing hazard, the use of the methodology for the second case study was initiated by questions presented at public meetings for developing geothermal resources in the Geothermal Resource Zone of the Puna District on the Big Island of Hawaii. Although geothermal resources were utilized in the past on a minor scale, further development posed unanswered questions regarding the potential for toxic emissions from geothermal well blow-outs. Residents in areas likely to be developed expressed concerns that the additional risk for sensitive populations would be unacceptable given the risks from natural hazards in the area. Community groups questioned whether the development would require improved alert and notification systems for emergencies, given the unique and uncertain nature of the resource and its potential volatility. The groups argued that the additional warning systems were not their responsibility, nor one they could easily afford, given the maintenance costs of such systems in their sparsely populated communities. Furthermore, they argued that people with the greatest sensitivity to the risks of elevated level of hydrogen sulfide from the potential geothermal well blow-outs would be the most difficult to evacuate if an accident occurred. These sensitive groups included both the elderly and young children.

Land use planning in Hawaii is a complex and highly politicized issue. The number of stakeholders interacting in the geothermal resource development areas include private entrepreneurs, a number of population sub-groups, Native Hawaiians, various agencies within the counties, the state agencies and officials, and numerous federal agencies and military installations that control large land areas for training and defense purposes. Positioned in mid-Pacific, Hawaii is also host to large numbers of Asian tourists. With limited space and a long history of non-local or absentee ownership, land is also very expensive.

Historically and culturally significant artifacts and land use patterns have also been retained. Some Native Hawaiians maintain traditional practices that involve gathering indigenous plants (some highly sensitive to changes in environment) and worshipping Pele, the spiritual goddess of Hawaiian volcanoes. Other factors that affect land use planning are related to the unique topography and benign climate of the islands that attract tourists from all over the world and support a large agricultural export industry, including macadamia nuts, orchids, and anthuriums. Thus geothermal development would have to retain the cultural and aesthetic characteristics of the land while protecting people and property from further risks.

The existing natural hazards and the relative isolation of the islands have been both a blessing and a cause for concern for residents. While somewhat unique and often spectacular, the natural hazards are ubiquitous, violent, and unpredictable. The volcanoes naturally emit noxious gases, including hydrogen sulfide, and lava flows from eruptions often cover valuable land and roads. The proposed sites for geothermal development were located in the Puna

region of the Big Island on the lower flanks of the active Kilauea volcano, an area considered to have the most potential in terms of geothermal resources. The siting decision was further complicated in that the Hawaiian islands are highly dependent on imported sources for energy production and the development of the natural resource would help meet the island's future needs and alleviate some energy dependency.

We were interested in determining if developing the geothermal resource in rural areas subject to a variety of episodic hazards was significant to warrant further analyses. Factors related to public health and safety include the community's emergency response capabilities. For example, there may be sizable populations or sub-groups (such as a large elderly population) that would need additional help or who would be unable to evacuate in an emergency. Our attempt was not to draw conclusions about the possible environmental effects of the proposed development, but to develop a data set of population indicators which could be used for public decision making on proposed sites. Eventually another data set was developed using similar GIS platform to map areas determined environmentally sensitive and coordinated those findings with our population data. The result provided an overview of areas that in theory should be avoided in selecting sites.

We employed the GIS methodology to examine whether the potential development would occur in proximity to population sub-groups most likely affected by toxic emissions. We determined these sensitive groups to be the very young (under age 5) and the elderly (over age 65).

3.2 PUBLIC HEALTH RISKS RELATED TO GEOTHERMAL ENERGY PRODUCTION

The primary risks to human health from energy production plants are determined by the concentration of pollutants to which an individual is exposed, the individual's susceptibility, the mixture of compounds, and the duration of exposure, e.g., the source and length of exposure. Individuals may be at increased risk because of certain factors—developmental processes, an existing disease, prior exposure to a particular chemical, or nutritional deficiencies—that predispose them to respond to chemicals at much lower levels or after much shorter periods of exposure than other members of the general public (Seidman et al. 1991).

The lack of empirical data on individual vulnerability contributes to the difficulty in determining the risk from emissions of energy facilities. Some computer models estimate deposition from emissions expected to impact populations within a range of 3500' depending on meteorological conditions and the source terms. By determining the number of occupied residences within 3500' of a proposed plant site, estimates can then be made about the expected impacts. The models, however, do not include the effects from topographic features on plume dispersal nor the cumulative or synergistic effects from interaction with other chemicals naturally occurring in the atmosphere.

The analysis of vulnerability required methods for estimating impacts on the population sub-groups present in the area. For purposes of our analysis we used all persons over 65 and all persons under age 5 (cohorts available in census block data) to estimate the most vulnerable persons. We did this for several reasons. First, these groups generally experience the worst respiratory distress, whether chronically or of an acute nature. Further, these groups are also the most likely to be dependent on care-givers for transportation and thus unable to move quickly on their own when a hazard threatens. Thirdly is that the distribution of these groups can be compared to similar groups either within the region, to the state as a whole, or to similar groups nationally. Finally, special or institutionalized populations (e.g., day-care centers and nursing homes) may be at greater risk than other populations because of limited or impaired mobility. No institutionalized populations were found in the areas under consideration except for one school.

