ABSTRACT

This study follows existing methods of vulnerability assessment for coastal area studies, but attempts to apply them to an inland study area: the Spring Creek watershed of Centre County, Pennsylvania. The study uses a geographic information system to identify and assess the area’s vulnerability to natural and technological hazards, and to determine social vulnerability to these hazards. Results show that vulnerability to natural hazards varies minimally within the study area, with the exception of floods and wildfires. Vulnerability to technological hazards, however, varies spatially based on exposure to these hazards. Analysis of the impact of socio-economic status on vulnerability shows that as this status varies across the study area, vulnerability to technological hazards changes. Conclusions promote the importance of using geographic information systems to examine and mitigate vulnerability in local and regional land use and planning.

Key Words: Vulnerability assessment, climate change, environmental hazards, natural hazards, technological hazards, Geographic Information Systems (GIS)
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Chapter 1: Introduction

People experience and are aware of environmental variations in their everyday lives, from air quality fluctuations to temperature extremes and storms. Most people also experience environmental changes over the course of their lifetimes, although they might not be as aware of those changes. This thesis examines the impact of environmental change in terms of vulnerability to natural and technological hazards. Current research methods for identifying and mapping natural and technological hazards in coastal areas reveal variations in vulnerability in relation to coastal zones. This research addresses the following questions: How does vulnerability vary across inland areas, as opposed to coastal zones? What natural and technological hazards might increase vulnerability in an inland area? And how might human actions and land uses become implicated in determining vulnerability?

Located in central Pennsylvania, Spring Creek is a tributary of the Susquehanna River. The Spring Creek watershed is the home of Pennsylvania State University’s main campus at University Park, adjacent to State College. Bellefonte, the Centre County seat, is also located in the watershed. Although the Spring Creek watershed is only one of five major watersheds in Centre County, most of Centre County’s population either lives or works in this area. The vulnerability assessment of the Spring Creek watershed identifies major natural
hazards affecting the area’s population, and presents illustrations of the spatial variability of these natural hazards by means of a Geographic Information System (GIS). In addition, technological hazards are explored as representations of direct human-environment relations. Socioeconomic data is included to describe and explain the spatial variability of natural and technological hazards. This socioeconomic data illustrates local differences between people and land uses within different parts of the watershed.

This thesis starts with a review of literature dealing with vulnerability assessments and risk studies. An important part of this review is the exploration of prevalent perspectives in the social justice and climate change literature. A summary of methodologies used in the thesis also explains the reasoning behind conducting this vulnerability assessment in terms of natural hazards, technological hazards, and socioeconomic data. Results indicate that although vulnerability to natural hazards varies minimally within the watershed, the spatial variability of vulnerability to technological hazards varies significantly. Proximity to chemical sites and land uses at and around those sites affects human-environment relations in the watershed. A discussion of several key chemical sites and a description of land uses, socioeconomic data, and a brief history of the area provide additional understanding of the area. Finally, concluding remarks suggest the relevance and importance of such research.
Chapter 2: A Synthesis of Current Human-Environment Research

In human-environment research, the term vulnerability is loosely defined as the potential for loss, but many variations of this definition exist. Nevertheless, most current research follows one of two dominant approaches. The first focuses on vulnerability as the potential of exposure to an environmental hazard, while the second explores patterns of exposure and the associated losses related to exposure levels. Environmental hazards are defined as the combination of natural hazards and technological hazards (Smith 1992). A third approach (Cutter 2000) combines biophysical risk with social implications to determine the vulnerability of places.

In this study, vulnerability of the Spring Creek watershed is examined based on environmental hazards and the socioeconomic implications of these hazards. The following synthesis of human-environment research concerning vulnerability offers theoretical perspectives on vulnerability, ranging from quantitative technological and bureaucratic approaches to qualitative social response approaches. In addition to these two theoretical approaches, several interdisciplinary approaches, including a full-cost accounting approach, are presented. Finally, several models for conducting vulnerability assessments offer the advantages and disadvantages of both quantitative and qualitative approaches.
Theories

1. The Technocratic Approach

The United Nations (UN) declared the decade from 1990-2000 the “International Decade for Natural Disaster Reduction” (IDNDR). Based on theories that technology and quantitative methods can reduce potential loss, especially in poor regions, this effort disregarded qualitative theories and methods. The UN mission concerned “the international transfer of knowledge, disaster education, and providing guidelines/recommendations to decision makers,” thus presenting human-environment researchers and the UN as knowledge-rich bodies (Verstappen, 1998). This creation of a technology and a knowledge-rich group of researchers, geoscientists, engineers, and civil defense planners unfortunately innately discriminates against historical cultural practices and local societal solutions in the study areas.

Many risk and vulnerability assessment researchers and climate change researchers have criticized the role of the United Nations in its mission to improve vulnerability research in other countries, specifically in the Third World. For example, Mitchell (1988) openly criticized the IDNDR, writing that new research, as proposed by the Decade, is not easily justified when much current knowledge and research remain unutilized. Mitchell argues that the Decade failed to acknowledge that researchers cannot alter societal processes in the space of a decade, and that the technological transfer of knowledge and expertise—as proposed
by the UN-sponsored Decade—disregarded expenses, sophisticated monitoring abilities, and management expertise of the study areas. Mitchell suggests that the Decade did not allocate adequate attention to non-structural, low-level technology, or alternative approaches to hazard reduction. Additional research into the efficacy of cooperative scientific endeavors is recommended before the UN proposes large, cooperative projects. In support of Mitchell’s ideas, Alexander (1991, p. 212) offers what he calls an extreme, but perhaps accurate, interpretation that “the Decade represents an attempt by engineers and physical and natural scientists to concentrate academic power and funding opportunities into their own hands in the name of applying their sciences.”

2. The Socially Responsible Approach

a. Human Ecology

Similarly, many climate change researchers conducting vulnerability research criticize the Decade’s technological approach. These researchers champion a socially responsible approach, seeking greater appreciation for social responsibility in the use and development of quantitative tools (Bohle, et al. 1994). Accompanying his criticism that “the IDNDR has assumed the status of a ‘techno fix,’ in which the proponents of technology and hard science use it as a justification for generating yet more of the same,” Alexander (1991) proposes the field of human ecology as an ecocentric, rather than traditionally
technocentric approach. He argues that economic power, which fuels technocentrism, “is related to the seriousness of disaster impacts in a non-linear way that is tempered by political factors and the tendency to accumulate physical capital and thus increase vulnerability” (Alexander, 1991, p.221). In human ecology, various degrees of adaptation may triumph over economic power and physical capital. For example, Alexander views hazard zone occupation along a continuum ranging from persistent occupation to migration to safer zones. Viewing humanity’s adjustment to natural hazards increases awareness of the constant dynamic between humans and our environment, combining research in the social sciences with that in the physical and natural sciences.

