

University of Delaware
Disaster Research Center

PRELIMINARY PAPER
#186

THE ENVIRONMENTAL DISASTERS OF
THE FUTURE WILL BE MORE AND
WORSE BUT THE PROSPECT IS
NOT HOPELESS

E. L. Quarantelli

1992

DRC PRELIMINARY PAPER #186

THE ENVIRONMENTAL DISASTERS OF THE FUTURE
WILL BE MORE AND WORSE BUT THE
PROSPECT IS NOT HOPELESS

E. L. Quarantelli
Disaster Research Center
University of Delaware
Newark, Delaware, 19716 USA

Abstract

On the global scene, but particularly in modern societies, we are inevitably faced with more and worse disasters in the future. There will be both quantitative and qualitative increases in the negative direction. This stems from two major ongoing trends---industrialization and urbanization---inherent in the very structure of modern social life. The first trend almost assures that disaster agents and occasions will increase. The second trend is raising the risks and vulnerabilities of impacted populations and societies. To recognize these upcoming transmutations in disasters is not to argue that nothing can be done by way of disaster planning. In fact, our view is just the opposite; a clear recognition of the reality of what is very likely to occur in the 21st Century will allow more effective and efficient disaster planning than we have had up to now.

*This is a more extended written version of the briefer oral remarks made at the opening Plenary Session of the 4th Disaster Prevention and Limitation Conference on September 8, 1992 at the University of Bradford, England. For specific references and a bibliography see E. L. Quarantelli, *More and Worse Disasters in the Future: The Social Factors Involved*, Preliminary Paper #173, Newark, DE.: Disaster Research Center, University of Delaware, 1991; see also, E. L. Quarantelli, "Urban vulnerability and technological hazards in developing societies". Pp. 187-236 in Alcira Kreimer and Mohan Munasinghe (eds.) Environmental Management and Urban Vulnerability. Washington, D.C.: The World Bank, 1992.

The Coming Century

We are moving into the 21st Century. It is only a few years off. But it is safe to say that its social landscape and features will be rather than different from that in which we have lived in the 20th Century. What is in place now and was in being a generation ago will be rather different in the next generation.

Massive social changes of all kinds are happening in the political, economic, familial, cultural, and educational areas. These are not only occurring in the developing nations of the world and in Eastern Europe too in the wake of the collapse of the Soviet Empire, but also in the developed societies, found mostly in Western Europe as well as in Canada, the United States, Australia and a few others countries elsewhere. The most important structures and activities of human life are drastically changing. This can be seen in many ways. Just think of the new family forms and the role of women, the democratization of governments and the rise of citizen activism, the complicated ways goods and services are being marketed and distributed, the growing dominance of non-traditional artistic and musical forms, or the different means such as computers being used for training and educating people.

The societies of the 21st Century will have, if existing trends continue, cultural values and beliefs which emphasize productivity of goods, economic growth, national wealth and international competitiveness. This orientation is based on improving technology and its application in all spheres--agricultural, industrial and informational. The continuing drive towards technological growth and application means an acceleration of long standing trends towards structural differentiation and complexity which are mostly to be handled by bureaucratic organizations, increasingly centered in urban localities. This is also accompanied by increasing pressure towards democratization which includes a drive for the rights of citizenship, inclusion and participation in the polity, equality, justice, and adequate welfare provisions. All these factors will affect the appearance, characteristics and dynamics of disasters, and the planning and managing of such occasions.

Among the social changes we particularly want to note are two. They are not totally new but they are massive and accelerating in their recent manifestations. We have in mind the ever increasing industrialization of the world as well as the quickening of the urbanization process. Industry with its accompanying new kinds of technology is spreading everywhere. This is paralleled by an ever increasing involvement of populations in an urban way of life concentrated in constantly enlarging metropolitan areas (by the year 2010, there will be 511 metropolises exceeding a million inhabitants each and for the first time the world population will be predominantly urban, 51.8%; 15 years later, there will be 639 metropolises of over a million persons).

Now these two related processes, that of industrialization and of urbanization have consequences for disasters. They insure that in the near future we will have both more and worst disasters. Built into the very nature of social life as they are, industrialization and urbanization will of necessity quantitatively increase and qualitatively worsen the disasters of the 21st Century.

In the next two sections of the paper we want to illustrate and explain why this will happen.

