Chapter One

Map Scale, Danger Zones, and Safe Places

A convenient place to begin is with the effect of map scale on the perception and portrayal of danger. The most basic of cartographic concepts, scale determines the detail, size, cost, and reliability of a map and restricts the range of appropriate uses. Although its most important ramifications are qualitative, scale is a numerical concept, which cannot be broached without at least a few numbers. I promise, though, to keep the treatment brief and the arithmetic simple.

Cartographers define scale as the ratio of the length of a symbol on the map to the length of the corresponding feature on the ground. On a typical topographic map with a scale of 1:24,000, a 1-inch line represents 24,000 inches on the ground, or 2,000 feet. The ratio is often written as a fraction, in this instance, 1/24,000. By convention, the numerator is 1, and the same units (feet, meters, miles, or whatever) are implied for both numerator and denominator: 1 inch representing 24,000 inches is the same scale as 1 centimeter representing 24,000 cm. Map scale can also be portrayed graphically with a scale bar representing one or more typical distances or stated verbally, as in “One inch represents two thousand feet.”
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Geographers use the fractional form to distinguish large-scale maps from small-scale maps. The rule to remember is that large-scale maps have larger fractions, with small denominators, and small-scale maps have tiny fractions, with relatively large denominators. For example, 1/24,000 is markedly larger than a scale of 1/250,000, whereas 1/100,000,000 is much, much smaller. Most geographers regard maps with scales of 1:24,000 or larger as “large-scale” maps and maps with scales of 1:500,000 or smaller as “small-scale,” with “intermediate-scale” a fuzzy category somewhere in between. These labels are useful because large-scale maps can cover neighborhoods and other small areas in considerable detail, whereas small-scale maps provide highly generalized portraits of states, countries, or continents. At 1:1,000,000, for instance, a one-inch square on a map might encompass a vast city, whereas at 1:10,000, the same square would cover no more than a few city blocks.

Map scale affects the generalization and usefulness of a map. Because a small-scale map cannot hold as much local detail as a large-scale map, its hazard zones necessarily have smoother, comparatively vague boundaries. Moreover, when a small-scale map is compiled from a set of large-scale maps, not as many roads, streams, and boundaries can be shown, and small occurrences of principal features must be amalgamated with neighbors or dropped altogether. Without further generalization, the map would be hopelessly cluttered and useless. Yet even though details must be sacrificed to clarity, a small-scale map can condense an enormous amount of information into a convenient size. For some hazards, a concise, small-scale overview of regions at greatest risk can enlighten policymakers as well as the general public.

The six highly generalized maps in Figure 1.1 have very small scales. The Electric Power Research Institute’s monthly magazine used them to illustrate a story on disaster planning. Scattered throughout the article as elements of an attractive page layout, the original maps appeared at a scale of approximately 1:60,000,000. I made them even smaller (about 1:100,000,000) to fit onto a single page. Although such very small scales preclude state boundaries and place names, the grossly distorted coastlines and international boundaries provide an informative caricature of the United States.

Intended largely as a graphic decoration, the crude earthquake map at the upper left in Figure 1.1 identifies seismic hazard zones not only in California and Puget Sound but also in Utah, South Carolina, and the St. Lawrence Valley. And the dark area near the middle of the map
represents the country's largest known earthquake, a series of four massive shocks centered on New Madrid, Missouri, and felt throughout a large part of the United States during the winter of 1811-12. Other maps in the series show that hurricanes are troublesome along the Atlantic and Gulf coasts, ice and snow affect the northern half of the country more than the southern half, and geomagnetically induced currents (a danger principally to electrical transmission lines) are related to latitude.

Like many cartographic generalizations, the earthquake map lumps together several areas with noteworthy differences. As the next chapter describes, earthquakes in California are more frequent and affect much smaller areas than earthquakes in South Carolina or the central Mississippi Valley. Similarly, the ice-and-snow map does not distin-
guish among wind-driven blizzards in the Midwest, massive snowfalls east of Lake Ontario, and damaging ice storms farther south.

Another necessity of cartographic generalization, the suppression of small occurrences, is especially obvious on the flood map, which highlights the Mississippi floodplain and fourteen smaller areas experiencing disastrous flooding in recent decades. Many more flood-prone areas exist, but most are too small to include. Moreover, the flood zones on the map must be exaggerated to make them show up. Although flooding is a serious hazard along the upper Mississippi, for instance, the inundated area is usually much narrower than the fifty to one hundred miles suggested by the map.