Bohle et al. (1994) explore famine related to vulnerability and the co-evolution of vulnerability and climate change, arguing that human ecology, expanded entitlements, and political economy define vulnerability. They present a causal structure of vulnerability, with three nodes of exposure, capacity, and potentiality. “A theory of vulnerability should be capable of mapping the historically and socially specific realms of choice and constraint—the degrees of freedom as it were—which determine risk exposure, coping ability, and recovery potential,” (Bohle et al., p.39). As opposed to Alexander’s more traditional definition of human ecology as the application of ecological concepts to the study of society, the authors apply human ecology to “the ways in
which the transformation of nature by human labor is rooted in the specific eco systemic properties (climatic, pedological, ecological) of the environments of which society is a part” (Bohle et al., pp.40).

Therefore, within the human ecology theory of the socially responsible approach to risk and vulnerability assessments, researchers disagree about human ecology is defined and applied.

b. Interdisciplinary

Not all researchers within the socially responsible approach to risk and vulnerability assessment research suggest applying human ecology theories to their studies, but most—even proponents of human ecology theories—agree that risk and vulnerability assessment research should embrace a multidisciplinary approach (Alexander 1991). Even the inclusion of risk assessments with vulnerability assessments is a recent interdisciplinary approach that some researchers criticize. For example, social scientists at the First Open Meeting of the Human Dimensions of Global Environmental Change Community at Duke University in 1995 questioned the integration of vulnerability analysis with other forms of assessment in an attempt to clearly define the research field (Dow and Downing 1995). In addition to highlighting questions of language consistency and scale of analysis, an emphasis on recent advancements in vulnerability research bring additional disciplines to the field.
Climate change researchers working in impact assessment are combining their efforts with social scientists “to explore the utility of integrating socio-economic and climate scenarios as a means of understanding future societal responses to the unfolding impacts of climate change”. (Lorenzoni et al., 2000, p. 145) This integration utilizes a link between emissions scenarios to scenarios of future socio-economic change, and it combines local habitants’ reactions to exposure with large-scale climate model outputs. Through a series of interviews, the authors address which climate and non-climate factors influence local behavior.

“Assessing the vulnerability of social, economic, political, and/or ecological systems to climate change and climate variability in ways that systematically incorporate their ability to adapt” represents a combination of climate change and vulnerability research (Yohe et al. 1999, 233). Disagreements abound within the proceedings of the Intergovernmental Panel on Climate Change at the Workshop on Adaptation to Climate Variability and Change. Still, Yohe et al. compare two theoretically different approaches within climate change and vulnerability. The first approach deals with conducting detailed analyses of vulnerability to uncertain climate change and variability in specific systems, while the second approach identifies the most vulnerable systems across the globe. Here, the authors argue from their role as climate change researchers, and their preference for identifying
the most vulnerable climate systems before conducting vulnerability assessments takes precedence.

Stephens and Downing (2001) present three interdisciplinary approaches to quantitative vulnerability tools (i.e., three essentially mathematical models) characteristically used throughout the Third World). Here, a vulnerability assessment is a two-step process of first identifying who is at risk, and then prioritizing needs. The three models include the Food and Agriculture Organization Global Information and Early Warning System, the Save the Children Fund Household Food Economy Approach in the RiskMap Program, and Classification and Regression Tree analysis. These models will be discussed later in relation to their importance as models for vulnerability assessments.

Finally, Kelly and Adger (2000) discuss approaches to vulnerability assessment related to climate change and climate variability by focusing on the socioeconomic well being of a society. Like Downing (1991) and others, these authors define vulnerability not in relation specifically to natural hazards, but in relation to any external stresses. In this sense, many vulnerability studies combine climate change with societal stresses to assess vulnerability (Downing, 1991). Kelly and Adger examine the ways that global warming alters people’s ability to cope with and adapt to environmental changes. Because their main concern is not the physical, biological, or chemical effects of climate change, they employ a vulnerability assessment that includes
social dimensions, exposure, and adaptation of people in the study
region.

c. Full-Cost Accounting

Morrow (1999) focuses her research on the United States instead of the developing world. By choosing to focus on developed nations, she “problematizes” the developed nations, illustrating “how risk is similarly concentrated in certain categories of individuals and households in developed nations” (p. 1). Morrow believes that disaster vulnerability is socially constructed, in that it is created from the social and economic circumstances of everyday life. She begins by examining economic and material resources, and continues through her argument with human or personal resources, such as education, family and social resources (i.e., what she calls “networks of reciprocity”) and with political resources of power and autonomy. With these nodes identified, the author exemplifies and explains her argument through the illustration of Hurricane Andrew. Morrow criticizes the disregard for local involvement and leadership in sustainable development programs. She argues that successful disaster-resistant communities work on the basis of agency and grassroots activism.

Morrow continues her argument through her work with the H. John Heinz III Center for Science, Economics, and the Environment (2000). Twenty-three authors from business, insurance, academia, and government came together through the H. John Heinz III Center to
combine risk and vulnerability assessment research with case studies from the United States and with full-cost accounting theories. The authors define hidden costs as those not directly reported in economic, or monetary, terms. They argue that the true impacts of disasters cannot be fully realized unless assessments include these indirect results, or hidden costs. To do so, the authors suggest defining new cost categories, determining the appropriate metrics, and establishing database protocols and monitoring systems to institutionalize the assessment process for future automation. This, the authors conclude, could result in more appropriate mitigation investments. While the book expands Morrow’s socio-economic argument for full-cost accounting, it also suggests a union of local maintenance with national supervision.

Bankoff (2001) criticizes both the technocratic approach to vulnerability research and the socially responsible approach. He argues that “inadequate attention has been directed at considering the historical roots of the discursive framework within which hazard is generally presented, and how that might reflect particular cultural values to do with the way in which certain regions or zones of the world are usually imagined”(p. 20). Bankoff cites Blaikie, et al. (1994), contending that people in poorer countries suffer disproportionately from repeated shocks and stresses, which natural hazards aggravate. Bankoff, however, accepts the study of vulnerability as a theoretical concept. His qualm is the way in which researchers who focus on developing nations
continually represent these areas as the most vulnerable and in need, without recognizing the potential for local contributions in mitigating efforts in these areas. Had Bankoff considered Morrow’s work in championing a full-cost accounting approach, he probably would have agreed. “Reducing vulnerability to a formulaic expression that explains the way in which human activities affect the physical environment and increase the impact of hazard, if not the frequency of disaster, is to ignore the important role that hazard has historically played in actually shaping human culture,” writes Bankoff (p. 30). Although he might agree with Morrow’s argument that disaster vulnerability is socially constructed, Bankoff takes this argument one step further to challenge the efficacy of quantitative methods.

