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PLANNING FOR HAZARDS

IN EVERYDAY LANDSCAPES

by Robert W. Kates

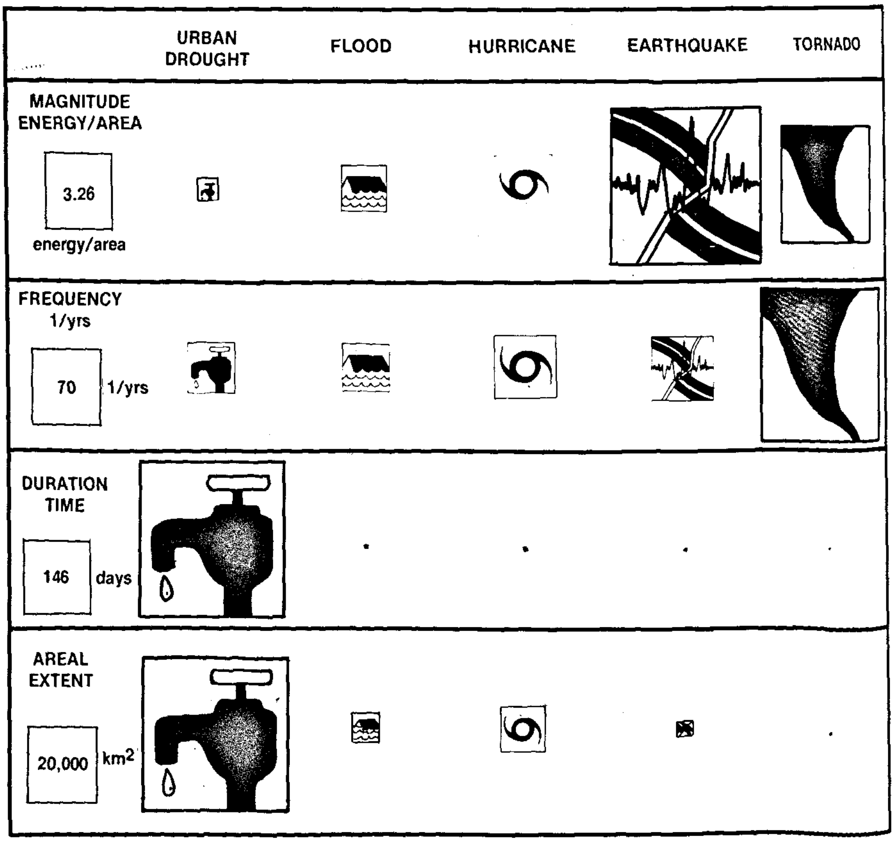
A river's rise, a crustal fracture, a reduction in soil moisture, an increase in windspeed — all are acts of nature, God, or gods; but floods, earthquakes, droughts or storms are acts of men. This is one central finding after 15 years of intensive geographical research on natural hazards, their geophysical dimensions, human impact and social response. While reminiscent of the somewhat sophomoric question, "If a tree falls in the wilderness and no one hears it, is it sound?", this finding is nonetheless significant. *There are no floods unless there are people, buildings or livestock to be damaged; there is no drought unless crops wither and water supplies dry up.* The responsibility falls where it should, on those who use and inhabit the large areas of the earth subject to high recurrent natural hazards, and even more directly on us who plan land use and design habitations.

If nature is neutral, human occupance is not accidental. People encounter hazard in their search for the useful. The 50 million Americans at major risk from hurricanes, the 20 million at major risk from earthquakes, the 35 million at major risk from floods, are not at risk by chance. Mankind has always chosen the intersections of land and water as desirable sites for settlement, for they provide multiple opportunities for ecological access. Thus, where *mountains and marsh meet the sea*, where hillslope gives way to rich valley plain, where hilltop offers view for protection or pleasure, where narrow valley provides gaps in mountain massives — all are ideal places to use or inhabit. They are also ideal places for earthquake, *hurricane, flood or landslide.*

Thus, while the hazardous is useful, it is also costly. It includes not only the toll of life and property destroyed in natural disaster, but also the everyday expenditures designed to reduce or prevent such disaster. The costs usually *are heaviest on those least able to pay*, at least on a global scale. Floods in Sri Lanka (Ceylon) cost that small nation between 1% and 2% of the GNP; in the U.S. it was perhaps 1/10 that amount. For a comparably-sized earthquake in Managua, Nicaragua, and San Fernando, *California, the death toll in Managua* was 70-100 times greater. Overall, the global pattern is high death rates and proportionately high loss rates in developing countries, and rising absolute losses and declining deaths in industrialized countries.

