IBS

INSTITUTE OF BEHAVIORAL SCIENCE ■

RESEARCH PROGRAM ON
ENVIRONMENT and BEHAVIOR ■

University of Colorado at Boulder
Boulder CO 80309-0484

WORKING PAPER EB2004-0002■

Migration and Environmental Hazards

Lori M. Hunter

March, 2004

Migration and Environmental Hazards

Lori M. Hunter

Institute of Behavioral Science, Program on Environment and Behavior
Department of Sociology
University of Colorado at Boulder

Running Head:
Migration and Hazards

Key words:
Environmental Hazards, Internal Migration, International Migration, Migration, Natural Hazards, Technological Hazards, Residential Mobility

Correspondence:

Lori M. Hunter
Program on Environment and Behavior
Institute of Behavioral Sciences
University of Colorado at Boulder, CB 468
Boulder, CO 80309
PH: 303-492-1006
FX: 303-492-1231
Lori.Hunter@colorado.edu

Migration and Environmental Hazards

Abstract: The incidence of natural hazards (e.g., earthquakes, hurricanes) and the presence of technological hazards (e.g., nuclear waste facilties, chemical spills) are both on the rise. This paper offers a review of research examining the association between migration and both natural and technological environmental hazards, with migration ranging from forced to voluntary. Using examples from both developed and developing regional contexts, the overview demonstrates that the association between migration and environmental hazards varies by setting, hazard types, and household characteristics. In many cases, however, research suggests that environmental factors play a role in shaping migration decisions, particularly among those most vulnerable to environmental hazards. Research also suggests that risk perception acts as a mediating factor. Classic migration theory is reviewed to offer a foundation for examination of these associations.

Migration and Environmental Hazards

Several classic theoretical perspectives on migration, operating at micro and macro scales, provide foundations for examination of the association between migration and environmental hazards. Importantly, however, while contextual factors are often noted in these frameworks, they are rarely emphasized. Further, to the extent that empirical work has been undertaken with regard to the association between migration and environmental hazards, little of such work is grounded in these classic frameworks. The purpose of this review is to summarize classic migration theories of potential use in the exploration of environmental context within migration research, while also providing a synthesis of existing efforts examining, more specifically, migration as associated with both natural and technological hazards.

In *Population and Development Review*'s Supplement to Volume 28, a broad array of methods were presented for examination of the association between demographic and environmental change (Lutz, Prskawetz, and Sanderson 2002). The review presented here highlights work examining, as put forth by the Supplement's Editors, the ways in which changes in the natural environment affect human population (E→ P). Although existing research on migration and environmental hazards does not incorporate dynamic modeling of environmental processes, such efforts do offer examples of the ways in which demographers might incorporate environmental context into exploration of demographic processes.

An environmental hazard has been defined by hazard researchers as, in the broadest sense, a threat to people and their valuables (Cutter 2001a). Interactions between social, natural, and technological systems can yield environmental hazards (Cutter 2001a), and both natural hazards (e.g., earthquakes, hurricanes) and technological environmental hazards (e.g., nuclear waste facilties, chemical spills) are on the rise.

With regard to natural hazards, it is conservatively estimated that environmental hazards caused over $300 billion in property and crop damage and nearly 9000 deaths during 1975-1998 (Mitchell and Thomas 2001). In developing nations, death tolls are much higher than in more developed contexts, while in developed countries, economic losses outweigh human losses (van der Wink et al. 1998). Further, it is likely that impacts will escalate, since research portends that a warming climate will increase extreme weather events (e.g., McGuire, Mason and Kilburn 2002). With regard to technological hazards, over 6,000 deaths are attributed to the 1984 gas leak in Bhopal, India, while over 135,000 residents were evacuated as a result of the 1986 accident at the nuclear power plant in Chernobyl, Ukraine. In the U.S., the continuing debate over the nuclear waste storage at Yucca Mountain, Nevada, testifies as to the ongoing presence of these issues in contemporary society (*Pollution Engineering* 2002; Riddle and Shaw 2003). Today's public is, indeed, attuned to environmental hazards; as stated by risk researchers Cvetkovich and Earle (1992:3), "complacency may have been an appropriate description of public responses to environmental hazards 25 years ago, but it is no longer apt." How this attention plays out demographically, particularly with regard to migration, is the focus of this review.

Migration as a demographic process can be associated with environmental hazards in several ways. On the one hand, proximate environmental hazards might influence residential decision-making by shaping the desirability of particular locales. In this case, we might consider environmental hazards as factors shaping migration. On the other hand, migration can represent an exacerbating force with regard to environmental hazards as a result of increasing population density in vulnerable locales. Consider, for instance, the dramatic population increases in in earthquake- and hurricane-prone regions of the U.S. (Mileti 1999) and the movement of poverty-stricken households to floodplains in Bangladesh (e.g., Lein 2000; Zaman 1991). In this case, we might consider migration a factor shaping the scale of environmental hazards, and the scope of the resulting disaster should one occur. Regardless of these important associations, scholarly explorations of environmental hazards as either cause and consequence are few. As stated recently by the National Research Council's Committee on the Human Dimensions of Global Change (1999:57) "there is very little empirical documentation of the relationships between migration and environment."

This paper offers a synthesis of the work that has been done on the association between migration and environmental hazards, with the hope that the synthesis can provide a foundation for future endeavors in this area. The review is presented in several sections. First, classic theoretical foundations of potential use in exploration of the link between migration and environmental hazards are outlined. Second, a section on natural hazards offers brief background on the hazards themselves, followed by an overview of social science work associating migration and natural hazards. A similar section comes next, but with a focus on technological hazards. These reviews are followed by a brief overview of several data sources offering insight into natural and technological hazards. Finally, the overview is brought together in the concluding section, with two additional perspectives offered with regard to migration and environmental hazards.

It is important to note that there are environmental dimensions of relevance to migration that are not covered in this review. In particular, cumulative, slow-onset, changes as related to natural processes are important particularly within the context of subsistence economies (e.g., Lonergran 1998). Deforestation, land degradation, erosion, desertification, and climate change are examples of environmental change potentially playing a role in migration decision-making processes. These arenas are, however, left for review within another context.

Theoretical Foundations: Migration and Environmental Hazards

As mentioned, many classic migration frameworks incorporate environmental considerations (e.g., DeJong and Fawcett 1981; Lee 1966; Speare 1974; Wolpert 1966), albeit often in quite subtle ways. The most relevant of these frameworks integrate non-economic aspects of residential satisfaction within the process of migration decision-making. Wolpert is often credited with the initial development of a migration model incorporating non-economic aspects of residential satisfaction (Fredrickson et al. 1980). Wolpert's theoretical "stress-threshold" model (1966) posited that migration is a response to stress experienced from the current residential location, with residential "stressors" including environmental disamenities such as pollution, congestion and crime. The model suggests that these "stressors" bring about "strain" which may lead to consideration of residential alternatives. Further, potential migrants determine the "place utility" of alternative residential locations based upon the anticipated satisfaction derived from relocation to a particular locale.

Considerations along these lines were further developed by Speare (1974). More specifically, Speare outlined characteristics of the individual, household, housing unit location and social bonds as they influence residential mobility, arguing that individuals experience a "threshold of dissatisfaction" after which they may consider residential relocation. He operationalized "utility" into varying levels of satisfaction in order to examine the effects of social and contextual factors on individual stress thresholds. Speare argued that residential dissatisfaction may result from a change in household needs, in a particular location's social and physical amenities, or a change in the standards used to evaluate these factors. Within Speare's framework, physical amenities (or their opposite, physical disamenities) as "locational characteristics," are of most relevance for consideration of environmental hazards.

Other relevant frameworks operating at the individual or household scale include the Value-Expectancy (V-E) model in which migration motivation is defined as a function of the value placed on certain goals, combined with the perceived likelihood that a chosen behavior will lead to those goals; the V-E model's basic components are, therefore, goals (values, objectives) and expectancies (subjective probabilities). Several general values/goals are outlined (i.e., wealth, status, stimulation, autonomy, affilitation, morality), with the general value/goal of "comfort" likely encompassing environmental context. Included within the goal of "comfort" is a "more pleasant residential environment …. [and] … a healthier or less stressful setting" (DeJong and Fawcett 1981:50). Still, it is argued that decisions with regard to moving or staying are shaped by the ways in which these values/goals interact with individual and household characteristics, societal and cultural norms, personal traits, and variation in opportunity structures between areas.

Critical consideration of temporal shifts in individual- and household-level migration decisions can be found in Zelinsky's (1971) explication of the "mobility transition hypothesis." With a focus on the association between modernization and migration, Zelinsky argues that social and economic change inherent within modernization yield increases in personal freedom and declines in the difficulties inherent in breaking ties with residential origins. These changes, it is argued, enhance the role of personal preferences in migration decision-making processes (Zelinsky 1971). Given reserarch suggesting that individuals often express preferences for residential environments free of environmental hazards (e.g., Blackwood and Carpenter 1978; Hsieh and Liu 1983; McAuley and Nutty 1982), it might be suggested that modernization increases households' ability to act freely upon these preferences for less risky residential environments.

