Environmental Stress and Health

John S Picou and Keith Nicholls, University of South Alabama, Mobile, AL, USA
Rainer Guski, Ruhr Universitat Bochum, Bochum, Germany

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Abstract

This article examines the relationship of environmental stress to disturbances in behavior, mental health functioning, and public health for people impacted by a variety of ecosystem disruptions. The biophysical environment has enduring characteristics that are intimately linked to human social systems. Economic, social, cultural, and spiritual connections between the 'social' and 'biophysical' environments have been compellingly identified in the literature. Such exchange relationships between natural and human systems establish continuous dialectical interactions, which often results in changes to both. Extreme environmental stress in the form of catastrophic natural and technological disasters seriously undermines the human condition and quality of life in the modern world. We will briefly identify the context of contemporary risk and review the health consequences of extreme environmental stress.

Risk and Environmental Stress

The changing nature of risk in late modernity has been chronicled in the writings of Ulrich Beck (1992) and Kai Erikson (1994). Beck notes that 'manufactured' (human-generated) risks threaten the safety of the biophysical environment, while Erikson identifies the consequences of such risks for humans as a 'new species of trouble.' The relatively recent emergence of human-generated environmental risks and the extensive depletion of natural resources have produced stress and disruption to ecosystem services, social organizations, and the dynamic relationships between these entities (Kroll-Smith and Couch, 1993).

As defined by Beck (1992), modern environmental risks are characterized by new issues and concerns for human communities. First, these new environmental stressors are global, invisible, and often undetectable by human sensory perception. Second, they transcend generations; for example, massive amounts of radiation can impact future generations through an increased likelihood of birth defects. Third, such risks preclude causal attribution so that survivors can never be adequately compensated for damages (Beck, 1992). Downstream toxic contamination involves myriad sources of air, water, and soil pollution, while death, declines in public health, psychological pathology, and the loss of community are not compensable damages. This insidious 'collective trauma' invades the human condition on a permanent basis, separating the self from others, eroding trust and social relationships through the establishment of uncertainty and dread as social norms (Erikson, 1994).

Such anthropogenic environmental stress can alter traditional patterns of social organization by draining social capital and producing systemic corrosive communities (Freudenburg, 1997). This recognition of the potential untoward consequences of manufactured risks for both the natural and social environments has resulted in a reconsideration of the types of disasters that will characterize the twenty-first century. Traditionally viewed as 'natural' (meteorological and seismological events) or 'technological' (human-caused contamination), modern disasters now include a variety of hybrid 'natech' disasters, as well as acts of terrorism. Although terrorism is not a 'new' political event, the post-9/11 disaster landscape must include these purposeful, violent acts as human-caused destruction that involves the release of toxic chemicals and massive devastation of the built environment (Marshall et al., 2003). Furthermore, hurricanes, floods, and tsunamis will potentially impact chemical production and energy facilities, which, in turn, release toxins and radiation into the environment. Hurricane Katrina and the Fukushima tsunami are two obvious examples of these modern natech disasters (Picou, 2009a).

When we relate these catastrophic types of disasters to environmental stress, it becomes apparent that such events have enduring characteristics, which are beyond the control of residents of impacted communities. Although people may consider the toxic contamination produced by technological, terrorist, and natech disasters as harmful to their health and well-being, they can actually do very little to cleanup or reduce continuing radioactive and toxic emissions. The reaction by government and corporate authorities is often framed within a narrative that exposure poses little or no threat to ecosystem vitality or public health, and that the cleanup and containment of toxins, radiation, etc. has been successful. Such admonitions only exacerbate the fears and uncertainties of a distrusting public, resulting in long-term corrosion of the social fabric. Such secondary disasters stall timely ecological and community recovery from these extreme forms of environmental stress. In short, the consequences of modern technological, terrorist, and natech disasters become debated or contested in their aftermath. From official accounts of damages to protracted adversarial litigation, there is no consensus achieved on the final consequences of the event (Picou, 2009b).