**Models**

Research examining risk and vulnerability in developing countries employs quantitative models of the types of formulaic expression that Bankoff criticizes. For example, Blaikie et al. (1994) present a “disaster pressure and release model” as a tool to examine how disasters occur when natural hazards affect vulnerable populations. In this model, “a disaster is the intersection of two opposing forces: those processes generating vulnerability on one side, and physical exposure to a hazard on the other” (p. 25). This pressure and release model presents an essentially conceptual cause and effect framework for understanding
the relationship between hazards, disaster, and vulnerability, but a second model explores social vulnerability more directly. In the second model, called the “access model,” access to resources is examined with respect to individual households, groups of households, and a time series to understand how people’s vulnerable changes with respect to access to resources. Resources, according to Blaikie et al. (p. 46), refer to the “economic and political processes that allocate assets, income, and other resources, in a society.”

As noted earlier, Stephens and Downing (2001) evaluate three different mathematical models. They focus on early-warning systems, but argue that practical challenges and conceptual frameworks are equally important to understanding people’s vulnerability to natural and technological hazards. Politics of negotiation between institutions are highlighted as one of the major impediments to effective decision-making, choice of methods, and targeting. The authors conclude that all three methods—the Food and Agriculture Organization Global Information and Early Warning System, the Save the Children Fund Household Food Economy Approach in the RiskMap Program, and the Classification and Regression Tree Analysis—combine environmental processes with social vulnerability. None of the mathematical models proved successful in accurately targeting vulnerability, and the authors conclude that the quality of the outcome will always be dependent on the quality and accuracy of the data used.
Mathematical programs and quantitative models dominate methodology in assessing risk and vulnerability in the developing world, and Geographic Information Systems (GIS) dominate the methodology for assessing risk and vulnerability in the United States. Clark et al. (1988) explored vulnerability of a coastal community in Massachusetts to extreme storms using a GIS. The authors argue that “Climate change may affect the frequency, intensity, and geographic distribution of severe coastal storms” (p. 59) as an underlying reason for incorporating the use of a GIS to examine the spatial variability of baseline flooding and the coping abilities of people as a result. The authors support the causal model of many structural approaches, such as methods proposed by Blaikie et al., but they suggest points for local intervention for policy-makers, managers, and community organizers. In this sense, the method proposed by Clark et al. combines the local grassroots agency efforts that Morrow discusses with the causal, structural approach researchers concerned with developing countries generally employ.

Finally, social vulnerability is included in the GIS framework for assessing risk and vulnerability in the United States. Cutter et al. (2000) employ an essentially quantitative theoretical framework to explore social vulnerability in their article. Perhaps this approach is due to the lack of any comprehensive framework to assess social vulnerability and full-cost accounting in the context of biophysical vulnerability. Results of this study, however “suggest that the most biophysically vulnerable
places do not always spatially intersect with the most vulnerable populations” (Cutter, et al. pp. 731). The incorporation of social vulnerability in a GIS approach to assessing risk and vulnerability calls for further interdisciplinary work.

Conclusions

Most vulnerability studies focus on case studies of coastal areas to illustrate theories, concepts, and methods for conducting vulnerability assessments. For example, Cutter et al. study Georgetown County, South Carolina for their GIS analysis. Clark et al. study the coastal town of Revere, Massachusetts. The H. John Heinz III Center authors focus on Hurricane Hugo and its impacts along the coast of South Carolina, and Lorenzoni et al. study East Anglia in the United Kingdom. These researchers represent a growing trend in assessing risk and vulnerability in the United States and Europe; this marks a shift from focusing case studies on developing nations. The IDNDR’s multitude of case studies, Downing’s work concerning famine in Africa, and the work of Blaikie et al. remain centered around reducing vulnerability to stresses and hazards in developing nations.

Researchers in the fields of risk and vulnerability assessments have yet to agree on many theoretical issues concerning the inclusion of various disciplines and the role that climate change research can play in shaping ideas of biophysical and social vulnerability. Many researchers
argue for more accurate representations of human factors and how these factors relate to climate or biophysical phenomena. Some contend that methods should include all possible qualitative factors to create full-cost accountability in a vulnerability assessment. Others argue that quantitative methods are necessary to assess people’s vulnerability.

The only strong consensus among vulnerability researchers is the necessity of a case study approach to illustrate theories, concepts, and methods. Authors who do not employ case studies write about theory without empirically observing their theories in practice. Within the case study consensus, many researchers suggest the possibility or capability of applying similar methods to an inland study area, but this research has yet to surface in the literature. Therefore, a need for a case study of an inland area exists to demonstrate that current methodologies—or a combination of several different theoretical frameworks—work in non-coastal contexts.
Chapter 3: Methods

Methodologies for conducting vulnerability assessments vary greatly depending on the number of hazards under consideration and the scope and scale of the project. In conducting a vulnerability assessment of the Spring Creek watershed, several research methodologies were considered. Of the possible approaches, Cutter, et al. (2000) includes methodologies for incorporating social vulnerabilities based on demographics and other data into an otherwise biophysical analysis. Additionally, the National Oceanic and Atmospheric Administration Coastal Services Center’s Community Vulnerability Assessment Tool provides a framework for understanding coastal hazards, risks, and vulnerability research and mitigation (NOAA-CSC, 1999).

In this study, the Cutter et al. and NOAA CSC coastal methods will be applied to natural hazards, technological hazards, and socioeconomic data in an inland location, i.e. the Spring Creek watershed. Vulnerability in the watershed will be considered as a function of natural hazard impact, frequency, and magnitude. Socioeconomic data will be included to present demographic variability within the watershed. Technological, i.e., human-induced, hazards will be considered as a possible effect of hazardous substances located in the watershed. Different land uses will also be considered as they relate to biophysical and socioeconomic vulnerability.
Natural Hazards

Hazards affecting the Spring Creek watershed were identified using the National Climatic Data Center (2002) database. The following hazards were identified:

- Drought
- Flood
- Fog
- Hail
- Hurricane & Tropical Storm
- Lightning
- Tornado
- Wild/Forest Fire
- Precipitation
- Snow & Ice
- Temperature Extremes
- Thunderstorms & High Winds

Using a relative priority matrix for ranking the effects of natural hazards suggested in NOAA CSC (1999), each natural hazard’s frequency was added to its area of impact, and this result was multiplied by a magnitude of damages. A ranking scale of one to five (one being lowest) was used and total scores for each natural hazard in Centre County’s Spring Creek watershed was determined (Table 3.1). Based on this relative priority-ranking matrix, snow and ice storms receive the highest risk measurement in the watershed, followed closely by drought. Thunderstorms and high winds also occur frequently with great impact and magnitude of damages. Temperature extremes, floods, hail, tornadoes, and heavy rain occur less frequently, affect smaller areas, and present fewer damages.
Table 3.1: Relative priority-ranking matrix for natural hazards affecting the Spring Creek watershed in Centre County, Pennsylvania, based on a scale of one to five, with one being lowest. The sum of “Frequency” and “Area of Impact” is multiplied by “Magnitude of damages” to determine the “Total Risk” score (NOAA CSC 1999).