The tornado map, with two distinct graytones showing different levels of risk, is less generalized than the other five maps. A light gray shading represents a moderate-risk zone covering much of the Midwest and Southeast, while a darker symbol identifies a high-risk belt running southward from Iowa into Texas. However crude this two-level classification and its geographic patterns, the map makes an important distinction between a hazard, which threatens life or property, and risk, the probability of realizing that threat. All hazard-zone maps are risk maps because they imply a greater threat in the vicinity

**Frequency of tornadoes: 1953–1962**

of the hazard. But in this case, different area symbols express different degrees of risk.

Risk maps are especially important for tornadoes, which concentrate massive amounts of energy on very small areas and can strike anywhere. The typical tornado cuts a narrow swath, less than a thousand feet wide, and, except for flying debris, has little effect on nearby areas. Although its funnel cloud might skip across the surface for a distance of twenty miles or more, touching down briefly here and there, tornadoes seldom leave a trail of destruction more than a few miles long.

Tornadoes are so numerous (perhaps eight hundred a year in the U.S.) that a small-scale map cannot describe individual storms, at least not for more than five years or so. The dot map in Figure 1.2 strikes a visually effective compromise by representing only locations at which tornadoes first touched down, rather than the direction and length of their paths. To avoid graphic clutter in high-risk areas, a single dot represents an average location for two tornadoes. The *National Atlas of the United States* used this map to show tornado frequency for a ten-year period starting in 1953, when widespread use of weather radar and improved record-keeping began to yield reliable data.¹ Closely spaced dots reflect a comparatively high risk in Oklahoma and Kansas, Indiana and Illinois, and parts of the Southeast. These regions are especially hazardous on spring afternoons, when air rising from the heated surface can trigger violent upper-atmospheric encounters between warm, moist air from the Gulf of Mexico and dry, cold air from the north and west. By comparison, tornadoes are rare in the Rocky Mountain and Pacific Coast states, seldom reached by moist tropical air.

An accurate portrait of tornado risk requires more than a single decade of data. Based on twenty-eight years of record, Figure 1.3 offers greater reliability at the price of less precisely reliable symbols.² To accommodate additional data as well as illustrate significant regional differences, the mapmaker threaded isolines (similar to the contour lines on topographic maps) through places of approximately equal risk. For places directly on an isoline, decoding seems straightforward: the eye need only follow the risk contour to its label (conveniently stated as an annual average). But because contouring is based on a small number of data points, the positions of the lines and their labeled values can be misleading. For places between isolines, the viewer must accept a range of values or make a calculated guess. At Washington, D.C., for instance, the average yearly tornado inci-
Average annual tornado incidence per 10,000 square miles:
1953–1980

![Map showing tornado incidence](image)


...dence is between 1 and 3 tornadoes per 10,000 square miles. That is, in an average year a square 100 miles on a side will experience at least one but no more than three tornadoes. Viewers preferring a single number can note that Washington is slightly closer to a 3.0 contour than to a 1.0 contour and use this information to "interpolate" a rough estimate of 2.2. Though more precise, this single number is less dependable than the range 1 to 3 because interpolation from smoothed contours on highly generalized small-scale maps is notoriously unreliable. Like most small-scale maps, Figure 1.3 is trustworthy only as a geographic overview.

Comparison of the three tornado-hazard maps illustrates another pitfall of map generalization—the possibility that viewers might associate low risk with no risk. Although less common than in Kansas, for instance, twisters occasionally strike New England, upstate New York, and other white areas on the tornado map in Figure 1.1. I know from experience, as well as from the other two maps, that the white is misleading. A few years ago, on a Sunday drive through Fulton, New York, we saw the destructive signature of a small tornado that had skipped across town ten minutes earlier. Although the storm damaged several roofs, cars, and power lines, and started a few minor fires, no one was
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killed. But had the tornado lingered longer or struck a more populated area, it could have caused a major disaster. Fortunately for area residents who might have been outdoors at the time, National Weather Service personnel responsible for severe storm warnings do not ignore the possibility of tornadoes within the map’s white, low-risk zones.

Map scale is no less important than the map author’s fears, experiences, and group values. White middle-class Americans, for example, differ markedly from impoverished African Americans in the places they avoid, and, not surprisingly, both groups view danger differently from the scientists and government agencies responsible for most hazard maps. These differences are readily apparent in the *Places Rated Almanac* and similar guides pitched at comparatively affluent readers who either are free to move or enjoy thinking about relocating. A brief examination of the popular quality-of-life genre holds useful insights.