Environmental context finds substantially less emphasis within the neoclassical economic perspectives that tend to focus more on the human capital and economic dimensions of migration decision-making (Davanzo 1981; Harris and Todaro 1970; Todaro 1976). Here, migration is viewed as shaped by cost-benefit calculation with personal investment in migration behavior only being justified by sufficient returns to the behavioral investment. Environmental considerations are, in a sense, implicit here since environmental pollution or other risks may represent negative locational characteristics, while positive environmental attributes likely increase destination attractiveness. Econometric migration models have revealed associations with locational amenities (e.g., Knapp and Graves 1989) and some suggest that an indication of the societal value placed upon such amenities, or disamenities, is reflected in wage differentials across locations (Knapp and Graves 1989). Certainly in the conventional economic model, population movement acts as an equilibrating mechanism reducing geographic wage differentials (DaVanzo 1981), yet these wage differentials are, themselves, often due to variation in location-specific amenities (e.g., Graves 1983; Mueser and Graves 1995; Knapp and Graves 1989; Mathur, Stein, and Kumar 1988; von Reichert and Rudzitis 1994). The existence of location-specific amenities (or disamenities) is important, because migration is the only way to consume (or avoid) them. To be more specific, within the neoclassical framework individuals might accept somewhat lower pay to reside in a location with environmental amenities; conversely, individuals might have to receive higher compensation to continue to live in an environmentally unattractive or hazardous locale.

Shifting to frameworks with more emphasis on macro-level factors, human ecological models have more centrally considered contextual factors, although surprisingly little development has taken place with regard to features specifically related to the natural environment. The POET model, for example, conceptually considers the interrelationships between **P**opulation, **O**rganization, **E**nvironment, and **T**echnology (e.g., Duncan 1960; Duncan and Schnore 1961), with migration subsumed with "population" and environmental hazards potentially represented by both "environment" and "technology."

Linking macro and micro characteristics, Petersen's early typology of migration (1958, 1975) describes innovative or conservative migration behavior with specific incorporation of ecological "pushes" as a type of migratory force. He argues, however, that ecological forces tended to shape migration in primitive times and that a conservative response would yield nomadic tendencies within the risky area in an effort to recreate status quo without long-distance relocation. Innovative response would, instead, entail a flight from the risky area more generally to find a less risky ecological context.

As a final conceptual consideration, Gardner's (1981) work on the migration decision-making process aimed to identify particular stages within the decision-making process at which the effect of macro-level factors should explicitly be considered. He identified five such points: 1) formation of values; 2) real, place-related macro-level factors; 3) factors that affect accurate perception of place-related factors and thus one's expectations; 4) objective constraints and facilitators to migration, and; 5) factors that affect accurate perception of the constraints and facilitators (1981:63-64). Of particular interest within Gardner's efforts is consideration of the individual's formation of values, since it is these values that will shape perception of the local environment. As he states, studies of migration behavior rarely deal with the formation of values, although such work has been undertaken with regard to other demographic processes, namely fertility (Gardner 1981:65). In a sense, Gardner's efforts link macro- and micro- through arguing that *what people value* shapes perceived fulfillment at present location, with feelings of stress and dissatisfaction as related to macro context and value orientation creating preferred residential locations. These efforts reflect a more explicit consideration of the place of values within residential satisfaction, and therefore represent an extension to work by Speare (1974) and DeJong and Fawcett (1981). Gardner (1981:88) concludes:

> The study of migration decisions, while necessarily proceeding on the micro-level, must nevertheless take into account at all steps the influence of macrofactors, the social and institutional, the economic and *the geographic context* within which the individual exists [emphasis added].

As per Gardner (1981), Speare (1974) and others, residential preferences represent the proverbial glue holding together the connection between migration and environmental context. Social science research has revealed significant effects of perceived neighborhood quality on metropolitan net migration (Schacter and Althaus 1982) and that climate (summer humidity and winter severity) is a significant determinant of migration patterns (Schacter and Althaus 1982; Walters 1994) within the context of the U.S. In addition, levels of air pollution and healthy environments are often noted as desirable residential attributes (e.g., Blackwood and Carpenter 1978; McAuley and Nutty 1982). Further, Hsieh and Liu (1983) argue that in the short-run, "pursuance of better *environmental quality* is the dominant factor in explaining interregional migration" (emphasis in original, p. 431). The rural turnaround of the 1970s in the U.S. suggested that environmental amenties such as mountains, lakes and "other areas of natural beauty" represent contextual characteristics of importance within rural destinations as well (e.g., DeJong and Sell 1977:177).

That said, as Slovic (1987) argues, people respond to the hazards they perceive; as such, while amenities may act as migratory "pulls", is the converse necessarily then true that disamenities act as migratory "push"? Specifically, relocation in response to nearby environmental hazards cannot simply be assumed since individuals may not be aware of, or concerned with, the danger posed. Risk assessment reflects human judgments, with these judgments influenced by various psychological and social factors (Cvetkovich and Earle 1992). Several reasons can be outlined as to why residents might not migrate from hazard-prone areas. Residents may:

1. not be aware of hazard;
2. be aware, but do not expect a disaster;
3. expect a disaster, but do not anticpate loss;
4. expect loss, but not serious loss;
5. expect serious loss and have undertaken, or planning to undertake, loss reduction actions;
6. expect loss, but accepted as costs of gaining locational benefits;
7. have no choice in location (Kates 1962; expanded by Fordham 1992).

If aware of hazards, four mechanisms of adjustment are possible: 1) engineering mechanisms (technological adjustments); 2) symbolic mechanisms including culture (norms & values), 3) regulatory mechanisms (policy), and 4) distributional mechanisms (movement of people, activities, resources) (Micklin 1973; Mileti 1980). The focus within this review is on population distribution through migration. A useful heuristic is presented by Hugo (1996) in his work on environmental concerns as related specifically to international migration. Hugo (1996:107) presents a continuum whereby population mobility is viewed as ranging from totally voluntary, in which migration is entirely resultant of the choice and will of the migrants, to forced, where migrants face death in their present location. Migrants forced out of places of origin due to environmental disruption have been termed, in some contexts, as "environmental refugees" (e.g., Jacobsen 1988), although this terminology has proven problematic, since such refugees do not fit within conventional political definitions.

In the end, many classic migration frameworks offer potential for the specific inclusion of environmental hazards as contextual characteristics. Nonetheless, there has been a limited amount of scholarly work undertaken with regard to the migration-hazard association, with virtually none integrating classic migration conceptualizations.

Migration as a Response to Natural Hazards

Natural hazards are defined as those "extreme events that originate in the biosphere, lithosphere, hydrosphere or atmosphere" (Alexander 2000:9) "that pose a threat to people, their property and their possessions" (McGuire, Mason and Kilburn 2001:1). Many natural hazards are recurrent in time and relatively predictable in terms of location, although this is not always the case.

The impacts of natural hazards on society are substantial and are clearly on the rise (Abramovitz 2001). While severe storms, floods, and earthquakes result in lower levels of mortality than socio-political phenomenon such as civil strife, these natural hazards are more frequent occurrences and more generally affect relatively greater numbers of individuals (Smith 2001). Indeed, estimates suggest that between 1/5 and 1/4 of the Earths' human population was affected by natural hazards during the 1970s and 1980s (Abramovitz 2001). Even so, impacts are expected to increase; during the period 1972-1995, actual calamities increased by 5-7% per year, while the damage resultant of these disasters increased by 5-10% per year (Kondratyev, Krapivin, and Phillips 2002). Predictions to 2030 suggest a continuation of these trends in addition to their "enhancement" (Kondratyev, Krapivin, and Phillips 2002). Anticipated future increases in human impacts of these extreme events is due to two factors: population growth and resultant increases in the built environment in regions most vulnerable to high impact natural disasters, namely coastal and urban areas (Mileti 1999).

Also important with regard to the social context of natural hazards is social variation in vulnerability (Blaikie et al. 1994; Girard and Peacock 1997). At greatest risk are those at the low end of the socio-economic spectrum, both in developed and developing regions. Research has shown that SES is associated with hurricane mitigation in southern Florida, with low-income households more likely to live in highly vulnerable mobile homes and less likely to have invested in disaster mitigation such as hurricane-resistant windows and roofing (Peacock and Girard 1997). They are also more likely to have insufficient insurance and, therefore, inadequate settlements for rebuilding (Peacock and Girard 1997). In developing regions, the poorest inhabitants are often forced to live on marginal land outside urban areas or coastal zones, potentially prone to flood risk (e.g., Chan 1995). In an aggregate sense, a direct relationship exists between the level of development and type of natural disaster losses. In developing nations, death tolls are much higher than in more developed contexts, while in developed countries, economic losses outweigh human losses (van der Wink et al. 1998).

As noted above, a wide-ranging continuum characterizes the ways in which environmental hazards might act as a "push" factor in migration decision-making. With regard to natural hazards, forced migration is represented by evacuation (e.g., Ziegler and Johnson 1984), although this movement is typically only temporary and does not entail a permanent change of residential location. Some disaster-impacted residents do eventually choose to relocate, however, thereby engaging in voluntary migration. The wholesale relocation of communities represents another potential migratory outcome of natural hazards, also representing more permanent residential location. Such relocation is often mandated (therefore forced) migration, and will therefore be reviewed first below. As presented, the reviewed literature moves from forced migration to increasingly voluntary migration as a response to natural hazards.