<table>
<thead>
<tr>
<th>Natural Hazard:</th>
<th>Frequency</th>
<th>Area of Impact</th>
<th>Magnitude of Damages</th>
<th>Total Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drought</td>
<td>2</td>
<td>5</td>
<td>5</td>
<td>35</td>
</tr>
<tr>
<td>Flood</td>
<td>3</td>
<td>4</td>
<td>1</td>
<td>7</td>
</tr>
<tr>
<td>Hail</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Tornado</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Heavy Rain</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Snow &amp; Ice</td>
<td>4</td>
<td>5</td>
<td>4</td>
<td>36</td>
</tr>
<tr>
<td>Temperature Extremes</td>
<td>1</td>
<td>5</td>
<td>2</td>
<td>12</td>
</tr>
<tr>
<td>Thunderstorms &amp; Winds</td>
<td>5</td>
<td>5</td>
<td>3</td>
<td>30</td>
</tr>
</tbody>
</table>
In coastal areas, vulnerability to natural and technological hazards varies with proximity to the coastline. For example, locations closer to the coast would experience higher winds and more precipitation during a hurricane than locations further from the coast. In inland areas, the probability of experiencing fog and high winds in an inland area depends more on topography. However, vulnerability to storms in an inland area still varies significantly, especially with respect to proximity to hazardous sites such as chemical storage facilities. Most storm hazard data for the Spring Creek watershed could not be presented spatially in a Geographic Information System (GIS) due to the even distribution of natural hazard potential across the small study area. Therefore, only the natural hazards with spatial variation across the watershed were included in the GIS. Floods and wildfires vary based on spatial variability of floodplains and forested areas in the Spring Creek watershed, so these natural hazards were included.

**Technological Hazards**

Technological hazards include chemical site locations and the relative impacts of chemicals used, stored, and produced at these sites. The chemical site data include three classes, according to three classifications of the Environmental Protection Agency. The Comprehensive Response, Compensation, and Liability Act (CERCLA) was enacted by Congress in 1980, and is commonly known as Superfund
(EPA, 2002). CERCLA classification includes sites where chemicals have been released and sites where there is a threatened release of hazardous substances. The Resource Conservation and Recovery Act (RCRA) classification includes treatment, storage, and disposal sites. According to the EPA, RCRA “protects us from the hazards of waste disposal, conserves energy and natural resources by recycling and recovery, reduces or eliminates waste, and cleans up waste which may have spilled, leaked, or been improperly disposed of.” (EPA, 2002)

Finally, the Toxics Release Inventory (TRI) classification includes waste management activity sites and other facilities that store, manufacture, or use toxic chemicals (EPA, 2002). These site classification types distinguish between uses and treatments of chemicals; any one particular site cannot be registered as more than one classification type (CERCLA, TRI, or RCRA). However, one site location can have multiple registrations for one classification type.

These data sets were manipulated using an ArcView 3.2 GIS buffering function to create one-half mile buffered areas around each chemical site, and then to identify areas of higher vulnerability where two or more buffered sites overlapped (Bolin et al., in press). A one-half mile buffer was applied as a standard area for chemical releases (Cutter et al, 2000). Each hazard event and each buffered chemical site across the study area received an equal weight of one, creating a simple index of summations. The numbers of environmental hazard areas covering
the watershed study area were summed. For any point within the study area, biophysical and technological vulnerability change depended on whether or not that point falls within a buffered area. Additionally, if that point falls within an area where several buffered chemical sites overlap, potential vulnerability increases.

**Socioeconomic Data**

In addition to including storm event hazard data and chemical site data, several socioeconomic datasets were included to present demographic variability. The United States Census Bureau’s block group demographic classification was chosen to represent the study area population (American FactFinder, 2002). A block group is a subdivision of a Census tract and consists of all the blocks within a Census tract beginning with the same number. Although blocks are the smallest geographic unit containing 100 percent of the data, block groups are the smallest geographic unit containing sampled data. Therefore, block groups were chosen based on their sampled data attributes. Block group data for demographics were scaled based on the total number of people in each category. This number was normalized to the total population in each block group, and this scaling produced a percentage of people per the total population of each block group. This scaling and normalizing method was adapted from Cutter’s methods (Cutter, 2000) for incorporating socioeconomic data in vulnerability assessments.
Areal interpolation is the integration of spatial data from one classification system to another (Sadahiro, 1999). Integrating spatial data from a political boundary to a natural boundary would involve areal interpolation methods. In this study, the watershed boundary area and the census block group boundaries required this integration of spatial data from arbitrary political boundaries to the naturally occurring watershed boundary. These two types of data—natural and political—often do not match. Some areal interpolation methods suggest randomly selecting a point from within each political boundary to determine whether or not this polygon should be included in the natural boundary. This method might provide a quick solution for larger datasets including over 100 intersecting polygons around a boundary, but it was not a viable solution for the Spring Creek watershed study area. The Spring Creek watershed intersects only 15 block groups around its boundary, so a random selection of points would have been statistically inadequate.

An alternative solution to areal interpolation methods was used to estimate the percentage of people in each block group within the watershed. Many block group boundaries fell partially within the watershed boundary, and their representative demographics were also included (Figure 3.1). Voss and Long (1999) derive a method based on road lengths, suggesting that road length within an area provides an estimate of the population within that area.
Figure 3.1: Block groups and their boundaries, in gray, and the Spring Creek watershed basin boundary, in black
Population percentages of each bordering block group were determined based on its total road length within the watershed. This method provided an estimate of demographic characteristics for the block groups located partially within the watershed.