A summary of these catastrophic types of disasters is presented in **Table 1**. Developed by Erikson (1994), this 2×2 property space identifies the cause of the disaster (natural or human) and type of destruction (toxic or nontoxic) as the defining characteristics of catastrophic environmental stress. Secondary disasters result from toxic contamination produced by both natural and human causes, and a continuing spiral of social impacts emerge (Gill, 2007). Indeed, human communities lose social capital, while residents experience

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Table 1 Erikson's classification of disasters

	Cause	
Toxicity	*Human (technological)*	*Nature*
Nontoxic	Fires, dam collapses, airplane crashes, explosions	Hurricanes, floods, tornados, earthquakes
Toxic	Oil spills, toxic chemical spills, radiation leaks, toxic waste contamination, terrorism	Radon gas, natech scenarios – natural disasters that cause a technological disaster

Erikson, K.T., 1994. A New Species of Trouble: Explorations in Disasters, Trauma, and Community. W.W. Norton, New York.

deleterious medical and mental health consequences (Adeola and Picou, 2012, 2014).

The Context of Psychological Stress

Although there are many interpretations of how environmental risks and disasters impact people in the fields of medicine, sociology, and psychology, the Conservation of Resources (COR) stress model has been successfully used in research over the last 35 years (Hobfoll, 1989). As an explanatory framework, the COR model identifies resource loss, the threat of resource loss, and resource investment failure as primary determinants of psychological stress. This model considers four basic resources: (1) Objects (e.g., physical possessions, natural resources), (2) Conditions (e.g., good marriage; quality relationships), (3) Energies (e.g., money, knowledge), and (4) Personal characteristics (e.g., self-esteem, confidence). This comprehensive model predicts that psychological stress occurs when environmental risks and disasters alter values, produce extreme demands on individual and collective resources, overburden resource use, and produce strong mental damage (Hobfall, 1991). A variety of pathological psychological outcomes are predicted by the COR model, including anxiety, severe depression, posttraumatic stress disorder (PTSD), self-isolation, and anger. With technological, terrorist, and natech catastrophes comes acute uncertainty and dread on the part of survivors regarding the nature and extent of contamination and the future impacts of these forms of extreme environmental stress (Marshall and Picou, 2008).

Definitions of Environmental Stress

Although there are many different concepts of stress in the respective fields of medicine, psychology, and sociology, it is generally understood that stress is aversive for many people. Psychologists often employ the stress concept proposed by Lazarus (1966) and Lazarus and Launier (1978), which defines stress as a transaction between stimulus and response, i.e., the process that reflects the individual appraisal of a stimulus by persons who see an imbalance between environmental demands and their own response capabilities to cope adequately with the demands. A variety of mental health outcomes are associated with the recognition of loss or threat of loss to multiple types of resources conditioned by these stimulus/response transactions. These negative stimuli disrupt routine behavior and range from modest ambient stressors to cataclysmic events such as those noted above.

Characteristics of Environmental Stressors

Ambient stressors reflect continuous and intractable background characteristics of the physical environment (Campbell, 1983). Often unnoticed, the continuous hum of air conditioners, the permanent dust in an industrial area, and the faint hiss of the central heating system are common examples. People often adapt to ambient stressors, and they consider the costs of coping with such stressors to be more problematic than simply enduring them.

In addition, each type of environmental stressor can be categorized along several dimensions.

1. The major dimension is the degree of controllability over the environmental stressor (Campbell, 1983). Control may be either direct (e.g., switching off the neighbor's noisy lawn mover), indirect (e.g., closing the windows in order to reduce the noise penetration), social (e.g., calling authorities to stop the noise), or cognitive (e.g., knowing that the noise will stop in about an hour). Oftentimes, stress effects decrease with increased control, but control may have secondary stress effects (e.g., closing the windows will increase the temperature inside the house).
2. Related to cognitive control is the predictability of the stressor. High predictability of the occurrence and duration of an aversive agent may help people cope. For instance, residents in the vicinity of urban rail systems usually know the schedule of the trains and seldom complain about noise and vibration. Alternatively, knowing beforehand that a new airport will open in the neighborhood may cause greater stress effects than knowing that the old airport will close in the neighborhood (Hatfield et al., 1998).
3. Stressors may be more or less perceptually salient or identifiable. Some environmental agents are of rather low intensity and may either be not detected at all (e.g., low radioactive radiation), while others are only detected when intensity changes (e.g., the faint current of air conditioners). If an environmental agent is not perceptually salient, stress reactions may occur because people get informed about potential hazards. Such is the case for invisible and unknown toxic contamination.