Community relocation is one of three forms of reconstruction typically undertaken by disaster-impacted communities (Mileti and Passerini 1996). Reconstruction most often follows the path of rebuilding, whereby communities are reconstructed to restore their predisaster character. Such efforts to recreate the pre-disaster status quo are driven by human interest to reconstruct predisaster culture and interactions. Second, a community may be partially reorganized to take variation of risk within its boundaries into account. Changes in predisaster land use may, for example, restrict residential redevelopment in flood zones, instead zoning these areas for more flexible uses (e.g., recreational space). Finally, communities may be relocated to a less hazardous site, thereby requiring migration but reducing future damage (Mileti and Passerini 1996). An example of migration induced by hazard relocation is offered through the story of Valmeyer, Illinois, a village of 900 residents located 35 miles southwest of St. Louis (Rozdilsky 1996). Valmeyer flooded regularly, but following devastation by the 1993 Mississippi River floods, the community took rapid action to initiate a complete village relocation project. Flood water had reached depths of 10-15 feet in the village center, destroyed the town's infrastructure, and severely damaged 98% of the village's structures. In October, 1993, a new town site was established outside of the flood plain, on top of a nearby bluff, and in April 1995, the first reisdent moved into his home in the new town. The community, which includes many of the town's residents prior to the flood, has reconstructed itself with a new sense of permanence (Rozdilsky 1996).

Community relocation is, however, a relatively rare occurrence, especially within the context of developing nations. Environmentally-induced permanent migration of a less organized kind typifies these interactions in less developed contexts. Hugo (1996) presents an analysis of reports on Asian environmental migrants as presented in the *United Nations Disaster Research Organization News* for the period 1976-1994. The results demonstrate that over the last 2 decades there has been a trend toward increasing numbers of people displaced by environmental disasters (see Table 1). As for specific contributions to these "environmental refugee" flows, in 1994, mass migration to urban areas within China took place as a result of floods and droughts in upland areas (Kaye 1994). Natural calamities also often "push" migrants from rural to urban areas in Bangladesh, such that "an unusual increase of beggars and people looking for work in cities and towns is part of the aftermatch of drought and floods." (*Population: UNFPA Newsletter* 1984). It has been argued that millions are displaced annually as a result of environmental factors in Africa as well (see Table 1).

(Table 1 about here)

Local displacement also takes place, such as in portions of Bangladesh, where floods and cyclones regularly occur, often with dramatic outcomes (Lein 2000; Zaman 1991). Agriculture in Bangladesh is very much dependent on annual flooding and the floods, therefore, take on unique cultural meaning. Although necessary, the persistent floods also result in changes in river courses, with many Bangladeshis losing homes and lands to erosion each year (Zaman 1991). In a survey undertaken in a Bangladesh floodplain in the mid 1980s, 64% of sample households reported having been displaced by erosion at least once, with the mean number of displacements being seven (Zaman 1991). Typically, migrant households relocate only a short distance away; in the aforementioned survey, nearly 88% of households had remained within 2 miles of their previous residence (Zaman 1991). Short distance migration is a product of lack of resources, presence of kin, and belief that land will re-emerge to be reclaimed (Zaman 1991). Migration here is a household coping mechanism, with household members typically having little faith in finding permanent residence; displacees often continue to live in fear of eviction, either by governmental authorities or natural forces (Haque and Zaman 1989; Mutton and Haque 2004; Zaman 1991).

Sometimes, however, migration in response to hazards is not feasible. In Peninsular Malaysia, researchers argue that structural factors such as poverty, low educational attainment and social mobility, insecure land tenure, a lack of government aid, disaster preparedness and/or relief programs restrict the residential choices of many inhabitants of risk-prone regions (Chan 1995). Based on 1992-93 interviews with members of 618 flood-prone households, Chan (1995) argues that migration is an option available only to wealthier households. Poor floodplain residents' migratory options are severely limited, and, if provided the opportunity to relocate, do so only to often find themselves on different floodplains because these are the least expensive places to live.

In cases, some household members will migrate while others stay behind. These decisions also represent household migratory strategies as related to natural hazards. Here we can look to work by Ezra and Kiros (2001) undertaken in ecologially degraded and drought-prone communities in Ethiopia. Multilevel models estimating young adult migration within this context provide evidence for the "new economics of migration," whereby migration of some household members becomes a family strategy for those living in uncertain natural environments. Results suggest that a community's vulnerability to food shortages as a result of drought contributes significantly to outmigration as a strategy to assist relatives (Ezra and Kiros 2001).

Household migration strategies as related to natural hazards are also seen in South America. On May, 31, 1970, a major earthquake struck Peru, killing as many as 70,000 residents and injuring 150,000 others. Osterling (1979) undertook a study of the ways in which this catastrophe contributed to outmigration of peasant workers from the highland region of Ancash, the area most destroyed by the quake, to Huayopampa a rural community four hours drive north of Lima. Results suggest that most migrants were compelled to seek employment through migration because the natural disaster had intensified traditional poverty in their origin villages. Only a handful of migrants indicated that the earthquake was their primary migration motivation. Indeed, the natural disaster is seen to have stimulated an ongoing process of modernization and acculturation, primarily with regard to Ancash young men, by "forcing some of the victims to seek their fortunes within a labor economy" (Osterling 1979: 120). Migrants were innovative in responding to the earthquake by capitalizing on social networks that facilitated migration to Huayopampa which is seen as a training ground for preparation for an eventual permanent move to Lima (Osterling 1979).

Within the context of the U.S., different evidence emerges. Making use of the American Housing Survey, Morrow-Jones and Morrow-Jones (1991) find that, as compared to migrants generally, those noting natural disaster as the reason for their move tend to be older, are more likely female-headed households and minority group members, and characterized by lower income and educational levels. As such, the researchers conclude that the less socio-economically advantaged may be those most likely to migrate following a natural disaster. It is suggested that those households with more assets may be more likely to rebuild (Morrow-Jones and Morrow-Jones 1991), perhaps as a result of lessened damage due to their ability to undertake more mitigation measures such as installation of disaster-resistent windows and/or roofs (Peacock and Girard 1997).

In the end, natural hazard risks are "dynamic and complex" (Alexander 2000:11), as are the migratory responses of households to natural hazards. Within developing regions, descriptive work suggests that millions migrate annually as a result of environmental conditions, suggesting that environmental decline may be an important "push" factor fueling urbanization (e.g., Hugo 1996; Jacobsen 1988). In some cases, local mobility is a more typical response to regularly occurring natural hazards (e.g., Zaman 1991). Finally, analytical efforts suggest that the environment as a contextual factor, interacts with individual, household and other community characteristics to shape household migration decision-making (e.g., Ezra and Kiros 2001). Within more developed regions, there is some evidence that "flight" from hazardous areas is as much related family composition, community ties, and job status as concern with the risk itself (Goldhaber et al. 1983). Other evidence suggests that, in more developed regions, socio-economically advantaged households may be those least likely to migrate in response to natural hazard impacts (e.g., Morrow-Jones and Morrow-Jones 1991).

Migration in Response to Technological Hazards

Human societies, technology, and the natural environment interact to yield technological hazards (Thomas and Mitchell 2001). Such hazards are often the product of complex systems, with some scholars arguing that failure within these systems is inevitable (Perrow 1984, 1999). As distinguished from natural hazards, technological hazards might yield releases of toxic materials, episodes of severe contamination, structural collapses, and transportation, construction or manufacturing accidents (Alexander 2000: 9). The 20th century has several dramatic examples to offer with regard to disasters which have resulted from the presence of technological hazards including a fatal gas leak in Bhopal, India (1986), radioactive releases from nuclear plants in Chernobyl, Ukraine (1986) and Three Mile Island, Pennsylvania (1979) and toxic contamination of a residential neighborhood in Love Canal, New York (1978). A geographic bias exists within social research relating population redistribution to these hazards in that the majority of scientific explorations have been undertaken within the context of developed nations.

In general, the public expresses high levels of "dread" and fear with regard to many technological hazards (e.g., Slovic 1987). Indeed, risk assessment experts are often perplexed by the public's concern with hazards that are technically assessed as relatively minor risks (Cvetkovich and Earle 1992; Erickson 1994; Kunreuther, Flynn and Slovic 2001; Treichel 2000). Some argue that the invisible nature of many environmental toxins, in addition to the uncertainty of potential health effects, play important roles in the magnification of perceived risk and the difficulties in determining the severity of hazard (Thomas and Mitchell 2001). As stated by Erickson (1994), these "new species" of trouble:

> are seen as having been produced by human hands, they involve some form of toxic contaminant, and they blur the line we have been in the habit of drawing between the acute and the chronic (Erickson 1994:22).

More explicitly, the “social amplification” of technological risks is the product of, not only direct physical consequences, but interaction of psychological, cultural, social, and institutional processes that amplify or attenuate public experence of risk. In particular, risk perception is shaped by media coverage, level of dread, and cultural placement of blame (Kasperson, Renn and Slovic 1988; Renn et al. 1992).