In the main, we will be talking about disasters, those crisis occasions generated by the threat of or the actual impact of relatively sudden natural and technological disaster agents (such as earthquakes, toxic chemical spills, floods, radiation fallouts, hurricanes, forest and brush fires, landslides, explosions, volcanic eruptions, structural failures, tornadoes, transportation wrecks and crashes, avalanches etc). To a lesser extent our comments are also applicable to slow moving and/or very diffuse agents such as are involved in social occasions like famines, droughts, epidemics, toxic poisonings through hazardous wastes, radiation contaminations through radon gas, many air and water pollution episodes, etc. Because of time limitations we will leave aside discussing the applicability of our observations for other even more different kinds of crises, especially the ones involving social conflicts such as in civil strife, revolutions, riots, terrorist attacks, acts of sabotage, product tampering, etc., although our belief is that these also will increase in the future.

Increases in Disaster Agents and Occasions

1. There are new and escalating kinds of technological accidents and mishaps that were almost non-existent prior to World War II and that will increasingly result in disasters.

To the category of so-called natural hazards the human race has been increasingly adding a relatively newer category of technological accidents and mishaps. These are the disasters in the technological area resulting from human errors and collective mistakes of groups. To the "Acts of God", we have now added the "Acts of Men and Women" or "Society".

Technological hazards are a relatively new class of danger which contemporary society is only just beginning to recognize. Disaster wrought by the unintended consequences of technology has largely been a product of the large-scale industrial development initiated by the 18th century industrial revolution. Mishaps associated with technology have occurred since the first tool was developed by a human. However, the scale of consequences, in terms of social disruption and the endangering of the social infrastructure, only reached significant proportions with the development of large industrial complexes to mass produce myriad goods.

This and the activities associated with industrialization--the discovery and invention of new energy sources together with large-scale production and storage requirements; the establishment of transportation modes, haulage routes and depots; the need for disposal of unwanted wastes; increasing amounts and dangers from atmospheric pollutants; the development of mass transit modes, networks and stations--have produced conditions which have jeopardized public safety and enlarged community vulnerability. Unfortunately, because of the increase in industrialization, they will increasingly create greater risks and eventual disasters.

The major technological threats are currently in the chemical and the nuclear area. The manufacture, processing, transportation or distribution, storage, and the application or use of many products of these two areas are inherently hazardous. They almost insure quantitatively more and qualitative worse future disasters.

a. The chemical area.

Chemicals have truly transformed the world and modern societies are impossible without them; their use reflects a widespread desire to have higher standards of living and particular lifestyles which otherwise could not be achieved. The technology of chemistry has been consciously developed and applied because of the perceived and actual benefits involved.

However, there are multiple risks associated with the production, transportation, storage and use of dangerous chemicals for there are multiple ways in which human and other organisms, plant life and fauna, and physical material objects can be destroyed, damaged or other directly negatively affected by a dangerous chemical. A chemical emergency or disaster can involve many perilous happenings unlike a typical earthquake or a volcanic eruption. The referents of the term "chemical hazard" are multiple .

Even localities which in the past had none or few risks from natural disaster agents, are now vulnerable if they have any roads, railways or navigable waterways in the vicinity of toxic chemical spills, explosions, or fires. In a sense, the development of major transportation infrastructures has reduced the geographic selectivity of possible disaster impacts. Almost any inhabited areas of societies have now become vulnerable to disasters from hazardous chemicals even though there be no manufacturing, storage or use facilities in the vicinity. Not all developed societies or communities within them are subject to major natural hazard threats; but now almost all are as they are increasingly subject to risk as dangerous chemicals are more and more moved around.

Furthermore, the threat of greater disasters of this kind is increasing because of the greater amounts of dangerous material involved. In addition, to the in-plant and transportation kinds of acute chemical types of disasters, we have also been adding the

more slowly developing and diffuse types associated with hazardous waste sites. Love Canal and Times Beach in the United States as well as Seveso in Italy are examples of what we may expect more in the future. In fact, the Seveso Directive issued in 1982 by the Council of European Communities accepts the probability of such future disasters by attempting to set as legal policy the idea that citizens must be adequately informed of the nature of and extent of existing hazards, the planning measures being undertaken, and what might be expected of a disastrous occasion.

b. The nuclear area.