Place-ratings guides adopt one of two designs: the travel narrative, in which individual chapters describe each well-rated place, or the systematic inventory, in which individual chapters address specific locational factors, such as climate, crime, and employment. The prototypical place-ratings travelogue is *Safe Places*, published in 1972 and substantially revised in 1984 as *Safe Places for the 80s*. The earlier edition describes fifty towns and small cities in thirty-five states, which journalists David and Holly Franke visited on a 105-day, 20,000-mile trip that began and ended in Manhattan. Although a map of the Frankes’ circuitous route decorates the endpapers, they grouped their chapters alphabetically by state and shared no experiences enroute from one town to the next. But by integrating interviews and personal observations with facts and figures, they avoided much of the tediousness of fifty chapters of listy prose constrained by a standard outline. I’ve had my copy for more than two decades—a gift from Marge, who knows I like to daydream about places—but have never read the 932-page volume cover to cover. Most readers, I suspect, use the book as I do: as an informal geographic encyclopedia.

As its title implies, *Safe Places* is about avoiding crime, urban riots, and other big-city unpleasantness that made “law and order” an effective political slogan for conservative and centrist Republicans. (Husband David had worked on the *National Review* and wrote a book about William F. Buckley, Jr., and wife Holly had been a staff assistant for two Connecticut congressmen.) Although the Frankes also con-
sidered affordable housing, low property taxes, and other quality-of-life factors, they selected their fifty places largely because of low crime rates. Not surprisingly, none of their recommended places was a large city, and only one (Green Bay, Wisconsin) was a medium-size city (population between 50,000 and 250,000). Their introductory chapter underscores this point with an anecdote: throughout the trip, luggage left in the back seat was safe at night, but several weeks after the Frankes returned home to New York, someone stole their car.4

Although the Frankes later moved to the village of Ridgefield, Connecticut, a safe sixty miles away, crime remained the overriding concern. The introduction to Safe Places for the 80s describes their simple three-step screening process:5

1. Determine the overall crime rate.
2. Choose a top limit on the overall crime rate.
3. Compile the rates for each category of crime.

The result was an expanded list of 105 low-crime communities in thirty-nine states—only 13 carried over from the earlier edition. To justify their narrow view of “safe,” the authors brushed aside two other common hazards:6 "Each year almost one out of three households in the United States is hit by crime. Crime is more a threat to you than the possibility of an automobile accident or being stricken by cancer or heart disease." In addition to ignoring the more frequently fatal consequences of cancer and cardiovascular disease, they also dismissed the toxic threats of Three Mile Island, Love Canal, and Mount St. Helens.

Safe Places contains no hazard maps, not even a map of crime rates. But for each town or city a small, arty regional map shows principal highways, physical features, and a selection of landmarks and neighboring cities. For example, the map for Belvedere, California (in Marin County, north of San Francisco), verifies that San Francisco Bay isolates the village from "hippies and street people" in Haight-Ashbury and Berkeley. The map also shows the nearby village of Tiburon as well as Sausalito, Oakland, and the direction to Point Reyes National Seashore—but not the Hayward and San Andreas faults.7 In their accompanying text the Frankes mention the San Andreas fault fleetingly, but only as the site of the few communities on the Peninsula without high rates of property crime. Nowhere do they tell or show the reader that parts of Belvedere are susceptible to violent shaking from ruptures along either of the area’s major faults.8

The genre's other exemplar is the Places Rated Almanac, subtitled
Your Guide to Finding the Best Places to Live in North America. As its name implies, Places Rated scores the nation's 323 metropolitan areas (plus another 20 in Canada) on ten factors of interest to anyone thinking of locating a business, relocating a family, or retiring. These factors cover a broad range of concerns: cost of living, jobs, housing, transportation, education, health care, crime, the arts, recreation, and climate. Authors David Savageau (a "personal relocation consultant") and Richard Boyer (an award-winning mystery writer) use statistical data, mostly from government agencies, to rate and rank all major cities separately for each factor. In the final chapter, they add up the ratings and construct a single, composite ranking from "best" to "worst." These rankings and the reactions of local officials in the nation's "best" and "worst" cities are widely reported by the news media every four years, when the book is revised. Boosters who are unabashedly enthusiastic or predictably angry have helped make Places Rated a persistent best-seller since its first edition in 1981.

Despite a few chapters that mention environmental threats, Places Rated is less aware of hazards now than in the early 1980s. Crime rates computed by the FBI continue to influence the ratings, but no other factors play a direct role. In 1985, for instance, a joint health-care environment index not only included demerits for each pollutant that exceeded the EPA standard but levied additional penalties against cities with dangerously high ozone levels. Moreover, although earlier editions treated nuclear power as an environmental hazard, the cost-of-living chapter now mentions only the added burden on electric customers of local utilities owning a nuclear plant. The climate chapter, which continues to rate places only for climatic mildness, retains a short discussion of natural hazards (hurricanes, tornadoes, and earthquakes) but dropped an earlier section on water quality.