First reviewed are two cases in the U.S. that represent one end of the migration continuum -- forced migration -- as a result of technological environmental hazards. In 1942, the Hooker Electrochemical Company purchased a canal as part of a failed residential development, to to be used for the disposal of chemical wastes. The “Love Canal” was consequently used as a burial site for 19,000 metric tons of hazardous wastes and, after being covered with earth and clay, the site was sold to the school board of Niagara Falls in 1953 for one dollar. The following year, a school and residential community were built on the site (Paigen et al. 1987; Vyner 1988). Approximately 1,000 families eventually moved into the area, with chemical odors, skin problems and spontaneous chemical fires continually troubling the residents. Studies suggested that human exposure to toxic chemicals may have occurred as a result of chemicals leaking through basement walls and as a result of children’s exposure in the playgrounds and neighborhood creeks (Paigen et al. 1987). Following epidemiological studies, in 1980, President Carter ordered a total evacuation of the community and signed an appropriation bill providing funding for permanent relocation of 900 families (CHEJ undated).

As another example of involuntary migration as a response to technological hazards, in 1982, the EPA condemned the small town of Times Beach, Missouri after discovering dangerous levels of dioxin, a potent carcinogen. Years earlier, waste oil had been regularly sprayed on the town’s streets to control dust. The oil was pumped from an indstrial vat where the Vietnam-era defoliant Agent Orange was once stored; dioxin was a byproduct of the production of germicides and herbicides. Concern first surfaced in the late 1970s when horses began dying at a riding stable whose arena had been sprayed, but not until

1982, was it confirmed that the town at-large had been exposed due to contaminated oil. Following EPA and CDC studies, in early 1982, in a joint federal-state action, the EPA, the Federal Emergency Management Agency (FEMA), and the State of Missouri allocated resources for the permanent relocation of Times Beach residents (EPA 1983). The EPA released $33 million to FEMA to purchase 801 permanent and mobile homes, over 2,000 residents, in Times Beach, and more than 40 businesses.

Involuntary relocation such as occurred at both Love Canal and Times Beach represents an extreme with regard to migratory response to technological environmental hazards. More often, temporary evacuation is a short-term relocation response, but many residents eventually return home. Even in the wake of evacuation in response to a fatal gas leak in the Bhopal, India, epidemiological research revealed a lack of large-scale permanent outmigration (Dhara and Dhara 2002). The environmental hazard posed by the Three Mile Island (TMI) incident also provided a research context in which to explore the dynamics of voluntary migration.

At 4:00 AM on March 28, 1979, a reactor at the Three Mile Island (TMI) nuclear power facility near Harrisburg, Pennsylvania suddenly overheated, releasing radioactive gases. Over the next several days, radioactivity was sporadically released from the plant and approximately 60% of the population living within five miles evacuated the area (Goldhaber et al. 1983). The median distance traveled was 85-100 miles (Zeigler and Johnson 1984). In an exploration of TMI-related outmigration, Goldhaber et al. (1983) found that only 1-2% of the population within a 5-mile radius appeared affected by the crisis in such a way that they permanently moved from the area, and that other factors such as job and family characteristics had considerably greater effect on moving than did attitudes about TMI (see Table 2).

(Table 2 about here)

Of course, tracking post-disaster migrants such as undertaken by Goldhaber et al. (1983) is difficult since their migration destinations are mostly unknown. An alternative perspective from which to explore this association is through queries of those in affected communities with regard to their *desire to move*. As suggested by Gill and Picou (1998:804), “contamination and subsequent uncertainty regarding exposure, long-term environmental damage, and the alteration of lifescape reduce the quality of life in contaminated communities.” As might be expected, slightly more residents expressed a desire to move as a result of TMI, as compared to those households who actually did migrate from the area. Flynn (1979) found that 17% of household heads living within 5 miles of TMI responded that someone in their household had “considered moving, while only 6% reported that someone has “definitely” decided to move because of TMI (as presented in Goldhaber et al. 1983). Still, relatively few proximate residents express a desire to relocate.

A somewhat different finding emerges from work following a series of explosions in Haifa, Israel, in December 1988 (Kirschenbaum 1996). Approximately 3,000 residents were evacuated after the explosions and subsequent fires emanating from a “gas farm” containing about 1,100 tons of liquid cooking gas. Hazardous materials at nearby petrochemical plants also ignited. Interviews with 100 evacuated household heads within 2 weeks of their return home revealed nearly half emphatically desired to relocate. The desire to move was particularly discernible for better educated respondents and those with greater potential loss of fixed assets. Also, of prime concern was the perceived psychological damage that parents felt their children experienced as a result of the disaster event, compounded by a sense of helplessness during the event (Kirschenbaum 1996).

Gill and Picou (1998) also examined migration intentions in comparative work exploring social response to 3 technological hazards or disasters: a train derailment in Livingston, Louisiana, a Superfund site in the Southbend subdivision of Houston, Texas, and the Exxon Valdez oil spill in Prince William Sound, Alaska. Gill and Picou (1998) found that, following these disasters, residents viewed their communities as less desirable places to live, and between 29-79% of residents desired to move, while 14-83% expected to move from the affected areas. In particular, residents of the Superfund community expressed especially high levels of outmigration desires, with perceived threats to the physical health of self and family associated with greater desire to relocate.

Of course, in-migration may also be effected by environmental hazards, whereby migrants see potential destinations as less attractive as a result of disamenities. Making use of choice experiments, Greenwood, McClelland, and Schulze (1997) examined the effects of perceptions of hazardous waste on the destination choices of potential migrants. The authors conclude that the presence of a nuclear waste repository makes a difference in destination selection; potential migrants are dissuaded from selecting a location with a repository, even if the repository poses little risk. Greenwood et al. (1997) also conclude that employment conditions are a particularly important consideration in the migration decision-making process, particularly of young migrants.

Results from aggregate analyses complement these individual-level explorations. Through modeling of aggregate population movements as associated environmental hazards, Hunter (1998) finds that U.S. counties with environmental hazards such as air and water pollution, hazardous waste and Superfund sites do not lose residents at greater rates than areas without such hazards. Areas with such risks do, however, gain relatively fewer new residents. These findings are corroborated by Murdock et al. (1999), who examine six counties impacted by hazardous facility development relative to their "non-waste" counterparts. Results suggest that waste-impacted counties did not have substantially different patterns of population change than non-waste counties. As related to long-term changes in waste counties, the researchers argue that waste development appeared to partially abate rates of population decline rather than lead to reversals in patterns of growth (Murdock et al. 1999). The results of both Hunter (1998) and Murdock et al. (1999) support earlier work by Flynn (1979), Goldhaber et. al (1983), and Gill and Picou (1998) suggesting relatively little outmigration as a product of technological hazards (although their might be *desire*). Still, such hazards may be likely to deter prospective migrants, as suggested by Greenwood et al. (1997).

Data Sources on Environmental Hazards

There are several secondary data sources of potential use in examination of environmental hazards as contextal factors in migration research. With regard to natural hazards, U.S. agencies such as the National Oceanic and Atmospheric Administration (NOAA), the Environmental Protection Agency (EPA) and the Federal Emergency Management Agency (FEMA) collect information on natural hazards and disasters, both within the U.S. and abroad. As an example, NOAA's National Geophysical Data Center (NGDC) plays a major role in post-event data collection. The NGDC assists in the detection, location, and evaluation of the extent of certain hazards (e.g., fires, floods, hurricanes, cyclones) using satellite data, with web-based data access for events across the globe. Included are the "Significant Earthquake Database," a global digital database containing information on more than 5,000 destructive earthquakes from 2150 B.C. to the present, as well as the National Hurricane Center's compilation of details on the deadliest and most expensive hurricanes in history. In addition, the World Meteorological Organization's Tropical Cyclone Programme has established nationally and regionally coordinated systems with several international hazard centers also providing access to regional data on extreme weather events. Finally, the Hazards Application and Information Center at the University of Colorado-Boulder acts as a clearinghouse for both data and research on the social dimensions of natural hazards.

Belgium's Centre for Research on the Epidemiology of Disasters (CRED) offers a databse (EM-DAT) that documents both natural and technological disasters around the world. Data reflecting the occurrence and effects of disasters, including numbers left homeless, from 1900 to present have been compiled from various sources such as UN agencies, NGOs, insurance companies, and research institutes. In the U.S., the EPA remains the primary data source for the quantification of proximate technological hazards and the level of hazard posed by industrial activities. Data reflecting facilities that generate, treat, store, or dispose of hazardous wastes are publicly available through the EPA's Biennial Reporting System (BRS). In 2001, over 19,000 facilities generated a total of over 40 million tons of hazardous waste (EPA 2001), and available through the BRS, are facility details including location as well as types and amount of hazardous waste generated or managed. In addition, the EPA's Office of Pollution Prevention and Toxics is responsible for maintenance of the Toxic Release Inventory (TRI), a public access database with information on the release and transfer of toxic substances into air, water, and land. The TRI list for 2001 included more than 600 chemicals and 30 chemical categories, and the database contains facility and chemical information, as well as the amounts of environmental chemical releases and off-site waste transfer (EPA 2003). Finally, available through the Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS) are data reflecting inactive or abandoned industrial sites contaminated due to the release of hazardous substances either from accidental spills or intentional disposal. "Superfund" sites are those contaminated areas which have been placed on the "National Priority List" for cleanup and as of the end of FY 2000, 1450 CERCLIS entries were considered Superfund sites.