Another increasing source of danger is the nuclear power industry. It has less than a half century existence. But it was developed because it initially seemed to offer a relatively dependable and relatively inexpensive source of energy especially for industrial expansion, compared with other energy sources such as oil which was seen as eventually depletable and increasingly costly to obtain. A move in the direction followed made much economic sense.

However, the risks associated with nuclear power has been illustrated, first by Three Mile Island, then Chernobyl. We may expect more along those lines given that there are over 435 commercial nuclear plants in existence at present. It should be noted that such a happening could pale the negative effects and consequences of Chernobyl, which contrary to much popular and even official thinking was far from a worst case scenario.

Apart from in-plant nuclear plant problems there are the risks associated with the transport of nuclear wastes over long distances. In the long run any society that presently has nuclear plants will be faced with the problems stemming from their necessary and eventual decommissioning. The large volumes of radioactive wastes resulting from the dismantling of such nuclear facilities will pose problems of disposal. The material is going to have to be transported from many places to some chosen sites, and naturally that raises the probability of some accident in all countries undertaking such transportation.

2. There are technological advances that reduce some hazards but add complexity to old threats.

Of course modern technology can and is used to try to eliminate or reduce some risks. The medical health area is marked by any number of such successful efforts. Unfortunately, sometime the positive consequences are accompanied by negative effects of a different kind. There are two aspects to this: (1) preventive or protective measures which indirectly lead to other kinds of possible disastrous occasions, and, (2) the scale of chain reactions possible in modern societies which as a result of network linkages can turn a minor emergency into a major disaster.

An example of the first is fires in high rise buildings. In combination with the highly combustible and toxic construction and furnishing materials presently used, they have brought an additional threat dimension to that kind of situation. We prevent people from being burned by raising the probability of their being asphyxiated. Even plane crashes are interesting along this line. Research has shown that the ensuing fires generally kill more passengers than the crash itself. Eighty percent of those that do die from the fire actually succumb to the gas and smoke from the lightweight burning cabin material! It is more economically to use less heavy material which however is not fire proof.

Technology sometimes is used in efforts to improve safety and reduce the possibilities of accidents and mishaps. This is a laudable effort but not necessarily always achieved. This can partly be seen in the following quotation from Lee Thomas, a one time head of the US Environmental Protection Agency. He said:

It is entirely possible that somewhere in the country toxic metals are being removed from the air, transferred to a waste water stream, removed again by water pollution controls, converted to a sludge, shipped to an incinerator and returned to the air.

He is pointing to the fact that many technologies that reduce or prevent the development of certain kinds of risk or environmental threats do so by solutions that can generate their own dangers.

As another example, in meeting the Clean Water Act of 1972 in the United States, the waste water treatment of sewage can lead to the production of sludge which will contain viruses, toxic substances and heavy metal. The sludge can be treated, but this will frequently produce methane gas and carbon dioxide. The latter in turn may contribute to the greenhouse effect which is warming the earth, which can lead to changing climatic and agricultural patterns, and may contribute to the melting of the polar ice caps and the subsequent rise of ocean levels. This last point is a controversial one, but if accepted, it indicates the probable flooding of many seaport cities in the developed world. So, an initial good measure may set off a chain reaction of bad effects.

But the linkages between happenings which may have ultimate negative effects, can be even more direct. This is because as technologies are elaborated and enlarged to meet the economics of scale, a small mishap at one point can bring down the total network or system. It has been noted that while small scale failure can be produced very rapidly, but that large scale ones can only be produced if large amounts of time and resources are involved. For example, there have always been electric power system failures. In fact, outages occur on a small scale almost every day even in developed societies. They are recognized as such, and coped with

as normal emergencies by the public utilities. But not only can something in a far distant place have local effects, but the complicated linkages almost insure that sooner or later there will be large scale effects as in the widespread blackout in 1965 which occurred in southern Canada and the northwest United States.

Perhaps many of the potential problems are summarized in a statement by an expert on telecommunications networks. He stated that the public switched networks are becoming more vulnerable to disruption because of the introduction of new technologies. Because of economic incentives to cut the costs of normal commercial operations, networks being developed are being designed without sufficient attention to emergency preparedness. Accidents, and disasters threaten networks of tomorrow with more extensive damage than they did yesterday's integrated network. Our Information Society relies on smoothly functioning communication networks, so consequences of network failure will be more severe.