Stressful life events also include incidents in the life cycle that require individual adaptive responses. Such events include changes in work, or residential environment, such as beginning a new job, moving to a new residential area, new construction work in the present residential area, or a perceptible change in the operating conditions of a nearby stressor. The event as such is usually short, but the behavioral consequences may extend through time.

Daily hassles are repeatedly occurring aversive events of ordinary life, such as arguments with colleagues, crowded classrooms, and traffic congestions on the route to work. Although they typically are more or less predictable, the individual has little means to avoid such hassles and their duration is rather short.

Variables Intervening between Stressors and Their Effects

Although varying degrees of environmental stress result in different social responses, it is also documented that the same stress exposure does not cause the same reaction in every person or in every situation. Situational, personal, and social variables determine whether an environmental agent becomes a severe problem for a person or a community.

There are variations in vulnerability to environmental stressors that characterize human populations (Donner and Rodriguez, 2008). The vulnerability model of environmental stress identifies socioeconomic status, gender, race, and age as examples of demographic vulnerability to extreme events (Thomas et al., 2013). On the other hand, the concept of resilience identifies the capacity of individuals, communities, and regions to resist, respond, absorb, and recover from extreme environmental stress. Resilient groups have the capacity to respond to environmental stress and recover from extreme disturbances in a timely fashion.

The Capital-Based Approach to Environmental Stress

Disaster researchers have identified five predominant forms of capital relevant to environmental stress: social, economic, physical, human, and natural (Portes, 1998; Aldrich, 2012). Social capital refers to the resources and abilities available to social groups through networks, trust, reciprocity, common values, and consensual rules (Bourdieu, 1986). Economic capital identifies the capacity to access financial resources, while physical capital refers to the scope and capacity of the built and modified environments. Natural capital refers to the abundance and availability of natural resources, while human capital refers to the coordination of all forms of capital to promote economic production. These forms of capital identify components for understanding vulnerability to extreme environmental stressors and the building of resilient responses to such events (Ritchie and Gill, 2007).

Case Studies of Catastrophic Environmental Stress

The following case studies briefly describe events that produced catastrophic environmental stress over the last 35 years.

Living in Contaminated Areas

Residential areas are sometimes built either on or in the vicinity of former industrial areas, and this can cause severe public health problems. One of the more infamous examples is Love Canal (Levine, 1982), a neighborhood in Niagara Falls, New York. This residential area was used by Hooker Chemical Company to bury 21 000 tons of assorted toxic waste. The emergence of chemicals in the air, water, and soil were detected in 1978, and health authorities warned the residents about the exposure risk. Over 900 families were evacuated. Despite attempts to cleanup this environmental tragedy, current residents have filed lawsuits and the physical and mental health impacts have had serious consequences for many residents (Levine, 1982). These negative outcomes include cancer, heart disease, anxiety, and severe depression.

A more recent example of residential contamination comes from the Wingate community in Fort Lauderdale, Florida. A municipal incinerator operated in this neighborhood for over 24 years and subsequent environmental testing revealed dioxin, mercury, arsenic, furans, and other carcinogenic compounds in the water and soil (Bevc et al., 2005). Research conducted 30 years after the closing of the incinerator found that physical symptoms of medical illness were related to exposure to chemicals, consumption of contaminated food, and mental health problems (Bevc et al., 2005). The human impacts of living in contaminated communities are serious for both the medical and mental well-being of residents and persist for extended periods of time (Edelstein, 2003).

Living with Nuclear Power Plants

Although the nuclear industry spends billions of dollars for public relations in the hope of changing public attitudes regarding the safety of nuclear power plants and nuclear waste, the general attitudes in Western societies remain skeptical. Such public responses are caused by the experience of technological catastrophes like Three Mile Island (TMI) in 1979 and Chernobyl in 1986. Seven years after the catastrophe at TMI, residents living near the damaged reactor reported more chronic stress symptoms and sleep disturbances than did control subjects (Davidson et al., 1987). The final health impacts of Chernobyl will never be known. However, increases in thyroid cancer have been documented in addition to those deaths reported in the first 4 months following the meltdown. Over 350 000 people were eventually evacuated from the highest radiation-contaminated areas. The psychological effects of these technological catastrophes on residents differ from those of natural hazards in many ways, e.g., they are more long lasting, and residents lose faith in public communications of authorities with respect to safety and control of health risks (Erikson, 1994).