Using the methodology, we were able to group the population by ages in the Puna district. Figure 4 indicates the centroid figures mapped for areas at risk, divided up by regions. Analysis comparing population groups under age five indicated no significant differences from similar age groups in the overall population of Hawaii County or the State (Table 2). However, comparison of population groups aged 65 or over by region indicated that twice as many older individuals as could be expected (given the state average) reside in Region B. Region B is located in a seismically active zone. Further north (regions C and D), the population groups aged 5 or over 65 are similar to the state averages as a whole. Thus, outside of the problems associated with emergency alert and notification activities in rural communities (especially if many are elderly and/or impaired), the populations represented are similar to cohort groups in the county and the state as a whole.

Effective emergency planning can mitigate the consequences of accidental releases for the population living in the vicinity of a proposed power plant. When locating a power plant in a lightly populated area where egress routes are limited, coordinated planning strategies between state, local, and industry representatives are particularly important. Because the maps produced using the GIS methods discussed describe where populations are located in reference to defined geographical markers such as roads and waterways, the maps also indicate available routes—a useful tool for planners and decision-makers.

Using our generated data, some reasonable judgments can be made about the impacts of a proposed geothermal plant siting. Even when an impact assessment assumes the worst case scenario, emergency planning and preparedness upgrades could significantly mitigate the potential effects of an accidental release from a proposed geothermal plant. Mitigative measures that could be adopted to protect populations include:

- (a) notifying the affected public in an expedient manner,
- (b) reducing the public's response time following notification,

Figure 4 Location of Census Block Groups A, B, C, and D in Hawaii County, HI

- (c) reducing the time needed to make official decisions regarding implementation of specific measures, such as issuing orders to evacuate or sheltering in place, and
- (d) identifying those requiring special assistance before an event to enhance their exit in an emergency.

Such mitigative measures insure that all persons regardless of race, income, or infirmity are assured of notification when at risk.

Table 2 Block Group Age Statistics

	Total population of block group (1990 census)	Percent of population under age 5	Percent of population over age 65 of block
Region A	1669	176/1669 = 10.5%	181/1669 = 10.8%
Region B	668	62/668 = 9%	134/668 = 20%
Region C	1417	162/1417 = 11%	161/1417 = 11%
Region D	2948	296/2948 = 10%	266/2948 = 9%
Hawaii County	NA	8%	12.5%
State of Hawaii	1,108,000	Ave. 8%	Ave. 11.3%

Source: Adapted from 1990 Census files, Dept. of Commerce, Bureau of the Census.

4.0 CONCLUSIONS

The purpose of this document is to describe an approach to assessing environmental justice issues at the start of proposed project. It is a structural approach to screening using readily available census data and commercial products that emphasizes the ability to replicate results and provide systematic data that can be used to identify spatial inequities. While our discussion of the methodology addresses only public health and safety issues related to certain minority and cohort sub-groups, systematic use of methodology could provide a valuable screening tool for identifying impacts particular to low-income groups. While the assumptions can be questioned as to applicability, they are based both on theory and practical knowledge.

The methodology can be applied at different spatial resolution depending on the nature of the impacts. For assessing populations at risk we used block level data. For identifying minority neighborhoods and assessing their proximity to the risk source we used block-group data similar to that used for identifying vulnerable age groups. Comparative data was generated at the county, multi-county and state levels. For interventions with a community wide impact, data at the place name or census tract levels may be more appropriate.

The methodology is not without some inherent bias, given the criticisms directed toward some of the census collection methods. However, if an impact affecting a minority groups is indicated through such screening methodology, analysts have a number of other strategies to further define (or reject) the probability. Such strategies could include conducting a special census of the area of impact, conducting surveys with a sample of the people impacted, or using focus group discussions to examine potential impacts. Determining where the populations are located also suggests that public meetings can be targeted in areas readily accessible to those groups.

What is often overlooked in the analysis of NEPA documents is that many of the predicted effects could be reduced by adopting policies early on that are designed to mitigate against the adverse impacts, both physical and social. The screening methodology proposed could be an important factor in eliminating the need for useless assessments as well as determining and/or initiating mitigation measures before projects are well developed, eliminating both economic and social costs while insuring that impacts are not being distributed unequally to low-income and/or minority groups.

Although NEPA provides the major legal framework for assessment of federal actions, changes in risks, knowledge, and society have contributed to the increasing conflict about technology in recent decades (NRC, 1989; Raymond et al. 1991). As the National Research Council (1989) points out, the hazards confronting populations have gained the attention of a wider range of political actors and that the attendant choices have a huge potential affect on the distribution of wealth, health and even political power in society. As traditional political issues such as public health, social equity, and due process become more prominent in technological decision-making, decisions once treated as essentially economic and economic come to be viewed as essentially political (Dietz and Rycroft, 1987).

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