3. New versions have developed of old or past dangers.

Certain dangers that take particular forms have been around for centuries. But in modern societies, new versions of the risks involved have taken new forms especially as large scale cities have come into being. Inevitably these kinds of communities require elaborate lifeline systems that literally are the physical or mechanical infrastructures on which they rest. For a small village, a well or two can provide the necessary water; for metropolitan areas, distant reservoirs, dams, pumping stations, pipelines and gauges, monitoring points, etc. linked together in complicated ways are needed to generate and distribute the water. This can create new versions of old or past dangers.

For example, droughts used to be thought of as mostly a rural problem. This is no longer the case. Increasingly in different parts of the world, urban and metropolitan localities are finding themselves faced with shortages or reduced water supplies. In the future there will be a disaster if a major section or all of an urban area runs out of water or has enough only for the most necessary of water needs. This is most likely to occur in combination with the collapse of a major tunnel, pumping station or other critical facilities of a water supply system.

This last probability is increasing because of a deteriorating physical and public works infrastructure of lifeline systems in a large number of older cities. The prevalence of decaying bridge and tunnel structures, crumbling highways, obsolete and overloaded waste water and sewerage treatment plants, worn out sewer and water mains, aging subway systems, suggest a variety of many potential disastrous possibilities beyond the isolated and occasional accidents of the past. There are also aging pipeline systems that were initially put in place for an expanding industrial sector.

None of the actual or potential disasters we have mentioned above are totally new, at least in the geophysical or physical sense, but they represent new versions of old threats, either because of where they could occur or the large scale nature which they can assume.

4. There is the emergence of new kinds of technological accidents and mishaps that can and will lead to disasters.

a. Developments in computer technology.

A major new threat that is developing is associated with all the disastrous consequences that will come from the computer revolution that human society is presently undergoing. Use of computers undoubtedly have improved disaster planning and managing, as well making life easier for most of us in many ways. But our increasing dependence on computer technology will magnify future disasters and turn some minor emergencies into major crises. This is particularly true in that many sectors of government and business are increasingly computer based for the data and information they need to function, sometimes literally from minute to minute. Thus, it can be predicted with certainty that computer systems and their networks will, for various reasons, cease to function, or function incorrectly (and we leave aside deliberate sabotage by the use of computer viruses). We will then have a really **new** kind of disaster--a computer disaster, with all kinds of negative chain reactions of an economic and social nature.

b. Biotechnological advances.

There are also going to be disasters that will be produced by biotechnology, especially genetic engineering. Basically, this technology involves altering the blueprint of living organisms--plant, animal or human--and creating new characteristics, some of which are very useful (e.g., various kinds of oil and chemical waste eating bacteria have been created that can be used to help clean up spills!). However, there clearly are all kinds of potential disaster possibilities with this kind of technology. There can be and will be the creation of, or the escape from control of, some altered organism that cannot be checked by present known means. Our ability to custom design living organisms almost insures that one day there will be some almost Frankenstein-like bacteria, plant or animal let loose on the world.

We feel as confident in making the assertion that biotechnology will similarly bring us a major disaster sooner or later. In fact, just as the 1970s was the time when the world became aware of nuclear power threats, the 1980s of the chemical hazards risks, the decade of the 1990s could very well be when we have a Chernobyl or Bhopal-scale like biotechnological disaster.

We are not anti-nuclear power, against the development of new although hazardous chemicals, or anti-genetic engineering; the industries and activities involved have and will continue to improve human and social life. But it is a fact that they also bring with them certain risks that will produce major disasters.

5. There will be an increase in multiple or synergistic type disasters resulting in more severe impact consequences.

There has been very little recognition given to the fact that natural disaster agents will increasingly generate or magnify concurrent technological disasters (and even possibly in the other direction). Increasingly so, because of the increased production, transportation and storage of hazardous substances of all kinds, natural disaster agents which in the past would have simply been natural disasters can now create technological disasters. For instance, a flood could inundate a chemical plant complex. The convergence of a tornado and a radiologically active cloud could pose a very threatening situation. As an example, in 1961, windstorms spreading radioactive material (plutonium and strontium) in the Lake Karachay region in the Southern Urals increased by about 30 to 50% the land area previously contaminated by an earlier nuclear disaster in Russia. The earlier technological disaster was magnified by a later natural disaster agent.