Summary

A methodology focused on biophysical hazards, technological hazards, and socioeconomic data was applied to the Spring Creek watershed study area. This method attempts to illustrate the human-environment relations occurring in the study area. Although many natural hazards in the study area’s environment affect its population, many of these natural hazards occur with equal likelihood across the watershed. Only wildfires and floods varied spatially. Technological hazards vary more significantly and affect the population based on proximity to these sites. Socioeconomic data were included to illustrate differences within the population across the study area. A reference table of datasets used in this thesis (Table 3.2) outlines specific datasets with corresponding dates, sources, and brief descriptions. The following chapter illustrates the study area’s vulnerability to natural and technological hazards.
<table>
<thead>
<tr>
<th>Variable</th>
<th>Date</th>
<th>Source</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Airports</td>
<td>2001</td>
<td>PA Bureau of Health, Department of Health Statistics</td>
<td>Shows positions of aircraft landing facilities licensed by the PA Department of Transportation</td>
</tr>
<tr>
<td>Basin</td>
<td>1996</td>
<td>Environmental Resources Research Institute, Penn State</td>
<td>Basin area of the Spring Creek watershed, including sub basins for all tributaries within the watershed</td>
</tr>
<tr>
<td>Block Groups</td>
<td>1995</td>
<td>US Bureau of the Census TIGER through Arc Data Online</td>
<td>US Bureau of Census, block group level for demographics</td>
</tr>
<tr>
<td>CERCLA</td>
<td>1994</td>
<td>US Environmental Protection Agency, Keith Andres</td>
<td>Superfund data in support of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)</td>
</tr>
<tr>
<td>Floodplains</td>
<td>1999</td>
<td>Office of Remote Sensing for Earth Resources, Penn State, PA Department of Environmental Protection</td>
<td>100-Year floodplains</td>
</tr>
<tr>
<td>Forests</td>
<td>1999</td>
<td>PA Spatial Data Access</td>
<td>Forested areas for Centre County</td>
</tr>
<tr>
<td>Heliport</td>
<td>2001</td>
<td>PA Department of Health, Bureau of Health Statistics</td>
<td>Shows helicopter landing site licensed by the PA Department of Transportation</td>
</tr>
<tr>
<td>Hospitals</td>
<td>2001</td>
<td>PA Department of Health</td>
<td>Shows licensed hospitals</td>
</tr>
<tr>
<td>Land Use</td>
<td>1999</td>
<td>PA Spatial Data Access</td>
<td>Land use classifications for Centre County</td>
</tr>
<tr>
<td>Local Roads</td>
<td>2001</td>
<td>PA Department of Transportation, Bureau of Planning and Research, Geographic Information Division</td>
<td>Shows local roadways in Centre County</td>
</tr>
<tr>
<td>RCRA</td>
<td>1994</td>
<td>US Environmental Protection Agency</td>
<td>Resource Conservation and Recovery Act sites including treatment, storage, and disposal sites (TSDs)</td>
</tr>
<tr>
<td>State Roads</td>
<td>2001</td>
<td>PA Department of Transportation, Bureau of Planning and Research</td>
<td>Shows roads within Centre County under jurisdiction of the Commonwealth of Pennsylvania</td>
</tr>
<tr>
<td>Streams</td>
<td>1998</td>
<td>Environmental Resources Research Institute, Penn State</td>
<td>Networked streams of Centre County</td>
</tr>
<tr>
<td>TRI</td>
<td>1994</td>
<td>US Environmental Protection Agency</td>
<td>Toxics Release Inventory sites</td>
</tr>
</tbody>
</table>

Table 3.2: A summary of datasets used, the dates they were prepared, their sources, and brief descriptions.
Chapter 4: Results

In this chapter, natural and technological hazards affecting the Spring Creek watershed are mapped to illustrate spatial variations in vulnerability. For example, hazardous chemical sites located on floodplains would be vulnerable to flooding. Land uses are included to present human activity and proximities of these varying land uses to hazardous chemical sites.

Natural hazards risks are first presented to illustrate spatial variation across the watershed. Locations of CERCLA, RCRA, and TRI sites are mapped to illustrate risks of technological hazards. Finally, land use is included to display human activity relative to these two types of risks.

Biophysical Vulnerability

Spring Creek’s flooding potential for a 100-year flood is illustrated in Figure 4.1. From 1993 to 1999, Centre County experienced twelve floods, none of which were 100-year flood events. In the event of a 100-year flood, portions of Bellefonte and Lemont would be affected.

In addition to flooding, wildfire vulnerability also varies spatially across the watershed. Forest coverage is considered to be the equivalent of areas at risk for wildfires (Figure 4.2). Most forest coverage within the watershed basin is concentrated along the major ridges and
Figure 4.1: 100-year floodplains of the Spring Creek watershed, (Office of Remote Sensing for Earth Resources, Penn State and Pennsylvania Department of Environmental Protection, 1999), (Environmental Resources Research Institute, Penn State, 1996), (Pennsylvania Department of Transportation, Bureau of Planning and Research, Geographic Information Division, 2001).
Figure 4.2: Wildfire risk areas (green), Spring Creek watershed. (Environmental Resources Research Institute, Penn State, 1996), (Pennsylvania Spatial Data Access, 1999)
mountains. Bald Eagle Ridge to the north, Nittany Mountain in the center and towards the east, and Tussey Mountain across the south comprise the major forest areas of the watershed. In addition, significant parts of the watershed are classified as urban land use areas but are heavily forested. One example is the appropriately named Park Forest residential development.

Severe weather events without spatial variability within the watershed include droughts, hail, lightning, tornadoes, precipitation, snow and ice, temperature extremes, and thunderstorms with high winds. In other words, there is equal probability of experiencing one of these hazards at any point in the watershed. Points with these hazards but also within floodplain and forested areas possess increased vulnerability.

**Socioeconomic Vulnerability**

Natural hazards, such as droughts, floods, hail, lightning and tornadoes, affect the population of the Spring Creek watershed, but hazards with spatial variability affect only certain portions of the population. In addition to the variability of the natural hazards floods and wildfires, technological hazards vary spatially as well. Here, chemical releases are considered for their spatial variability relative to reported chemicals at industrial, commercial, or research sites. The natures of possible chemical hazards are discussed before their distributions are displayed.
According to the United States Environmental Protection Agency, “the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), commonly known as Superfund, was enacted by Congress in 1980. This law created a tax on the chemical and petroleum industries and provided broad Federal authority to respond directly to releases or threatened releases of hazardous substances that may endanger public health or the environment” (EPA, 2002).