Summary and Conclusions

Cutter (2001b:157) argues that "there is no such thing as a 'hazard- or disaster-free' environment." Still, substantial variation exists with regard to the level of risk posed by particular geographic locales. Substantial variation also exists with regard to vulnerability, defined as the characteristics of a person or group in terms of their capacity to anticipate, cope with, resist and recover from the impact of a hazard. The review provided here examines migration as a particular coping strategy with regard to environmental hazards.

Both natural hazards (e.g., earthquakes, hurricanes) and technological hazards (e.g., nuclear waste facilties, chemical spills) are on the rise. It is likely that continued anthropogenic global warming will result in more extreme and therefore more hazardous meteorological phenomena (McGuire et al.

2001). In addition, the proliferation of modern industrial processes suggests increasing numbers of individuals will be exposed to air, water, and land pollution result of hazardous wastes and toxic releases. An especially interesting category of hazards has been termed “na-tech” (for natural-technological, McGuire et al. 2000:2). Such a category can be used to describe complex disasters for which there is a recognizable and substantial human contribution. Consider the devastating flood in Buffalo Creek, West Virginia where, on February 26, 1972, a makeshift mining company dam burst resulting in 132-million gallons of debris-filled water raging through a narrow mountain hollow. The hollow’s tight knit communities were destroyed, with devastating social consequences (Erickson 1976). More recently, in 1998, large-scale logging was a major contributory factor in the devastating flooding of the Yangtze basin in China (McGuire et al. 2000). To control Yangtze flooding, the Three Gorges Dam has generated an “orchestrated” natural disaster which will ultimately inundate 13 cities, 140 towns and more than 1,000 villages, resulting in the resettling of more than 1 million residents (Chao 2001; UNEP 2003).

The Three Gorges Dam represents one form of societal response in the face of environmental hazards. Specifically, the dam represents a engineering response, while other forms of societal reactions include cultural adjustment related to shifting norms and values, regulatory mechanisms typically in the form of policy, or distributional mechanisms involving the movement of people, activities, resources (Micklin 1973; Mileti 1980). Our focus in this review is has been on population distribution through migration.

Research suggests that some households engage in migration as a response to environmental hazards (e.g., Morrow-Jones and Morrow-Jones 1991), although there is also evidence that “flight” from hazardous areas is sometimes as much related to family composition, community ties, and job status as concern with the risk itself (Goldhaber et al. 1983). Further, more households typically express *desire* to relocate than actually do (Flynn 1979; Goldhaber et al. 1983). Such findings support Speare’s (1974) conceptual efforts with regard to residential preferences in which he argues that consideration of migration is a necessary, but not sufficient, condition leading to actual migration behavior. In addition, Speare notes that factors related to residential context interact with individual and household characteristics to shape migratory behavior (Speare 1974). Indeed, although research suggests individuals prefer hazard-free living situations (e.g., Blackwood and Carpenter 1978; McAuley and Nutty 1982), individual, household, or other contextual factors may simply not allow migration behavior in response to those preferences.

Linking risk perception to migration, in the wake of a disaster event, a geographic place may be recast with the disaster-afflicted negative image of the area affecting relocation decisions (Kielcolt and Nigg 1982; Kirschenbaum 1996). Research suggests that this “risk image” can be a powerful factor in the willingness of individuals to return to the area and/or stay in their homes (e.g., Dynes and Quarantelli 1976). This “risk image” is illustrated by work in Times Beach, Missouri following recognition of contamination but prior to the community buy-out. Residents who had not yet moved reported greater levels of anxiety, alienation and stigma reflecting their “distaste for living in such close proximity to dioxin” (Goodman, Vaughan, and Gill 1992). Of course, tradeoffs exist whereby there are perceived costs of continuing to reside in a risk area, or an area perceived as posing risk, that are judged against the perceived benefits gained – despite the risks (Kirschenbaum 1996).

Typically, poor, disenfranchised individuals, and minority groups make these tradeoffs, as these social groups are more exposed to the dangers of both natural and technological hazards relative to others (Cvetkovich and Earle 1992:2). However, this vulnerability manifests itself differently according to context and type of hazard. Here, the framework put forth by Kates (1962) and expanded by Fordham (1992) becomes useful. Recall the several reasons outlined as to why residents might not migrate from hazard-prone areas. Residents may:

1. not be aware of hazard;
2. be aware, but do not expect a disaster;

3. expect a disaster, but do not anticpate loss;
4. expect loss, but not serious loss;
5. expect serious loss and have undertaken, or planning to undertake, loss reduction actions;
6. expect loss, but accepted as costs of gaining locational benefits;
7. have no choice in location (Kates 1962; expanded by Fordham 1992).

The above review provides evidence of several such rationales. With regard to natural hazards, in less developed regions, hazardous areas are often settled by poor households, perhaps because they *have no choice in residential location* (e.g., Chan 1995). In more developed regions, more advantaged households tend to remain in hazardous areas, and rebuild in the face of disaster (e..g, Morrow-Jones and Morrow-Jones 1991), perhaps because they have *expected loss, but accepted these losses as costs of gaining locational benefits.* In addition, some research suggests that socio-economically advantaged households are more likely to have undertaken mitigation strategies (e.g., Peacock and Girard 1997), thereby suggesting they may have *expected serious loss and have undertaken, or planning to undertake, loss reduction actions.*

With regard to technological hazards, research suggests that structural factors may inhibit migration, in other words, some households *have no choice in location.* Recall the circumstances surrounding Love Canal where regardless of the *desire* to relocate, community residents were confronted with many different obstacles. As expressed by activist Lois Gibbs:

> Hazardous wastes can turn a home that most people have worked so hard to buy into a toxic prison, which they can't afford to sell (even if they could find a buyer) and can't afford to stay in because of what the chemicals are doing to their health (as presented in Freudenberg 1984:9).

The lack of large-scale migration from the area surrounding Bhopal, India in the wake of the fatal gas leak in 1984 (Dhara and Dhara 2002) may also be associated with structural forces impeding migratory options.

In addition, some research suggests that concern with environmental quality may not be sufficient motivation for relocation. As Wolpert notes (1966), an individual may accept a negative, yet stable, environment rather than face the stress associated with change. Short-distance relocation may be an option here, in a survey of Bangladeshi floodplain residents, nearly 88% of migrant households had remained within 2 miles of their previous residence (Zaman 1991). Such migration harkens to Petersen's classic migration typology (1958) in which he argues that a "conservative" migration responses remain within the risky area in an effort to recreate the status quo without long-distance relocation. Innovative response would, instead, entail a flight from the risky area more generally to find a less risky ecological context. Such efforts are, perhaps, reflected by the "economic migration" of select household members from some hazard-prone contexts (e.g., Ezra and Kiros 2001; Osterling 1979).

There are two other interesting perspectives from which to explore the association between migration and environmental hazards. First, as an alternative to the notion of "flight" from environmentally risky areas, we might think of the tradeoffs that households consider in their quest for a satisfactory residential environment. The earliest economic frameworks posited that migrants tend to choose destinations that offer the highest level of benefits. As defined by Graves (1983:542), these benefits are, "at the most general level, the variations in utility that result from occupying alternative locations." As an example, Nelson (1978) quantifies the value of air quality as the impact of air pollution on residential property values, and suggests that households more sensitive to the tangible and intangible effects of air pollution will take up residence in areas with relatively clean air. These types of arguments suggest that socioeconomically disadvantaged households may be more willing to accept proximate environmental risk in order to achieve affordable housing, perhaps related to #4 (*expect loss, but not serious loss*) in the Kates/Fordham (1962/1992) framework.

Second, and also as related to risk perception, some evidence implies that outsider perceptions of environmentally hazardous residential contexts may be fundamentally different from residents, thereby suggesting the importance of not imposing risk judgement when undertaking analyses on these associations. Two examples offer illustration. First, in a study of "environmentally devasted neighborhoods," Greenberg (Greenberg and Schneider 1996) visited several communities characterized by technological hazards. Upon visiting a community with a nuclear power plant, Greenberg engaged in discussion with three residents. First, he spoke with an Asian American male approximately 35 years old, who had recently relocated to the neighborhood. The "insider" explained that he perceived the nuclear station, located about two miles from his house, as a windfall because it paid such a large proportion of municipal taxes. His property taxes were low, the school had excellent teachers, and his children were getting free violin lessons (Greenberg and Schneider 1996:7). Second, Greenberg spoke with a Caucasian woman, approximately 70 years old, who lived about four miles from the nuclear power station. She felt that the utility company that managed the station was "doing the best they could," and that the electricity had to be produced somewhere. Although she had recently decided to move, her decision was based on the fact that her house was too large to maintain (Greenberg and Schneider 1996:7-8). Third, the owner of the local fruit stand suggested that Greenberg stop "gawking at the station" and go visit the nearby river if he "really wanted to see what the place is like (p. 9)." The researchers concluded that the "insiders saw, felt, heard, smelled, and responded to the entire place they lived in, not just the part that outsiders focused on" (Greenberg and Schneider 1996).