Not often noticed is that at least hypothetically is that this process could also go in the other direction. For example, an MIT study recently suggested that continuing pollution may result in stronger hurricanes. Continued air pollution that increase carbon dioxide levels, according to this research, could make some hurricanes up to 60% stronger in the next century. This last example suggests that not only are disaster agents and occasions increasing, but that because of human and group behavior, there will be an enlargement of social risks and vulnerabilities in the future, a matter to which we now turn.

Enlargement of Social Risks and Vulnerabilities

Parallel to the increase or negative changes in disaster agents, are certain transformation in the populations and communities which can be impacted. The end result of these social trends, mostly stemming from the urbanization process, is an enlargement of social risks and vulnerabilities, especially for modern societies. Thus, even if there had been absolutely no change at all in agents or occasions, we could still expect more and worse disasters just from the changes that have and are occurring in the individuals and groups, that are potential candidates for impact in the future.

1. Both natural and technological disaster agents will simply have more to hit and along some lines will have greater impact.

It is easy to overlook that natural disaster hazards have consequences only in a social context. Now such physical agents are probably not increasing per se (at least on any observable human time scale). However, what any physical agent can socially impact has and is changing.

Many different regions of many countries are being subjected to unprecedented population growth, building of structures, and economic development. For a variety of social reasons, many areas are being built up. This means that more than ever before there are greater number of people and greater amount of property vulnerable to the risks of different disaster agents. For example, there are more people and settlements than ever before in riverine flood plains. Because of social factors, where in the past there was marsh or swampy areas, there are now housing complexes and industrial parks. The same picture could be drawn for earthquakes, tornadoes, and volcanic eruptions (and of course the same is true for technological agents). There is simply more of a built environment they can impact. Where empty or very sparsely populated space might have been hit in the past, in the future many people and developments will be hit.

There is practically nothing of the reverse process, that is, abandonment or withdrawal of human activity from dangerous areas.

A way to document the probable greater future impact is to ask the following: if the last major natural disaster to hit an area were to hit exactly in the same way now or in the future, would there be more or less of an impact? We think almost all would say more.

Additionally, there will not only be more impact from the commingling of both natural and technological disasters, but the quality of the impact in some cases could be worse. For instance, in the United States, Canada and most of Western Europe (except in Italy), there have been only a handful of disasters in recent times where more than 1,000 persons have died. But some of the future possible disasters could create dead victims well in the high four or even five figures. Even handling relatively few dead bodies in most modern societies generates all kinds of problems from logistic ones of finding enough caskets to psychological ones of coping with dead bodies. Future disasters with numerous dead bodies will sharply increase those kinds of problems.

We can not only be certain of the happenings of certain kinds of technological disasters, but they too can result in qualitatively worse results than certain other kinds of disaster impacts. For example, chemical poisonings and radiation contaminations often require complex, sophisticated and labor intensive kinds of medical treatment. They can and do put much more of a strain on emergency medical services than the "ordinary" disaster. Often in these kinds of disasters, material things, equipment, land, can be polluted and contaminated in ways different than the usual. The cleanup is often far more costly and requires more specialized

knowledge than is usually the case, say after floods or earthquakes. Also, in some instances, there are second order effects; for example, health consequences can surface years later, a major concern in Russia and the Ukraine following Chernobyl.

2. More vulnerable kinds of population will be impacted than in the past.

Populations in future disasters, because of social changes--some of lifestyle, others of a demographic nature--will be more vulnerable to negative effects.

Changes in lifestyles can increase vulnerabilities to disasters. For example, notions of leisure times and vacations are very widespread in developed societies. This in turn leads to the creation of certain kinds of resort areas which are particularly vulnerable. Such changes in lifestyles are leading more people to be tourists in resort areas at risk from such happenings (a similar pattern is true in Europe with respect to avalanches in ski resort villages). Also, increasingly families are building second or vacation homes in wildlands that are rather vulnerable to brush fires. This is in addition to the encroachment of homeowners whether in the French Riviera or southern Florida on land which used to be much more sparsely populated in the past.

Then there are other even more fundamental changes in family patterns; the form of the family has been changing. For example, more and more, the traditional type of the family known as the nuclear one, a husband and wife with children, is less and less the dominant form. Households are increasingly made up of members that consist of single people, childless couples, both male and female single parents, unmarried same or different couples such as heterosexual partners and gay couples, as well as unrelated roommates. Much disaster planning implicitly assumes that most households will be made up of nuclear families. But this is a diminishing social pattern. Furthermore, the other types of growing kinds of households all present different kinds of issues and problems for disaster planning and managing.