CERCLA sites are defined by the Environmental Protection Agency based on priority for cleanup: the information system (CERCLIS), the National Priorities List (NPL), Archived sites on the NPL, and “brownfields” sites. Although most of the CERCLA sites in the watershed are located currently in the EPA’s Archived sites of the National Priorities List, two sites—the Kepone site and the Bellefonte Landfill—remain scheduled for cleanup.

The Resource Conservation and Recovery Act (RCRA) “protects human health and the environment from the potential hazards of waste disposal, conserves energy and natural resources, reduces the amount of waste generated, and ensures that wastes are managed in an environmentally sound manner,” according to the United States Environmental Protection Agency (EPA, 2002). Toxic Release Inventory (TRI) sites include waste management activities and other facilities that store, manufacture, or use toxic chemicals (EPA, 2002).
Some researchers suggest buffering roads and railroads to include vulnerable areas to runoff and accidents involving spills or fires, but a 0.5-mile buffer of all railroads and state roads in the watershed would have left very few areas in the watershed untouched. Therefore, roads are included in most illustrations to suggest additional areas of concern. Local roads also present a rough estimate of population densities within the watershed.

The extent of CERCLA, RCRA, and TRI sites within the watershed is illustrated in Figures 4.3-4.5. One-half mile buffer areas around each chemical site illustrate the immediate areas potentially affected by a spill, fire, or other event. A buffer is a GIS technical term used to describe the creation of an area from a point. In this case, a one-half mile radius buffer area was used. Although each chemical reported by each of these sites has a different containment and evacuation area, (ATSDR, 2002) one-half mile radii were used as a standard to avoid overestimating effects of a chemical release. Buffered CERCLA sites (Figure 4.3) are more numerous and closer in proximity to one another than RCRA and TRI sites. TRI sites within the watershed represent two overlaps (Figure 4.4), shown in medium gray.

The three RCRA sites within the watershed are depicted with buffered areas (Figure 4.5), and although none of the three sites overlaps another, they do overlap with TRI or CERCLA sites. Thus, the spatial
Figure 4.3: Buffered CERCLA sites, with one site (light gray), two site overlaps (medium gray) and three or more site overlapping areas (black) in the Spring Creek watershed (Environmental Resources Research Institute, Penn State, 1996) (United States Environmental Protection Agency, 1994)
Figure 4.4: Buffered TRI sites (in medium gray) with two overlapping buffered areas (in dark gray) in the Spring Creek watershed.  
(Environmental Resources Research Institute, Penn State, 1996) (United States Environmental Protection Agency, 1994)
Figure 4.5: Buffered RCRA sites (in medium gray) without any overlapping buffered areas in the Spring Creek watershed. (Environmental Resources Research Institute, Penn State, 1996) (United States Environmental Protection Agency, 1994)
organization of the CERCLA, RCRA, and TRI sites within the watershed area illustrates these overlapping areas (Figure 4.6).

A means for interpreting both biophysical and socioeconomic vulnerabilities within the watershed area is suggested (Figure 4.7). Forest areas, as illustrated in Figure 4.2, are also included here, along with agricultural areas, commercial, industrial, mined lands, residential areas, and recreational areas. Although many small residential, commercial, and industrial areas are difficult to resolve, the spatial proximity of industrial sites to commercial and residential areas suggests increased vulnerability to technological hazards. In addition, many CERCLA sites included in Figures 4.4 and 4.5 are located on vacant or unused land, indicating perhaps that a cleanup was performed or the site was abandoned.
Figure 4.6: Buffered CERCLA sites (in red), TRI sites (in yellow), and RCRA sites (in blue) with overlapping areas (in green, orange, and purple) in the Spring Creek watershed. (Environmental Resources Research Institute, Penn State, 1996) (United States Environmental Protection Agency, 1994)
Figure 4.7: Buffered CERCLA, TRI, and RCRA sites (in white outlines) with land uses in the Spring Creek watershed. (Environmental Resources Research Institute, Penn State, 1996) (United States Environmental Protection Agency, 1994)
Summary

This chapter demonstrates that although biophysical risks exist within the watershed, vulnerability across the area for most natural hazards remains constant. However, vulnerability to technological hazards varies significantly, and certain chemical sites present greater potential risks than others. The combined interaction of many of these chemical sites, including their proximity to one another and to densely populated areas, exacerbate vulnerability to these hazards.
Chapter Five: Discussion

As illustrated in the previous chapter, land uses provide a means for interpreting biophysical and socioeconomic vulnerabilities. In the following chapter, several chemical sites will be examined, and socioeconomic data will be presented in relation to these chemical sites. Although the chemical sites by themselves represent technological hazards, socioeconomic data combined with these technological hazards present the socioeconomic vulnerability of the watershed.

An Examination of Several Chemical Sites

Some areas within the watershed are more vulnerable to technological hazards due to their proximity to chemical sites. The locations of CERCLA, RCRA, and TRI sites provide information about what land use classifications correspond to different chemical sites (Figure 5.1). Transparent white circles represent the one-half mile radii around each site, and land use classifications appear within each circle. The dense grouping of overlapping white circles in the map’s center represents an industrial and commercial area located along Route 26, east of State College. In this area, many sites represent archived CERCLA sites. Although neatly mown grass patches appear harmless in this industrial landscape, the EPA lists many of these grassy areas as chemical sites not yet warranting the cleaner “brownfields” classification. Many of these sites
Figure 5.1: Buffered CERCLA, TRI, and RCRA sites (outlined in white) with land uses in the Spring Creek watershed. (Environmental Resources Research Institute, Penn State, 1996) (United States Environmental Protection Agency, 1994) (Pennsylvania Spatial Data Access, 1999)
appear in gray in Figure 5.1, indicating “Vacant or Unused Land” or “Vacant structure”.

In addition to being located on vacant or unused land, many chemical sites in the watershed are located on active mined land or industrial sites. For example, the large blue area south of the map’s center represents an active limestone quarry. Recent highway construction of Interstate 99 in the watershed has increased demand for crushed stone from this quarry. Plans to expand the quarry have resulted in a public debate and hearing concerning environmental impacts (CDT, 2002). The EPA classifies this quarry as a CERCLA site; although it remains an active quarry, the EPA has not yet approved any cleanup that may have occurred.