In similar findings from research across the globe, Lein (2000) examines environment, hazards, and migration among residents of a *char*, new land formed through accretion, located in the middle of Jamuna river in Bangladesh. He concludes that "it is misleading to perceive the *chars* as high-risk areas filled with marginalized, poor people living on the brink of disaster." (Lein 2000:126) Instead, although life on the *char* is somewhat burdensome, residents contend that it is also rewarding and perhaps not as dangerous or disaster-prone as an outsider might think. Lein (2000) presents work by Schmuck-Widmann (1996, 76) who concluded:

> The perceptions of *char*-dwellers of their living conditions is fundamentally different from the view taken by outsiders. Life stories and accounts clearly suggest that flood and

> erosion do not have the character of catastrophe to them, contrary to the reports of press agencies and development institutions. They are recurrring events, forming part of the *char* dwellers' life-world. The people have adjusted and are not helpless victims of their environment.

The studies by Greenberg and Schneider (1996) and Lein (2000) both suggest the importance of considering insiders' risk perception in examination of migration as related to environmental hazards. They provide support for Slovic's (1987) contention that people respond to the hazards they perceive. Indeed, it is perhaps the <u>perception</u> of risk even more so than the probability of hazard occurrence that may be more related to migration. In a sense, these findings can be incorporated within the Value-Expectancy migration framework, whereby migration is a function of the <u>value</u> placed on certain goals, combined with the perceived likelihood that migration will lead to those goals. One such goal is "comfort" defined as a "more pleasant residential environment …. [and] … a healthier or less stressful setting" (DeJong and Fawcett 1981:50). Per Greenberg and Schneider (1996) and Lein (2000), neither *char* residents, nor residents of the neighborhood proximate to the nuclear power plant, appear to perceive their residential environment as necessarily unpleasant, or not to the degree that migration is a requisite response.

Examining the reciprocal nature of this association, migration represents not only a response to environmental hazards, but can also an exacerbating force with regard to risk. As related to "na-tec" hazards, the impact of many apparently "natural" disasters are largely the product of human decision-making, particularly as related to land use and socioeconomic activities (Alexander 2000). Large-scale human migration to cities and coastal areas is putting more people and infrastructure at risk (Abramovitz 2001; McGuire et al. 2000), and as such, the scope of potential damage from "natural hazards" has increased. In developing regions, environmental factors in origin locations often play a role in rural-urban migration, thereby fueling urbanization and the settling of oft-impoverished migrants in hazard-prone locales (e.g., Chan 1995; Kaye 1994; Lein 2000).

In developed regions, high amenity regions, such as coastlines, act as migrant "pull" factors. In the U.S., although coastal counties (excluding Alaska) constitute only 11% of land area, they are home to 53% of the population (Culliton et al. 1998; Culliton 1998). California, Florida, Texas and New York consistently account for a significant portion of coastal population growth. Indeed, from 1980-1990, central Atlantic coastal barriers counties had growth rates of up to 300%, while Florida coastal counties experienced net growth of up to 781 percent (Bartlett, Mageean, and O'Connor 1999). Rapid migration to coastal areas also characterizes population patterns in southern Europe (Hinrichsen 1998), thereby increasing hazard vulnerability and disaster potential. Coastlines aren't the only desirable hazardous environments; Palm (1981) investigated whether knowledge of earthquake hazards in amenity-rich, but earthquake prone areas, deterred people from making home purchases and found that it did not.

In the end, although hazards are an inescapable part of life (Smith 2001), vulnerability varies, as does the ability of individuals and households to engage in a range of coping strategies. Migration represents one particular strategy in the face of perceived risk associated with environmental hazards. Research suggests that the form of migration resultant of environmental hazards ranges across a continuum from forced to voluntary, and that the association between migration and environmental hazards varies by context, hazard type, and household characteristics. That said, there is substantial opportunity for demographers to contribute to a better societal understanding of population distribution as related to environmental hazards; Numerous secondary data sources reflecting environmental hazards are readily available, and classic migration theory has much to offer. Exploration of the link between population distribution is particularly timely since scholars predict increases in both natural and technological hazards, as well as increased human vulnerability due to population growth and shifts in population distribution and related infrastructure.

References

Abramovitz, Janet. 2001. *Unnatural Disasters.* Worldwatch Paper 158. Worldwatch Institute: Washington DC.

Alexander, David. 2000. *Confronting Catastrophe.* Oxford University Press: New York, NY.

Bartlett, Jay G., D.M. Mageean, and R.J. O'Connor, "Residential Expansion as a Continental Threat to U.S. Coastal Ecosystems." *Population and Environment: A Journal of Interdisciplinary Studies.* 21(5):429-468.

Blackwood, Larry G. and Edwin H. Carpenter. 1978. "The Importance of Anti-Urbanism in Determining Residential Preferences and Migration Patterns." *Rural Sociology*. 43, 1:31-47.

Blaikie, P., T. Cannon, I. Davis, and B. Wisner. 1994. *At Risk: Natural Hazards, People's Vulnerability and Disasters.* Routledge: London.

Center for Health, Environment, and Justice (CHEJ). undated. *Love Canal Fact Pack P001*. CHEJ: Falls Church, VA. Downloaded online March 2004: http://www.chej.org/LoveCanal.pdf

Chao, Julie. 2001. "Relocation for Giant Dam Inflames Chinese Peasants." *Palm Beach Post.* May 15.

Chan, Ngai Weng. 1995. "Choice and Constraints in Floodplain Occupation: The Influence of Structural Factors on Residential Location in Peninsular Malaysia." *Disasters*. 19(4):287-307.

Culliton, Thomas J. 1998. "Population: Distribution, Density, and Growth." NOAA's State of the Coast Report, Silver Spring, Md:National Oceanic and Atmospheric Administration. URL: http://state-of-coast.noaa.gov/bulletins/html/pop_01/pop.html (retrieved March, 1999).

Culliton, Thomas J., Maureen A. Warren, Timothy R. Goodspeed, David G. Remer, Carol M. Blackwell, and John J. McDonough III. 1990. *50 Years of Population Change Along the Nation's Coasts, 1960-2010.* Rockville, MD: National Oceanic and Atmospheric Administration.

Cutter, Susan L. (Ed.) 2001a. *American Hazardscapes: The Regionalization of Hazards and Disasters.* Joseph Henry Press: Washington DC.

----------. 2001b. "Charting a Course for the Next Two Decades." Chapter 7 (pp. 157-165) in *American Hazardscapes: The Regionalization of Hazards and Disasters.* Joseph Henry Press: Washington DC.

Cvetkovich, George and Timothy C. Earle. 1992. "Environmental Hazards and the Public." *Journal of Social Issues.* 48(4):1-20.

DaVanzo, J. 1981. "Microeconomic Approaches to Studying Migration Decisions." Chapter 4 (pp. 90-130) in" in G.F. De Jong and R.W.Gardner, eds. *Migration decision making: multidisciplinary approaches to microlevel studies in developed and developing countries*. pp. 13-58. New York: Pergamon Press.

De Jong, G.F. and Fawcett, J. 1981. “Multidisciplinary frameworks and models of migration decision making” in De Jong, G.F. and R.W.Gardner, eds. *Migration decision making: multidisciplinary approaches to microlevel studies in developed and developing countries*. pp. 13-58. New York: Pergamon Press.

DeJong, Gordon F. and Ralph R. Sell. 1977. “Population Redistribution, Migration, and Residential Preferences.” *The Annals of the American Academy* January:130-144.

Dhara, V. Ramana, and Rosaline Dhara. 2002. “The Union Carbide Disaster in Bhopal: A Review of Health Effects.” *Archives of Environmental Health.* September/October 57(5):391-404.
Duncan, Otis D. 1960. “From Social System to Ecosystem.” *Sociological Inquiry.* 31(2):131-139.

Duncan, Otis Dudley. 1960. “From Social System to Ecosystem.” *Sociological Inquiry*. 31(2): 140-149.

Duncan, Otis D. and L.F. Schore. 1961. “Cultural, Behavioral, and Ecological Perspectives in the Study of Social Organization.” *American Journal of Sociology*. 61:84-85.

Dynes, R.R. and E.L. Quarantelli. 1976. “The Family and Community Context of Individual Reactions to Disaster.” Pp. 101-119 in *Emergency and Disaster Management.* (Eds.) H. Parad, D. Resnick and L. Parad. Maryland: Charles Press.

Erikson, Kai. 1976. *Everything in its Path: Destruction of Community in the Buffalo Creek Flood.* Simon & Schuster: New York, NY.

----------. 1994. *A New Species of Trouble: The Human Experience of Modern Disasters.* WW Norton: New York, NY.

Environmental Protection Agency (EPA). 1983. “Joint Federal/State Action Taken to Relocate Times Beach Residents.” EPA Press Release, February 22, 1983.