*In the U.S. losses from all geo*physical hazards are on the rise, approaching $5 billion annually, with perhaps half as much again spent on preventive action. Deaths, on the other hand, have remained low — less than

Figure 1: Characteristics of Major U.S. Hazard Events



1000 out of 100,000 accidental deaths per year are attributable to natural hazards.

Hazard Events

The pattern of costs, losses, deaths and injuries is much affected by the specific characteristics of the hazard-producing events: their source, frequency, magnitude, duration, area affected and suddenness of onset. I can demonstrate this with five major U.S. hazards — urban drought, flood, hurricane, earthquake and tornado (fig. 1). For each I assumed a major hypothetical event that poses potential disaster for human populations and estimated the frequency of its recurrence, the relative magnitude of the event in terms of energy release or dissipation (measured by the solar constant), the areal extent or pathway covered by the event and its duration in time. In essence, for each of five major hazards for an imaginary place with a record of recurrent events, I ask the questions: how often? (Frequency), how powerful? (magnitude), how widespread? (areal extent), and how long? (duration).

We can identify a pattern in these events' chacteristics. A frequent event like drought lasts a long time and covers a large area, but is low in per unit energy release in contrast to tornadoes and earthquakes, which are rare, release enormous amounts of energy in short periods, and affect relatively small areas. We have called drought-like geophysical events pervasive and the high-