Then there have been and are changes occurring in the demographic characteristics of populations in modern societies. These can result in qualitative changes in vulnerability. As an example we may note that we are increasingly getting an older population in at least the majority of developed countries around the world. For various reasons older persons tend to live in areas which are more subject to risks such as the state of Florida in the United States. But irrespective of where they live, it is known that older people among other things are proportionately more likely to be injured in disasters. In addition, older victims find it more difficult to make up for property losses; in fact, the elder have proportionately more to lose.

There will be increasing risk for those already at social disadvantage in a community. The poor are the most vulnerable in several ways. They generally live in more dangerous locations such as flood plains or around chemical plants. Also, the poor at risk are less able to cope with the losses to be expected in disasters. The problem is compounded by the fact that certain of these populations in urban areas are particularly heterogeneous, which we will now discuss.

3. Increasingly metropolitan areas will be impacted: along certain social lines, they are not well suited for coping with disasters.

For a variety of reasons, some of which have already been indicated, cities and metropolitan areas will be increasingly subjected to disasters. In general, the social characteristics of such localities will tend to increase the difficulties in many kinds of crises because of the highly bureaucratic nature of urban organizations, and the heterogeneous sociocultural patterns of urban groupings. Since both make planning for and managing disasters more difficult, the more there are disasters in urban areas, the more there will be problems.

a. Urban bureaucracies.

It is necessary to avoid stereotypic and negative notions of bureaucracies when discussing such types of social organizations. It is nevertheless true that bureaucracies are not the social organizations best adaptive to cope with fluid and ambiguous occasions, among the very hallmark of the emergency periods of crises. Disasters involve nonroutine occasions. In those kinds of situations, as disaster studies have consistently found, new or emergent rather than traditional or standard behavior patterns are more adaptive for the demands or problems that surface.

When faced with survival or serious loss threatening catastrophic events, organizations are often advised to adopt radical or frame-breaking changes. However, research indicates that threatened organizations tend to do exactly the reverse: they tend to be rigid and detached, relying on existing strategies, routines and resources to pull them through such occasions. Put another way, since bureaucracies are not the best social organizations to prepare for and respond to disasters, their presence in the midst of such crises, can only magnify the problems that will appear.

b. Heterogeneous subcultures.

It is widely believed that many segments of urban populations live in very disorganized and anomic social settings. This is incorrect. This perception usually reflects the view of dominant and majority groups when they look at the non-mainstream social groupings that increasingly live in urban areas. But far from

disorganization and anomie, what is present are different social worlds and subcultures whose members have different values and beliefs than the dominant social pattern and culture, many of these stemming from different ethnic and/or religious backgrounds. Many of the cities in developed countries be it Germany or France, Canada or United States, have especially been the end point of migration from developing countries. A major consequence is that heterogeneity characterizes their urban way of life.

These kinds of population mix can affect disaster response in a variety of ways, make disaster planning even more complicated than usual, and generally raise the risks and vulnerabilities for the persons and groups in the mix. For instance, some ethnic and minority groups see hazards differently from other groups, with some assuming natural hazards can be overcome and others assuming human beings have to accept and adjust to threats. Depending on the belief, this can affect efforts at disaster mitigation or prevention. People from different cultures can also vary in their support for protective actions, with some taking a somewhat fatalistic and resigned position because of certain kinds of religious values. Adoption of emergency preparedness measures can be affected by this. Also, some groups have very extended kinship systems which can provide considerable support at times of crises; conversely, other disaster victims because they trust no one other than their own, may have few or none to turn to for social support. As another example we may note that studies show minorities often have the most problems recovering from disasters because they frequently are not that socially visible to those providing help.

Our point is that any kind of sociocultural mix along any of the lines indicated will complicate and generally make less efficient and effective any aspect of disaster planning or managing. A relatively homogeneous population is much easier to plan for and will have less risks and vulnerabilities in disasters.

4. Increasingly, localities will have disastrous conditions from disaster sources that may be quite distant.

An interesting pattern for some disasters of the future is that their source and their point of impact may be quite distant from one another. Sometime impact is within a limited geographic area, although threatening localities away from the original risk source. For example, a chlorine gas cloud in Florida drifted about 28 miles from where a train accident occurred; if the same derailment had occurred in a metropolitan area rail yard, millions of people would have been put at risk. As another example, a 1980 pollution episode of the Po River in Italy extended over a 60 mile stretch.