One chemical site affects residents of State College borough directly: the Applied Research Laboratory (ARL) located on the campus of the Pennsylvania State University. Classified as a CERCLA site, the one-half mile radius around the ARL includes public and semi-public land, recreation facilities, residential areas, and commercial areas. The United States Navy established the ARL at Penn State in 1945 and remains the Laboratory’s major sponsor. Central to naval research is the Garfield Thomas Water Tunnel. Built in 1949, the tunnel has served as a naval research site for torpedoes (ARL, 2002).
Demographic Implications

Socioeconomic vulnerability in the study area varies greatly because of proximity to classified chemical sites. Several socioeconomic factors were chosen based on the US Census Bureau’s socioeconomic data for block groups. Block groups have approximately equal populations, hence the widely varying sizes. Income levels, family types, language proficiency, education levels, and uses of public utilities and services were identified as relevant socioeconomic factors in creating either less risk or more risk in relation to the environmental hazards within or adjacent to the block groups. Locations of chemical sites were included to highlight possible trends in socioeconomic vulnerability.

Median income levels illustrate the spatial distribution of family wealth within the watershed (Figure 5.2). Studying family wealth in relation to risk explores trends associated with poverty and proximity of lower income areas to chemical sites. Block groups in State College, located in the lower left portion of the map, and Bellefonte, located in the upper east portion, represent lowest median income levels. Note that university students are the primary residents of these low-income units in State College. CERCLA sites, identified as squares (Figure 5.2), affect all levels of income across the watershed area: the ARL in State College affects the lowest two tiers of income levels (i.e. students), six sites affect the middle income level range of $22,001-$33,000, five sites
Figure 5.2: Median incomes by block group using equal interval classification (white areas represent $0-$11,000 while black areas represent $44,001-$55,000) in the Spring Creek watershed. CERCLA sites (red squares), TRI sites (yellow triangles) and RCRA sites (blue circles) are included to present relative proximities of median income levels. (Environmental Resources Research Institute, Penn State, 1996) (United States Environmental Protection Agency, 1994) (United States Bureau of the Census TIGER through Arc Data Online, 1990 census, 1995)
affect the $33,001-$44,000 income level range, and only one site affects the highest income level range. If these data represented income levels at places of work instead of residences, the block groups in State College and at Penn State University’s main campus would probably fall into the highest income level instead of the lowest.

Single people with children might require additional assistance in the case of a technological or natural disaster. The numbers of single-parent households per block group within the watershed area is illustrated in Figure 5.3. The highest numbers of single-parent households are located in two block groups north and south of State College. In State College, these are areas with high concentrations of apartment buildings. Nevertheless, the distribution of chemical sites throughout the watershed area does not present a clear trend associating this family type with proximity to chemical sites.

Language proficiency could impede socioeconomic vulnerability as well. The inability to speak English in the study area could lead to misunderstanding or complications in the case of a technological or natural disaster. Penn State University attracts many students, researchers, faculty members, and their families from foreign countries. Although English remains the dominant language throughout the watershed, some residents speak English as their second language. A spatial distribution of people unable to speak English within the watershed is illustrated in Figure 5.4.
Figure 5.3: Single-parent households by block group using equal interval classification (lightest areas represent 0-17 people while darkest areas represent 69-85 people) in the Spring Creek watershed. CERCLA sites (red squares), TRI sites (yellow triangles) and RCRA sites (blue circles) are included to present relative proximities of median income levels. (Environmental Resources Research Institute, Penn State, 1996) (United States Environmental Protection Agency, 1994) (United States Bureau of the Census TIGER through Arc Data Online, 1990 census, 1995)
Figure 5.4: Inability to speak English by block group using equal interval classification (lightest areas represent 0-26 people while darkest areas represent 106-132 people) in the Spring Creek watershed. CERCLA sites (red squares), TRI sites (yellow triangles) and RCRA sites (blue circles) are included to present relative proximities of median income levels. (Environmental Resources Research Institute, Penn State, 1996) (United States Environmental Protection Agency, 1994) (United States Bureau of the Census TIGER through Arc Data Online, 1990 census, 1995)
The large block group between State College and Bellefonte represents the Rockview State Penitentiary, which accounts for relatively low frequencies of English speakers. Several block groups in and around State College represent the highest numbers of people unable to speak English. For example, in one block group south of State College along Route 322, as many as 132 people were unable to speak English in 1990. This trend of inability to speak English in the block groups surrounding State College could represent the growing numbers of foreign students and faculty members at the Pennsylvania State University and the university’s efforts to expand and promote research.

Education levels could also impede a person’s ability to understand natural and technological hazards and react appropriately in the event of disaster. Education levels based on high school graduation numbers in the watershed are illustrated (Figure 5.5). The one block group in black represents the highest number of people with high school graduation as their highest level of educational attainment. This is the Rockview State Penitentiary, which is located in this block group and where many people have not attained education beyond high school. The one CERCLA site in this block group corresponds with the prison location. Conversely, block groups in and around State College and the Pennsylvania State University show much lower numbers, representing education levels above high school.
Figure 5.5: High school graduation as highest level of education by block group using equal interval classification (lightest areas represent 0-216 people while darkest areas represent 865-1080 people) in the Spring Creek watershed. CERCLA sites (red squares), TRI sites (yellow triangles) and RCRA sites (blue circles) are included to present relative proximities of median income levels. (Environmental Resources Research Institute, Penn State, 1996) (United States Environmental Protection Agency, 1994) (United States Bureau of the Census TIGER through Arc Data Online, 1990 census, 1995)
Mapping household use of public water utilities indicates levels of reliance on city and township water facilities. Households with wells might respond differently to a flood or chemical spill in the water than those relying on public systems. Block groups represented in white or light gray rely heavily on public water facilities, but block groups in darker gray or black rely on personal water supplies, such as wells, more heavily (Figure 5.6). As a result, block groups that rely heavily on public water facilities are generally located closer to State College and Bellefonte, and block groups representing households using wells or other private sources are located farthest from State College and Bellefonte, in the extreme north central and south central areas of the watershed. The two block groups with the highest numbers of people relying on private water sources are the block groups furthest from State College and Bellefonte. These rural populations would be directly affected by a chemical release into the local groundwater. Three CERCLA sites are located in the northern block group, which is bounded by the Spring Creek along its southern border.
Figure 5.6: Households with private water (i.e., wells instead of public water) by block group using equal interval classification (lightest areas represent 0-93 people while darkest areas represent 375-468 people) in the Spring Creek watershed. CERCLA sites (red squares), TRI sites (yellow triangles) and RCRA sites (blue circles) are included to present relative proximities of median income levels. (Environmental Resources Research Institute, Penn State, 1996) (United States Environmental Protection Agency, 1994) (United States Bureau of the Census TIGER through Arc Data Online, 1990 census, 1995)
Summary