Even though hazards have little direct effect on its ratings, Places Rated includes a few informative small-scale hazard maps. In the climate section, for instance, a U.S. map shows high- and moderate-risk areas for tornadoes and hurricanes, and a similar map describes geographic variation in both the severity and the frequency of earthquakes. And another map identifies places mentioned in the chapter's discussion of weather extremes. These maps are part of the rich supplementary information overlooked by journalists and other readers interested primarily in the almanac's famous (or infamous) composite rankings.

Although Places Rated dominates the genre in sales, several other
books serve important niches. In 1993, for instance, Norman Crampton based *The 100 Best Small Towns in America* on a screening of government statistics and more than five hundred telephone interviews with local officials and other boosters. By focusing on communities with populations between 5,000 and 15,000, he appealed to readers seeking a quality of life very different from *Places Rated’s* metropolitan areas, defined by a central city with at least 50,000 residents. Although crime rate is only one of fourteen selection factors, Crampton’s approach and organization is similar to *Safe Places*. (In 1974, David Franke’s *America’s 50 Safest Cities* offered Conservative Book Club members and other readers a somewhat similar, crime-only treatment of cities with populations over 50,000.) Crampton ignores other hazards anecdotal as well as systematically. For example, the chapters for Moses Lake, Washington, which received ash from the Mount St. Helens eruption in 1980, and St. Helens, Oregon, only fifty miles away, reveal nothing about volcanic hazards. And his book has only one map, a double-page spread showing state boundaries and identifying the towns by name.

Published a decade earlier, *The Best Towns in America: A Where-to-Go Guide to a Better Life* demonstrates that older is not always less informative. In selecting fifty places with populations between 25,000 and 100,000, author Hugh Bayless consulted maps as well as numerical data. In addition to crime, taxes, accessibility to a major city, and various regulations on land use, gun ownership, and pollution, Bayless considered a variety of natural hazards. His second chapter, “Best Towns Are Safe,” presents small-scale versions of several cartographic sources, including maps of tornadoes, hurricanes, potential nuclear targets, potential pollution (nuclear power plants, chemical waste dumps), and earthquakes. Less reliant on statistical data than other writers, Bayless was circumspect as well as confident in his selections: “While nowhere is completely safe, there are many places where safety is great and hazards are distant. All of our best towns are reasonably safe—much more so than the big cities, and appreciably more so than other towns.”

Concerned more with removing hazards than merely avoiding them, environmental scientist Benjamin Goldman published a guide similar to *Places Rated* in its organization and use of numerical data but narrowly focused on technological hazards. His title and subtitle *The Truth about Where You Live: An Atlas for Action on Toxins and Mortality* aptly describe his approach. With more than a hundred maps, the book
clearly qualifies as an atlas. Almost half of its maps address mortality directly, by showing death rates for the 3,073 counties of the forty-eight contiguous states. Nearly as many maps provide equally detailed county-level portraits for a variety of industrial toxins and other pollutants, and additional maps address several relevant demographic, socioeconomic, education, and health services factors.

Although "where you live" exaggerates the precision of county data, Goldman offers a comprehensive treatment of both effects and causes. Too coarse to show individual neighborhoods and the effects of minor polluters, county data nonetheless provide a practicable compromise between state and metropolitan area data, which lack geographic detail, and city and town data, for which mortality rates can fluctuate wildly from year to year—particularly for less common causes of death. Rates for small places are intrinsically unstable because an extra death during the year can boost the death rate by 10 percent or more, whereas one fewer death could cause an equally prominent drop. To provide greater reliability, Goldman computed average rates for a fifteen-year period and also adjusted for age differences among counties. Without age adjustment, high death rates would typically occur—unsurprisingly and with little meaning—in counties with comparatively older populations. To identify influences of race and gender, he prepared separate maps for white males, white females, minority males, and minority females for ten environmentally sensitive mortality factors, including infant mortality, birth defects, and lung cancer.