But more important are when hazardous effects go over important jurisdictional boundaries. sometime of nation-states. For example, the 540 mile Meuse River arrives in Maastricht, The Netherlands loaded with human sewage and chemical waste picked up earlier

upstream in France and Belgium. As is well known, the radiation fallout from Chernobyl fell in various parts of the world, but especially in certain European countries. The even more recent example of pollution in the Rhine River which starting near Basel, Switzerland, affected about six different nations and polluted upriver for almost 800 miles, or the Ohio River pollution which had severe consequences for several states are again harbingers of what we might expect more in the future. In fact, West Europeans have recently expressed concern for future risks to themselves, not over their own nuclear plants, but from deteriorating facilities in Eastern Europe, especially the six nuclear plants in Bulgaria which produce about 40 percent of the country's electricity.

Consequences at a distance are not confined to technological type disasters. A Japanese bank recently analyzed the effects on the world economy as a result of a major earthquake in Tokyo. It projected that because of the central role of Japan and the internationalization of financial markets, the economic after shock would be felt around the world. It noted that in 1987, some 18.7% of the about two billion in foreign money which flowed from abroad into US securities came from Japan. The report also estimated that if the earthquake had occurred in 1988, world economic growth would have been curtailed by 0.3 percentage points in 1989; by 0.9 percentage points in 1990; by 1.5 points in 1991; by 2.1 points in 1992; by 2.4 points in 1993 and by 2.6 points in 1994.

Additionally, certain kinds of technological type disasters can reach far away in both time and space. This occurred in a PBB pesticide poisoning in Michigan in the 1970s which worked its way into the second generation, the children of the original victims later living thousands of miles away from the original pollution source. We might especially anticipate the more slowly moving and diffuse kinds of disaster threats to cut across such space and time dimensions, and we can expect them to increase in the future.

5. Certain of the future disasters have catastrophic potential even if they would occasion no casualties nor have physical impact.

Some disasters in terms of their direct effects would be primarily economically costly. It has been noted, for instance, that early discussions of disasters equated the magnitude of impact to the number of people killed or injured, or to the amount of property damaged. Unfortunately, things are not this simple. The accident at Three Mile Island provided a dramatic demonstration that factors besides injury, death, and property damage impose serious costs. Although there was not a single death at TMI and that few if any latent cancer fatalities are expected as Slovic has written:

no other accident...has produced such costly societal impacts. The accident...certainly devastated the utility that owned and operated the plant. It also imposed enormous costs

(estimated at 500 billion dollars...) on the nuclear industry and on society.

It did this through stricter regulations and the reduced operation of reactors worldwide, greater public opposition to nuclear power and greater reliance on more expensive energy sources, and increased costs of reactor construction and operation.

As a variant of this, we may note that some future disasters will be very socially disruptive, less because of their direct physical effects, but from consequences because of the way they will be perceived. A good example of this occurred in Brazil a few years ago. A cancer treatment machine abandoned in a junkyard released some dangerous cesium 137 which through radiation contamination killed about four people and seriously affected about 44 others.

But far more consequential was the perceived risk to anyone in the affected locality, namely Goiania, Brazil. The occasion is almost a classic case of the potential negative impacts of perceived risk. Over 100,000 residents out of a total population of about one million in the area underwent Geiger counter examinations to detect possible contamination; it was reported that about 8,000 formal certificates were issued to counter the effects of being stigmatized as a hazardous carrier of radiation. This was not an unreasonable coping effort since the anxiety over potential contamination led hotels elsewhere in the country to cancel reservations of persons from Goiania, buses and airplanes to refuse to take Goianians as passengers, and some doctors and dentists to take new patients who did not have the certificates. There was also cancellations of scheduled conventions in Goiania. One estimate was that regional tourism fell over 40% and it was reported that property values fell, with sales levels for the entire city and state being affected. Possible as much as 50% of the state's export sales were lost during one month with the area's agricultural products being boycotted (or purchased at 50% of value). Even textiles and clothing manufactured in Goiania were affected--some losing nearly 40% of their value.