----------. 2001. *The National Biennial RCRA Hazards Waste Report*. EPA: Washington DC. Retrieved online March 2004: http://www.epa.gov/epaoswer/hazwaste/data/brs01/national.pdf

----------. 2003. *2001 Toxics Release Inventory Executive Summary.* Office of Environmental Information. EPA: Washington DC. Retrieved online March 2004: http://www.epa.gov/tri/tridata/tri01/press/executivesummarystandalone.pdf

Ezra, Markos and Gebre-Egziabher Kiros. 2001. “Rural Out-Migration in the Drought Prone Areas of Ethiopia: A Multilevel Analysis.” *International Migration Review.* 35(3):749-771.

Fordham, M. 1992. *Choice and constraint in flood hazard mitigation: the environmental attitudes of floodplain residents and engineers.* PhD, Middlesex Polytechnic, Enfield.

Fredrickson, Carl, Tim B. Heaton, Glenn V. Fuguitt and James J. Zuiches. “Residential Preferences in a Model of Migration Intentions.” *Population and Environment.* 3, 3+4, Fall/Winter:280-297.

Freudenburg, Nicholas. 1984. *Not in Our Backyards! Community Action for Health and the Environment*. New York: Monthly Review Press.

Gardner, Robert W. 1981. "Macrolevel Influences on the Migration Decision Process" Chapter 3 (pp. 59-89) in G.F. De Jong and R.W.Gardner, eds. *Migration decision making: multidisciplinary approaches to microlevel studies in developed and developing countries*. New York: Pergamon Press.

Gill, Duane A. and J. Steven Picou. 1998. "Technological Disaster and Chronic Community Stress." *Society and Natural Resources.* 11:795-815.

Girard Chris and Walter Gillis Peacock. 1997. "Ethnicity and Segregation: Post-hurricane Relocation." Chapter 10 (pp. 191-205) in *Hurricane Andrew: Ethnicity, gender and the sociology of disasters.* W.G. Peacock, B.H. Morrow and H. Gladwin (Eds). Routledge: New York, NY.

Goldhaber, Marilyn K., Peter S. Houts, and Renee DiSabella. 1983. "Moving After the Crisis: A Prospective Study of Three Mile Island Area Population Mobility." *Environment and Behavior.* 15(1): 93-120.

Goodman, Patricia G., C. Edwin Vaughan, and Derek Gill. 1992. "Relocation or Proximity? Major Factors Associated with Prolonged Impact Following Dioxin Contamnation and Flooding in Missouri." *International Journal of Mass Emergencies and Disasters.* 10(1):115-132.

Graves, Phillip E. 1983. "Migration with a Composite Amenity: The Role of Rents." *Journal of Regional Science,* 23(4): 541-546.

Greenberg, Michael and Dona Schneider. 1996. *Environmentally Devastated Neighborhoods: Perceptions, Policies, and Realities*. Rutgers University Press. New Brunswick, NJ.

Greenwood, Michael J., Gary H. McClelland, and W.D. Schulze. 1997. "The Effects of Perceptions of Hazardous Waste on Migration: A Laboratory Experimental Approach." *Review of Regional Studies.* 27(2):143-161.

Haque, C.E. and M.Q. Zaman. 1989. "Coping with Riverbank Erosion Hazard and Displacement in Bangladesh: Survival Strategies and Adjustments." *Disasters*. 13(4): 300-314.

Harris, J.R. and Todaro, M.P. 1970. "Migration, unemployment and development: a two sector analysis", *American Economic Review*, 60: 126-142.

Hinrichsen, Don. 1998. *Coastal Waters of the World: Trends, Threats, and Strategies.* Island Press: Washington DC.

Hsieh, Chang-Tseh and Ben-Chieh Liu. 1983. "The Pursuance of Better Quality of Life: In the Long Run, Better Quality of Social Life is the Most Important Factor in Migration." *American Journal of Economics and Sociology* 42, 4, October:431-440.

Hugo, Graeme. 1996. "Environmental Concerns and International Migration." *International Migration Review.* 30(1):105-131.

Hunter, Lori M. 1998. "The Association between Environmental Risk and Internal Migration Flows." *Population and Environment.* 19(3):247-277.

Jacobsen, Jodi L. 1988. “Environmental Refugees: A Yardstick of Habitability.” *Worldwatch Paper 86.* Washington DC: Worldwatch Institute.

Kasperson, Roger F., Ortwin Renn and Paul Slovic. 1988. “The Social Amplification of Risk: A Conceptual Framework.” *Risk Analysis.* 8:177-187.

Kates, R.W. 1962. Hazard and Choice Perception in Flood Plain Management. Research Paper No. 78, Department of Geography, University of Chicago.

Kaye, L. 1994. “The Reckoning.” *Far Eastern Economic Review.* Oct. 27:24-30.

Kielcolt, J. and J. Nigg. 1982. “Mobility and Perceptions of a Hazardous Environment.” Environment and Behavior. 14:131-154.

Kirschenbaum, Alan. 1996. “Residential Ambiguity and Relocation Decisions: Population and Areas at Risk.” *International Journal of Mass Emergencies and Disasters.* 14(1):79-96.

Knapp, Thomas A. and Philip E. Graves. 1989. “On the Role of Amenities in Models of Migration and Regional Development.” *Journal of Regional Science.* 29, 1:71-87.

Kondratyev, Kirill Ya., Vladimir F. Krapivin, and Gary W. Phillips. 2001. *Global Environmetnal Change: Modelling and Monitoring.* Springer-Verlag: Berlin, Germany.

Kunreuther, Howard, James Flynn and Paul Slovic. 2001. *Risk, Media and Stigma: Understanding Public Challenges to Modern Science and Technology.* EarthScan Publishers: London.

Lee, Everett. 1966. “A Theory of Migration.” *Demography*. 3(1):47-57.

Lein, Haakon. 2000. “Hazards and ‘forced’ migration in Bangladesh.” *Norwegian Journal of Geography.* 54:122-127.

Lonergan, Steve. 1998. *The Role of Environmental Degradation in Population Displacement.* Global Environmental Change and Human Security Project. International Human Dimensions Programme on Global Environmental Change. Research Report 1.

Lutz, Wolfgang, Alexia Prskawetz, and Warren C. Sanderson (Eds). 2001. Population and Environment: Methods of Analysis. *Population and Development Review.* Supplement to Vol. 28.

Mathur, Vijay K., Sheldon H. Stein and Rishi Kumar. 1988. “A Dynamic Model of Regional Population Growth and Decline.” *Journal of Regional Science.* 28, 3:379-395.

McAuley, William J. and Cheri L. Nutty. 1982. “Residential Preferences and Moving Behavior: A Family Life-cycle Analysis.” *Journal of Marriage and the Family.* May:301-309.

McGuire, Bill, Ian Mason and Christopher Kilburn. 2002. *Natural Hazards and Environmental Change.* Oxford Univeristy Press: New York, NY.

Micklin, M. 1973. *Population, Environment, and Social Organization*. Dryden Press: Hinsdale, IL.

Mileti, Dennis S. 1980. "Human Adjustment to the Risk of Environmental Extremes." *Sociology and Social Research*. 64(3):327-347.

----------. 1999. *Disasters by Design: A Reassessment of Natural Hazards in the United States*. Joseph Henry Press: Washington DC.

Mileti, Dennis S. and Eve Passerini. 1996. "A Social Explanation of Urban Relocation after Earthquakes." *International Journal of Mass Emergencies and Disasters*. 14(1):97-110.

Mitchell, Jerry T. and Deborah S.K. Thomas. 2001. "Trends in Disaster Losses." Chapter 5 in *American Hazardscapes: The Regionalization of Hazards and Disasters*. Joseph Henry Press: Washington DC.

Morrow-Jones, Hazel A. and Charles R. Morrow-Jones. 1991. "Mobility Due to Natural Disaster: Theoretical Considerations and Preliminary Analyses." *Disasters*. 15(2):126-132.

Mueser, Peter and Philip E. Graves. 1995. "Examining the Role of Economic Opportunity and Amenities in Explaining Population Redistribution," *Journal of Urban Economics,* 37: 1-25.

Murdock, Steven H., Richard S. Krannich, Frank L. Leistritz, Stephen Spies, J.D. Wulforst, Krissa Wrigley, Ralph Sell, S. White, and K. Effah. 1999. *Hazardous Wastes in Rural America: Impacts, Implications, and Options for Rural Communities.* Lanham, MD: Rowman and Littlefield Press.

Mutton, David and C. Emdad Haque. 2004. "Human Vulnerability, Dislocation and Resettlement: Adaptation Processes of River-bank Erosion-induced Displacees in Bangladesh. *Disasters*. 28(1):41+

National Research Council (NRC). 1999. *Human Dimensions of Global Environmental Change: Research Pathways for the Next Decade.* National Academies Press: Washington DC.

Nelson, Jon P. 1978. "Residential Choice, Hedonic Prices, and the Demand for Urban Air Quality." *Journal of Urban Economics*. 5:357-369.

Osterling, Jorge P. 1979. "The 1970 Peruvian Disaster and the Spontaneous Relocation of some of its Vicitms: Ancashino Peasant Migrants in Huayopampa." *Mass Emergencies*. 4:117-120.

Paigen, Beverly, Lynn R. Goldman, Mary M. Magnant, Joseph H. Highland, and A.T. Steegmann, Jr. 1987. "Growth of Children Living Near the Hazardous Waste Site, Love Canal." *Human Biology*. 59, 3, June:489-508.