Most socioeconomic factors illustrated here do not present significant relationships between socioeconomic status and risk areas. In the Spring Creek watershed, populations with the lowest median incomes are not more or less vulnerable than populations with higher median incomes. Most chemical sites are located in block groups with high and low median incomes. Similarly, chemical sites are not located in block groups with particularly high or low numbers of single-parent households. There is no relationship between a person’s ability to speak English and their proximity to chemical sites. The lack of relationships between these socioeconomic factors and people’s household proximity to chemical sites emphasizes a more equal, potentially non-biased, distribution of possible technological hazards across the Spring Creek watershed.
Chapter 6: Conclusions

Vulnerability to environment change has been analyzed in the local context of one watershed in central Pennsylvania. The thesis sought to answer the following questions: How does vulnerability vary across inland areas, as opposed to coastal areas? What environmental hazards (i.e., either natural or technological hazards) might increase vulnerability in an inland area? And how might human actions and land uses become implicated in determining vulnerability? To answer these questions, the thesis addressed the frequency, magnitude, and impacts of natural hazards—such as severe storms, temperature extremes, drought, wildfires, and floods—in the Spring Creek watershed. Locations of hazardous chemical sites were also mapped to illustrate spatial variations of risk to technological hazards.

The thesis also tried to demonstrate vulnerabilities to technological hazards such as proliferation of chemical sites, their proximity to one another, and their location relative to everyday human-environment relations. The results showed that although many natural hazards affect the people of the Spring Creek watershed, most of these natural hazards affect the population equally; little spatial variability to biophysical vulnerability exists in the study area. Vulnerability to technological hazards is more uneven. The locations of chemical sites relative to land uses, proximity to homes and businesses, and proximity to one another varies significantly across the watershed. The
socioeconomic analysis that accompanied the assessment of vulnerabilities to technological hazards demonstrated that although locations of hazardous chemical sites vary in land uses across the watershed, there is no underlying significance between the locations of these sites and land use or socioeconomic characteristics.

Local and national action can be taken to prevent excessive damage resulting from environmental hazards and their detrimental effects on people and the environment, but this mitigation is fraught with scientific debate and remains a difficult task. The ways in which people react and respond to environmental hazards vary, as do the ancillary effects of environmental hazards. For example, a flood or wildfire could unleash a technological hazard, if stored chemicals are released into the air or water as a result. Thus, local planners and officials should consider the interactions of natural and technological hazards and their resulting effects on human-environment relations. As shown in this thesis, planners could use GIS to examine and monitor hazardous sites, and mitigation could prevent these sites from harming nearby streams, soils, wildlife, and people.

This study of the Spring Creek watershed reveals that although environmental hazards continue to affect people and alter our relations with the local environment, people are also altering the environment and some environmental hazards may be exacerbated by our actions. Land uses, zoning, and targeted mitigation strategies can prevent
technological hazards from becoming technological disasters. In addition to researching the ways in which environmental hazards affect our lives and our environment, researchers should consider human actions and decisions that increase socioeconomic vulnerability to these hazards.
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Centre Daily Times (28 February 2002) “Quarry Digs Up Division”


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Title: Volunteer Editor for Web Site
Description:
- Received Yahoo’s “Pick of the Week” for 12/06/98
- Coordinated efforts between writers, producers, and technical support staff
- Edited website text and images
Institution: WPSX, PBS Channel 3, University Park PA
Supervisor: Executive Producer John Grant

Grants Received:

Research Experience for Undergraduates (REU) sponsored by the National Science Foundation, summer grant, 2001

Awards:

Golden Key National Honor Society; Fall 1999-present

Phi Kappa Phi Honor Society; Spring 2001-present

Phi Beta Kappa Honor Society; Spring 2002-present

Professional Membership:

Student Member of American Association of Geographers; Fall 2001-present

Presentations:

“A Vulnerability Assessment of the Spring Creek Watershed of Centre County, Pennsylvania” at the Annual Meeting of the Association of American Geographers, March 20, 2002
http://www.aag.org/

“The Role of Undergraduate Teaching Interns in Supporting On-Line Student Portfolios” at the Ninth Annual Teaching and Learning With Technology Symposium, April 7, 2001
http://www.personal.psu.edu/users/a/m/amb323/tlt.html

Community Service Involvement:

Penn State’s Green Destiny Council, Advisory Board of Directors, Spring 2000-present
http://www.bio.psu.edu/Greendestiny/index.shtml
  • Work with faculty, students, and administrators to incorporate ecological indicators on campus
  • Organize forum each semester for university discussion between researchers, community members, students, and staff
  • Recent forum topics of global climate change, race and diversity, democracy, and university spending

Penn State’s Habitat for Humanity, Spring 2000-present
http://www.clubs.psu.edu/habitat/local.html
  • Traveled to Gainesville, Florida for volunteer house construction project, Spring Break 2000
  • Raised funds for Spring Break trips
  • Helped to organize fundraising events (spaghetti dinners, canning, and used tool donations)
Le Cercle Français, Vice President Fall 1998-Spring 2000  
[http://french.la.psu.edu/frclub.html](http://french.la.psu.edu/frclub.html)
- Organized weekly conversation hours and movies to encourage learning French culture and language
- Tutored Penn State students in French 001, 002, and 003

International Languages House, Secretary, Vice President, Spring 1998-Spring 2000  
[http://www.clubs.psu.edu/ilh/aboutus.htm](http://www.clubs.psu.edu/ilh/aboutus.htm)
- Organized Intramural sports teams, movie nights, and French, German, and Spanish cultural events
- Met weekly with Residence Assistant and board members to plan events, collect dues
- Held monthly house meetings

**International Education:**

L’Athenee Royale de Marguerite Bervoets, Mons Belgium, Fall 1997-Spring 1998
- Completed college-level course in French as a second language
- Completed public high school courses taught in French of French Literature, English, Spanish, Latin Translation, Greek, and German

**Travel Abroad:**

Study Abroad to Mons, Belgium, Summer 1997-Summer 1998
- Lived with host families in southern Belgium, attended high school and college courses, and traveled extensively throughout Belgium
- Visited Germany: Koln, Munich, Berlin, and Freiburg
- Visited relatives in Helsinki, Finland for several weeks
- Visited Austria: Salzburg and Vienna
- Visited Italy: Florence, Venice, Pisa, and Tuscany
- Visited Prague, Czech Republic

**Language Proficiency:**

French: proficient speaking, writing, and reading ability
Some experience speaking and reading German, Dutch, and Spanish
**Computer Skills:**

Experience using Arc/View and Arc/Info GIS  
Experience using AVID video editing software  
Web site development skills in DreamWeaver, HTML, Microsoft FrontPage, Flash, and Visual Basic  
Proficient in Microsoft Word, Excel, PowerPoint, and Access

*References available upon request*

4/02