The catastrophe at Chernobyl caused severe psychological changes in the European population, especially with respect to the evaluation of nuclear power, the probability of a nuclear accident, and the health risks for children (Drottz-Sjöberg and Sjöberg, 1990; Hüppe and Janke, 1994). Many social scientists believe that the inconsistent risk communication policies of public authorities has contributed to the stress symptoms of residents who were minimally exposed to direct nuclear radiation. At this time, the TMI-2 reactor is permanently out of operation and contains no radioactive materials or waste. The Chernobyl reactor is covered by a concrete sarcophagus, which will be replaced with a new, safer shelter in the future.

When Oil Invades Our Water

On 24 March 1989, the supertanker *Exxon Valdez* slammed into a well-marked reef in Prince William Sound, Alaska. Over 11 million gallons of crude oil were released into one of the most pristine marine ecosystems in North America, causing massive death and destruction of fish, birds, and a wide variety of marine mammal populations. Over 25 years of longitudinal research on ecological and social impacts clearly reveal severe consequences for both the natural and human environments. Four years after the *Exxon Valdez* oil spill, the herring fishery collapsed, and to date this critical commercial and subsistence fishery has not recovered. Toxic impacts continue to be documented for sea otters, harlequin ducks, and many other species that are still being exposed to lingering oil in the spill area (Rice, 2009).

Research on the social and psychological impacts of the *Exxon Valdez* spill clearly reveal long-term economic, mental health, and community impacts. High levels of PTSD, depression, and community conflict persisted in Cordova, Alaska, for nearly 20 years after the spill (Picou, 2009b). As ecological impacts emerged over time and the protracted civil litigation continued until 2008, commercial fishers, Alaska Natives, and plaintiffs in the litigation were found to be at high risk for psychosocial damages (Picou et al., 2004; Gill et al., 2014).

On 20 April 2010, the Deepwater Horizon drilling platform, located 50 miles off the Louisiana Coast in the Gulf of Mexico, exploded, resulting in the release of approximately 200 million gallons of oil over a 3-month period. The immediate socioeconomic impacts for commercial and recreational fishing, tourism, and other coastal industries were devastating. Indeed, in the months after the explosion severe mental health impacts, similar to those of the *Exxon Valdez*, included uncertainty, PTSD, and suicides (Gill et al., 2011). The ecological consequences of this extreme form of environmental stress for the Gulf of Mexico will be monitored for many decades in the future. Furthermore, like the earlier *Exxon Valdez* spill, litigation will also continue well into the future, creating a context for prolonged disruption and stress for coastal residents.

Hybrid Forms of Environmental Stress

Natural disasters often have destructive consequences for chemical production systems, oil refineries, and local sources of toxic chemicals. This 'natural–technological synergy' results in technological failure, ecological contaminations, and toxic exposure for humans, creating a worst-case context for environmental stress. Air pollution, sediment contamination, and the movement of chemicals through the floodwaters of New Orleans from Hurricane Katrina created a classic natech disaster. In short, Hurricane Katrina was not only a massive meteorological event, but also a massive contamination event. The fact that Hurricane Katrina caused the release of 8 million gallons of oil is often overlooked by disaster researchers. At that time, this was the second largest oil spill in North American history, with only the 1989 *Exxon Valdez* releasing more oil (Picou, 2009a).

Earthquakes are another natural occurrence that can precipitate a natech disaster. Such was the case when a magnitude 9.0 earthquake struck off the coast of Japan on 11 March 2011. The quake generated a 50-foot tsunami which, in turn, damaged the Fukushima Daiichi nuclear power plant, resulting in a massive release of radioactive contamination. In addition to that released, a vast amount of radioactive water is being stored at the site. Cleanup and decontamination are expected to take decades. While there have been no deaths attributed directly to the radioactive release, hundreds died as a result of the ensuing evacuation and relocation of area populations. In addition, those exposed to radiation will experience severe stress and anxiety associated with the increased risk of cancer and birth defect for the rest of their lives and into the next generation.

Conclusions

Environmental stress must be framed in the context of modern risk. The global, uncontrollable, and invisible nature of contemporary risks produces extreme forms of environmental stress that threaten public health. The dual risks of natural and technological disasters will continue to challenge ecological resources and the social well-being of human populations throughout the twenty-first century.

See also: Ecology and Health; Globalization and Health; Injuries and Accidents: Psychosocial Aspects; Natural Disasters: Health-Related Aspects; Unemployment and Mental Health.

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