Palm, R.I. 1981. "Public response to earthquake hazard information." *Annals of the Association of American Geographers*. 71(3):389-399.

Peacock, Walter Gillis and Chris Girard. 1997. "Ethnic and Racial Inequalities in Hurricane Damage and Insurance Settlements." Chapter 9 (pp. 171-205) in *Hurricane Andrew: Ethnicity, gender and the sociology of disasters*. W.G. Peacock, B.H. Morrow and H. Gladwin (Eds). Routledge: New York, NY.

Perrow, Charles. L. 1984, 1999. *Normal Accidents: Living with High-risk Technologies*. Basic Books, New York.

Petersen, W. 1958. "A General Typology of Migration." *American Sociological Review*. 23: 256-266.

----------. 1975. *Population*. MacMillan Publishing Co., Inc: New York, NY.

Pollution Engineering. 2002. "Local Efforts to Protect Yucca Mountain." 34(1):8

Renn, Ortwin, William J. Burns, Jeanne X. Kasperson, Roger E. Kasperson, and Paul Slovic. 1992. "The Social Amplification of Risk: Theoretical Foundations and Empirical Applications." *Journal of Social Issues.* 48(4):137-160.

Riddle, Mary and W. Douglass Shaw. 2003. "Option Wealth and Bequest Values: The Value of Protecting Future Generations from the Health Risks of Nuclear Waste Storage." *Land Economics.* 79(4):537-549.

Rozdilsky, Jack. 1996. "Flood-Related Relocation of Valmeyer: Implications for the Development of Sustainable Cities." *Environment and Planning Newsletter.* Environmental, Natural Resources and Energy Division, American Planning Association, Center for Urban Policy and the Environment, School of Public and Environmental Affairs, Indiana University – Purdue University: Indianapolis, IN.

Schachter, Joseph and Paul G. Althaus. 1982. "Neighborhood Quality and Climate as Factors in U.S. Net Migration Patterns, 1974-1976." *American Journal of Economics and Sociology* 41, 4, October:387-399.

Slovic, Paul 1987. "Perception of Risk." *Science*. 236: 280-285.

Slovic, Paul, M. Layman, N. Kraus, J. Flynn, J. Chalmers and G. Gesell. 2001. "Perceived Risk, Stigma and Potential Economic Impacts of a High-Level Nuclear Waste Repository in Nevada" Chapter 6 in Kunreuther, Howard, James Flynn and Paul Slovic (Eds). 2001. *Risk, Media and Stigma: Understanding Public Challenges to Modern Science and Technology*. EarthScan Publishers: London.

Smith, Keith. 2001. *Environmental Hazards: Assessing Risk and Reducing Disaster.* Routledge: London.

Speare, Alden Jr. 1974. "Residential Satisfaction as an Intervening Variable in Residential Mobility." *Demography* 11, 2:173-188.

Thomas, Deborah S.K. and Jerry T. Mitchell. 2001. "Which Are the Most Hazardous States?" Chapter 6 in *American Hazardscapes: The Regionalization of Hazards and Disasters.* Joseph Henry Press: Washington DC.

Treichel, Judy. 2000. "Public Participation in Nuclear Waste Decisions: Public Relations or Transparent Adversary Science." *Risk: Health, Safety & Environment*. 11(3):221.

Todaro, Michael. 1976. *Internal Migration in Developing Countries.* ILO: Geneva.

United Nations Population Fund (UNFPA). 1984. *Population: UNFPA Newsletter.* 10, 11, November: 2.

United Nations Environment Programme (UNEP). 2003. "China shuts dam gates to block the mighty Yangtze." *The Environment in the News*. June 3.

van der Wink, G., R.M. Allen, J. Chapin, M. Crooks, W. Fraley, J. Krantz, A.M. Lavigne, A. LeCuyer, E.K. MacColl, W.J. Morgan, B. Ries,E. Robinson, K. Rodriquez, M. Smith, and K. Sponberg. 1998. "Why the United States is Becoming More Vulnerable to Natural Disasters." *EOS, Transactions, American Geophysical Union.* 79(44):533, 537.

von Reichert, Christiane and Gundars Rudzitis. 1994. "Rent and Wage Effects on the Choice of Amenity Destinations of Labor Force and Nonlabor Force Migrants: A Note." *Journal of Regional Science.* 34, 3:445-455.

Vyner, Henry M. 1988. *Invisible Trauma: The Psychosocial Effects of Invisible Environmental Contaminants.* D.C. Heath and Company: Lexington MA.

Walters, William. 1994. "Climate and U.S. Elderly Migration Rates." *Papers in Regional Science.* 73:309-329.

Wolpert, Julian. 1966. "Migration as an Adjustment to Environmental Stress." *Journal of Social Issues.* 22, 4:92-102.

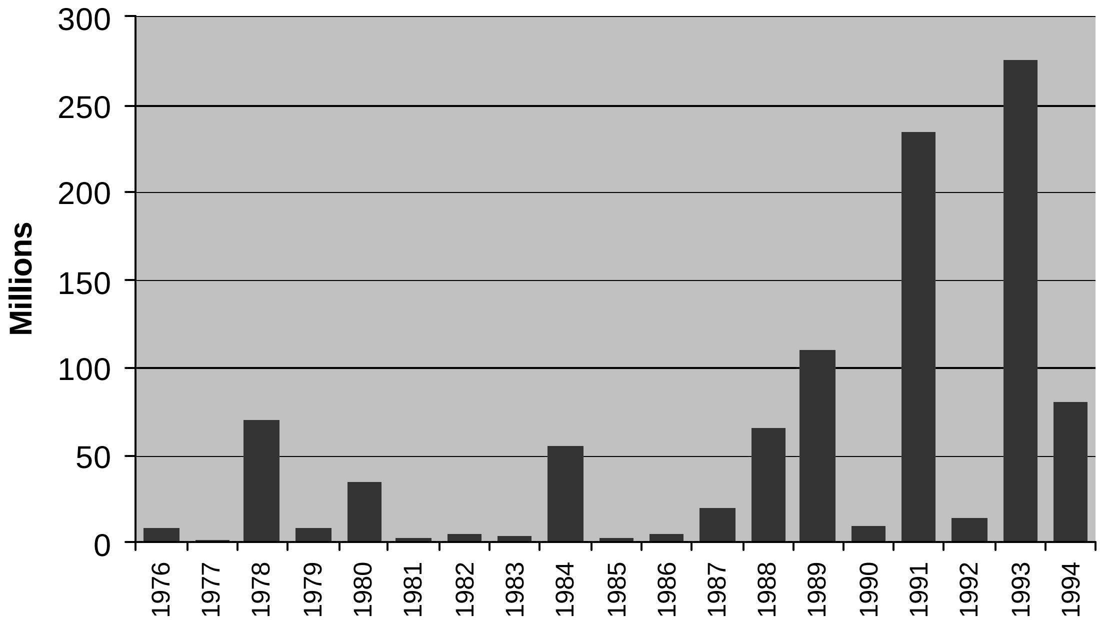
Zaman, M.Q. 1991. "The Displaced Poor and Resettlement Policies in Bangladesh." *Disasters*. 15(2):117-125.

Zeigler, Donald J. and James H. Johnson, Jr. 1984. "Evacuation Behavior in Response to Nuclear Power Plant Accidents." *Professional Geographer.* 36(2):207-215.

Zelinsky, Wilbur. 1971. "The Hypothesis of the Mobility Transition." *Geographical Review.* 61:219-249.

Table 1: Environmentally-Related Population Displacement, Asia and Africa.

Asia: Population Displacement by Natural Disasters, 1976-1994



Source: Compiled from UNDRO News, 1976-1994.

Displaced Population in Selected African Countries, September 1985

Country	*People Displaced (N)*	*Share of Population (Percent)*
Burkina Faso	222,000	3
Chad	500,000	11
Mali	200,000	3
Mauritania	190,000	12
Niger	1,000,000	16

Source: Jacobsen (1988:13)

Source: G.Hugo. 1996. "Environmental Concerns and International Migration." *International Migration Review.* Vol. 30, No. 1, Special Issue: Ethics, Migration, and Global Stewardship, p. 114 and p. 116.

Table 2: Percentage Distribution of Reasons for Moving Given by Local Movers, Outmigrants and Inmigrants, Three Mile Island Mobility Study.

	Local Movers	Outmigrants by distance		In-Migrants
Reason for Moving	0-5 miles	6-20 mi.	>20 mi.	
	N=72	N=125	N=107	N=164
Get away from TMI	7%	19%	19%	NA
Job related decision	7%	6%	43%	33%
Better location/better home	42%	28%	9%	23%
Marriage, divorce, or other living arrangement change	8%	13%	12%	11%
Other	35%	32%	17%	32%
Don't know	1%	2%	0%	1%
TOTAL	100%	100%	100%	100%

Source: M.K. Goldhaber, P.S. Houts, R.DiSabella. 1983. "Moving after the Crisis: A Prospective Study of Three Mile Island Area Population Mobility." *Environment and Behavior.* 15(1):p.105.