Goldman's typical treatment is a two-page spread with a map on the left and a table on the right. While the table lists rates and names for both the most and the least hazardous 2 percent of the nation's counties, the map emphasizes only the worst places. Solid black area symbols point out the 61 most hazardous counties in the top 2 percent, while progressively lighter gray tone symbols represent counties in the next lower 3, 5, and 15 percentiles. Although white (blank) symbols for the remaining 2,305 counties might (perhaps quite wrongly) imply little or no risk in the lowest 75 percentile, the contrast between this larger white area and the black and gray counties appropriately highlights high-risk regions, where need for action is greatest. Nonactivist readers can, of course, use Goldman's identifications of best and worst areas as an environmental supplement to the Places Rated Almanac.

My final example is only an honorary member of the place-ratings genre: Risks and Hazards: A State by State Guide does not rate places and was never sold commercially. I obtained my copy by writing to...
the Federal Emergency Management Agency (FEMA) and asking for publication no. 196, a 130-page booklet distributed free to promote disaster preparedness. This colorful and informative guide to seven hazards (earthquakes, volcanoes, hurricanes, tornadoes, snow and extreme cold, nuclear attack, and nuclear power plants) includes checklists of preparations and responses as well as brief treatments of tsunamis, floods, hazardous dams, and radioactive fallout. Our taxes paid for it, of course, and as collections of small-scale maps go, it's a good buy. My principal complaint is its state-by-state organization, which accords exactly two pages of maps to each state. The U.S. Senate might approve, but does tiny Rhode Island need—or deserve—as much space as complex California?

Each state's double-page treatment consists of a single "Nuclear Attack" map on the left-hand page facing several smaller hazard maps.

on the right-hand page. Although the nuclear-attack map reflects a threat less troubling now than during the cold war, its detailed depiction of likely targets is a compelling argument for any defense, including Star Wars and disaster preparedness, against the madness of "mutually assured destruction." As Figure 1.4 illustrates in black and white for Oklahoma, vivid blast-like symbols mark major cities, military bases, large dams, power plants, and other important industrial sites. Each three-part symbol uses yellow to identify an inner area with "few survivors," orange to show a larger surrounding zone with "50 percent casualties" and significant structural damage, and a thin red ring to bound an even larger outer zone with "up to 25 percent casualties" and lighter damage. (Densely packed, overlapping symbols in parts of Colorado, the Dakotas, Missouri, Montana, Nebraska, and Wyoming leave little doubt about the locations of missile silos.) Other maps suggesting the vulnerability of metropolitan populations inspire awe and respect, if not fear and anger, in the face of the nuclear standoff. In dramatizing the consequences of a nuclear war, these fifty dismal maps argue not only for civil defense and fallout protection (a FEMA responsibility) but also for peace negotiations and nuclear disarmament.

Each opposing page carries two to six maps of other prominent threats, the number of which varies from six for California to only two for Idaho, Nevada, North Dakota, and Utah. Smaller and less detailed than the nuclear-attack map, these maps vary from hazard to hazard. Each map of nuclear power plants, for instance, identifies the state's plants by name and location. (Commercial nuclear plants are hazardous because an accidental release of radiation, however unlikely, is nonetheless possible, and evacuation plans are required for ten- and fifty-mile "emergency planning zones" around each plant.) For each Pacific state a map with a red band along the coast points out areas "historically subject to tsunami." For states with active volcanoes, a hazard map identifies each volcano by name and uses a light, medium, or dark point symbol (little triangles) to show whether eruptions occur every two hundred, one thousand, or ten thousand years. Similar intensity codes describe three levels of risk for hazard zones on the earthquake, hurricane, and tornado maps.

Figure 1.5 illustrates in black and white two of the three risk maps provided in color for Oklahoma. Most prominent on the red-brown earthquake map is the absence of the solid red area symbol representing "high-hazard" areas; although a noteworthy threat, earthquakes
are less hazardous here than in California or Alaska. In contrast, on the greenish tornado map, a dark-green area symbol (representing an average annual tornado frequency of 7–9 per 10,000 square miles) indicates that residents of central Oklahoma must prepare diligently for destructive twisters. A third map (not shown) reveals that extreme cold and freezing (but not heavy snowfall) is a significant hazard only in the northwestern quarter of the state.

Although its maps are highly generalized, Risks and Hazards is a useful source of hazards information not available in conventional place-ratings handbooks. But don’t expect precision or easy answers. Careful page-by-page inspection of Risks and Hazards reveals that even for this limited subset of seven hazards, no part of the country is risk-free. And researchers tempted to construct a composite ratings map by piecing together the various maps and assigning weights to risk categories ought not ignore FEMA’s warnings that flooding and fallout radiation are potential hazards in all areas. As the following chapters indicate, a thorough search for “relatively safe” places demands a careful and critical examination of more detailed sources.