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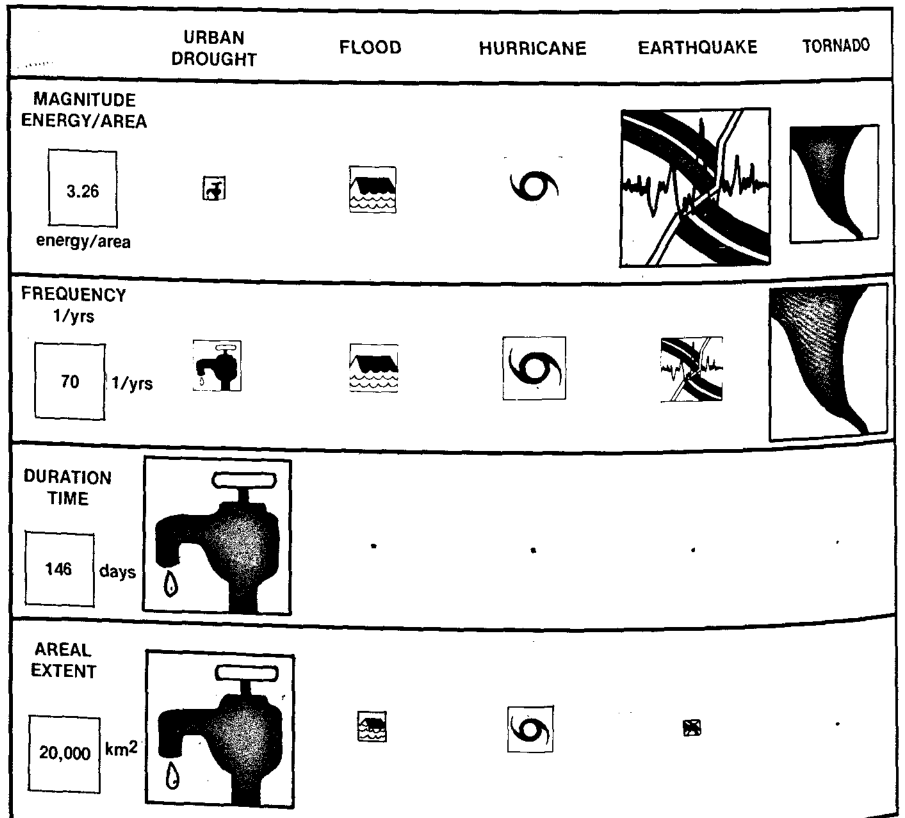
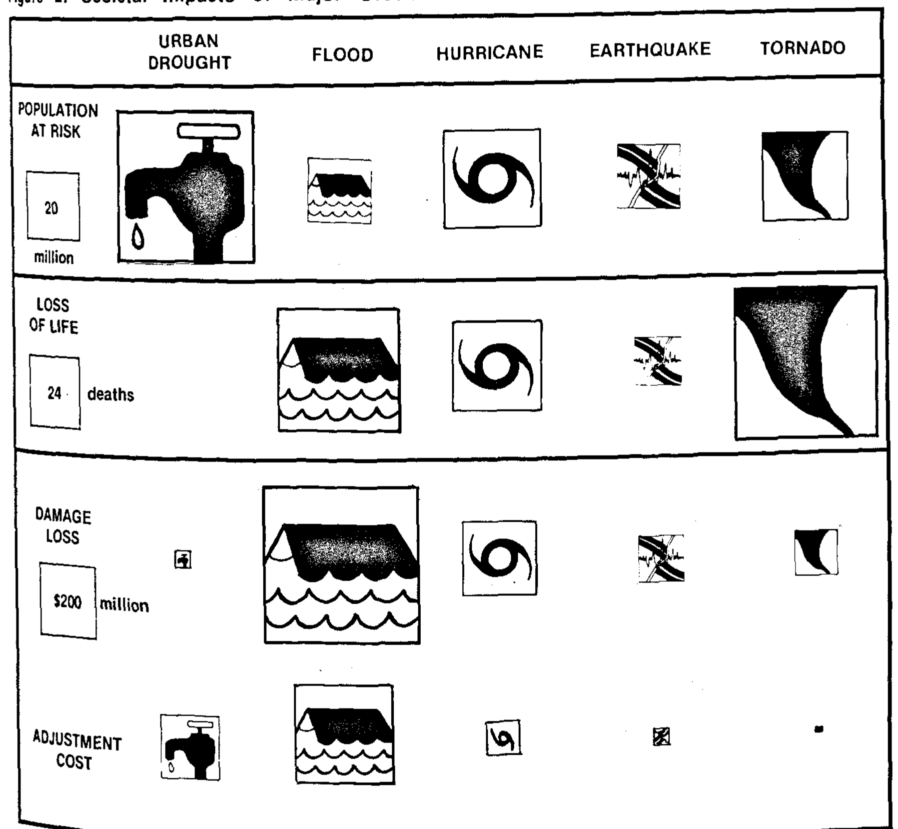


Figure 2: Societal Impacts of Major U.S. Hazards



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Social Response

The pervasive events are most readily responded to by society because they are frequent, provide time for an adequate response, and the low unit energy can be dealt with easily. Drought, fog, frost, soil creep and expansive soils are contained, so to speak, by long-term investments in preventive measures.

Consider, for example, urban drought where the population at risk is that half of the population of the U.S. which draws water from publicly-owned surface water systems (Fig. 2). To ensure a steady flow of water, they spend some $200 million per year for storage structures to ease the normal fluctuation of precipitation. Perhaps once in 30 years, precipitation shortfalls, cumulative over several years, lead to shortages and subsequent losses. But considering the risk to such a large population and high recurrence, these losses are surprisingly small for at least three reasons: the substantial investment in damage-reducing adjustments (dams, reservoirs, etc.), the considerable overcapacity provided in such structures, and the slowness of onset so that the creeping character of drought can be matched by modest reductions in consumption.

In contrast, tornadoes threaten some 40 million persons on the Great Plains, Midwest and Florida. The point recurrence for a tornado is extremely rare despite their large number per year (650) because the average path is quite small. Besides warning facilities (and these are limited), improved response to warning and storm cellars, little is or can be done to reduce the burden of hazard. Thus, while the death rates have diminished, they are still relatively high. The costs per capita for both tornadoes and droughts are of similar order, but the pattern of expenditure is reversed and the loss of life is fundamentally different. Drought, a pervasive hazard — frequent, low energy, and slow of onset — leads to development of high levels of preventive adjustment. Tornadoes — rare with high energy output, highly localized and of sudden onset — discourage prevention and lead to higher levels of death and relative damage. Earthquakes are similar to tornadoes.