Clearly these kinds of future disasters resulting mostly in non-physical but massive social, economic and/or psychological disruptions will have to be planned for in the future. There will be a need to get away from equating disasters only with fatalities, a rather narrow and almost completely discarded notion in most of the social science research literature.

The Future is Not Completely Bleak

So far we have painted a rather dismal picture of the future. But that is neither our intent nor what we want to stress. The future with respect to disaster planning is not as bad as might seem at first glance. There is reason to be somewhat hopeful.

First, we are not talking of a static situation insofar as such planning is concerned. In fact, just looking at the historical situation from the past to the present, one might be encouraged in terms of dealing with future disastrous occasions. The present is certainly better than the past.

Our center, the Disaster Research Center, has done considerable research on preparations for and responses to natural and technological disasters. Along some line our field studies report rather good news. For example, in looking at local emergency management agencies in the United States, we have found that they have much better disaster planning and managing and have better personnel than they once had. Across the country, their preparedness as a whole has markedly improved over the last 15 years or so.

A similar picture appears if one looks at most countries, developed or developing, around the world. In the last few decades planning for and responding to disasters has improved. There has been a particular acceleration of the process in European countries such as Italy, Great Britain, Greece and Spain. Where nothing once existed, much has been created; where there was something in place it has been made better. Almost anywhere that one looks the present as compared with the past is an improvement (except perhaps in Sub-Saharan Africa) although the arrangements may range from highly decentralized disaster planning systems as in Great Britain to highly centralized ones as in Japan.

There is no reason to think that the indicated improvements will not continue to occur. Major or image creating disasters in particular (such as a Chernobyl or a Bhopal) tend to generate efforts at crisis planning whether the occasions occur in western Europe, in India, or elsewhere. General social conditions such as greater expectations by citizens that they should be protected against environmental threats as well as particular happenings such as the UN Decade for Natural Disaster Reduction, assure that in almost all societies we can anticipate continuing if not increased attention to disaster planning.

However, it is very clear that on balance matters are going to get further unbalanced. We are going to be faced with more and worse disasters in the future no matter how much disaster preparedness and personnel have or could improve in any realistic sense. If we look not from the past to the present, but from the present to the future, the outlook is not fully favorable. Such changes as will occur in disaster planning while in the right direction will not be able to match the quantitative and qualitative increases in disasters.

Of course this is no different from what others have observed of more general environmental problems that face the world. As Smelser has written:

The various environmental crises that the world is facing--exhaustion of resources, spoilage, toxicity, and pollution--will grow worse before they grow better. The logic behind this assertion is that the impulse among nations to develop economically and compete with others is so strong that they will give greater priority than impulses to protect the environment. In the short run, environmental considerations constitute a cost and a liability in the drive toward competitive productivity. This effect will no doubt be stronger in those nations struggling to catch up--the former Eastern bloc and the Third World countries--than in the developed nations with developed environmental movements.

Nevertheless, this does not mean nothing can be done. A major first step is to understand the source of the problem for that will also tell us something on what needs to be done. Let us note one general implication of research based observations. It is that solutions are not to be found primarily in new technologies or better use of existing ones. The character of future disasters will primarily stem from social factors. Social problems can only be dealt with socially; improvements in technology can only address technological problems. This is not an argument against the use of technology or its improvement, only that if something is socially problematical, social solutions must be sought.

It certainly should be clear from our remarks that the more and worse disasters of the future can be primarily attributed to changes or trends in human or social factors rather than in meteorological, geophysical or technological happenings per se. Thus, the greater vulnerability of the aged to future disasters in developed countries is partly attributable to the fact that, for example, in the United States retired people increasingly tend to live in mobile or trailer home parks in flood plains and flash flood areas. Likewise, the increasing risk of populations in developing countries to earthquakes, typhoons, and landslides is equally partly attributable to the large number of homeless and very poor rural migrants flocking to and residing in more hazardous zones of metropolitan complexes such as Mexico City, Dacca, Hong Kong, Lagos, and Rio de Janeiro. A possible solution in both cases is the institution of appropriate land use management.

Finally, there is a need to be realistic about what can or cannot be achieved. There are limits. A risk free society is a chimerical dream. As someone has said, if the production of mushrooms were invented today, there would be those that would urge their total prohibition. The notions that risks and hazards and subsequent disasters can be completely eliminated is not borne out by history. That not everything can be done, does not mean that something can not be done. We can decrease the increase of future disasters and weaken somewhat their negative effects.