In between these extremes, floods and hurricanes exhibit characteristics of both classes of events. Flash floods in small mountainous watersheds approach the high-energy, localized effects of the intensive events. Floods on the main stream of a great river rise slowly and cover large areas at much lowered velocities of flow. Similarly, hurricanes differ widely in their impact — between the narrow coastal strip where they move on to land which is subject to high winds, massive rain and wave action and storm surge, and more interior areas. But it seems this combination of characteristics makes these the most costly hazards.

To a degree, society's response is a function of the hazard itself, but it is also a function of available wealth, social organization and pattern of settlement. For example, the high per capita losses per person in flood plains is not only an expression of the frequency of major floods, but of the historic strategic function of riverine sites as places of commerce, industry, residence, agriculture and water transport. Traditionally, a substantial portion of society's wealth and productive activity has been concentrated along both riverine and oceanic shores. In the face of hazard, the basic modes of response are similar: men can adapt themselves to the hazard, seek to modify the natural events or adjust their livelihood systems. In rare cases, they may make fundamental changes in their location or mode of existence. But application of these potential actions, the favored mix of social response, differs seemingly by wealth and social organization.

In folk society, ritual or myth softens the expectation of nature; extended families and clans share in the vicissitudes of nature, and many small adjustments are built into everyday life. For example, in the case of drought, oral histories are often dated by the occurrence of great droughts. Rainmaking powers and ceremonies are common, kinship relationships provide emergency access to multiple resource areas and occupations, and a surplus to allow for bad years is the rule in all subsistence societies. The response to hazard is both flexible and (in a group survival sense) successful, albeit burdened by occasional heavy losses of life when the system is overwhelmed by enormously powerful events, such as the recent drought in sub-Saharan Africa.

In contrast, industrial society narrows the range of response with increasing efficacy of technological power. Industrial man resorts less to prayer, seasonal movement, multiple occupation and careful selection of micro-landscape and topography. Natural events are met head-on, so to speak. Complex irrigation facilities are constructed to mitigate drought, dams are built to prevent floods, sea walls are constructed to block hurricane surges, steel frames are erected to resist earthquakes. This resort to the technological fix, while effective within a range, still has limits — costly ones to developed countries and tragic ones to developing countries.

In developed countries like our own, the resort to high capital-intensive adjustments may prove counterproductive. Partial protection of flood plains may actually encourage flood plain development. Sea walls may destroy the very amenity that encourages a seaward location. Irrigation may result in waterlogging and increased salinity. Seismic-resistant construction may provide buildings that maintain their form by avoiding collapse but lose their initial functionality. Indeed, while many adjustments may reduce the frequency of loss, catastrophic potential seems on the increase. Major tragedies appear very much in America's future; only their timing, location and magnitude are in doubt.

A major challenge is posed, therefore, to planners and designers to assist in the development of more flexible technical and social responses to landscape hazard. Can we broaden the range of technique and behavior in the face of hazard? Can we retain some of the flexibility and sensitivity to nature of the folk society, but translate such efforts into meaningful terms for our complex society and its economic-technical capability?

There is some evidence that this is indeed possible, and in selected areas we are moving in this direction. At the land management level, we are moving toward a minimal "design with nature,"* first in selected states and eventually everywhere by future national land management standards. Wetlands, flood plains, steep slopes, dunes and beach will have severely restricted permitted uses. To complement this trend, there is need at the site design level for new ways of providing access to hillside and shore without imperiling structure, occupants or environment; to make safe the second and mobile home; to build for the exceptional as well as the everyday. But planning for a hazardous future, either on the site or at the regional level, is not the everyday practice of any broad professional group. Learning how to do so is probably our most immediate need.

*From the title of the seminal book by Ian L McHarg.

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