Chapter Five

FUNCTIONS, REQUIREMENTS, SUPPLIES, DAMAGE, AND NEEDS

ABSTRACT

This Chapter describes methods for defining the level of damage from an event, its impact on the functional status of the affected society, and for identifying the needs that result from the damage. The event may produce damage to the population (injuries, death), its constructions and societal functions, and/or to the environment. Societal functions are described as production functions with inputs, transformations, consumption of resources, and outputs. Distinction between available supplies, requirements, and needs is stressed. The differences between damage assessments and needs assessments are described. Needs for goods and services that are greater than the available level of supplies produces deficits. The concept of thresholds of available resources required to maintain the pre-event functional state, those necessary to sustain basic functional states, and those required for survival is developed. Surplus of available supplies is subdivided into those needed for contingencies and those that comprise luxuries. Indicators are required that define either the level of function or the level of available supplies. Distribution of available supplies (who receives them) impacts whether critical and functional requirements of a population, or part of the affected population, are satisfied. When critical requirements are not met, the crude mortality rate increases. Severity scoring of the damage sustained and the effects of responses is described. All damage and needs assessments and responses to them relate to the pre-event state of the affected society, and the objective of disaster responses is to return the affected society to its pre-event functional state.

Keywords: assessments; consumption; contingencies; crude mortality rate; damage; function; goods; indicators; inputs; needs; outcome; output; pre-event status; production function; requirements; resources; severity scores; services; supplies; thresholds; transformations

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THE PROBABILITY THAT a society, a basic societal function (BSF) of a society, or an element of a BSF will sustain damage from an event has been discussed in Chapter 4. An event may affect each of these components to a varying degree depending upon the nature of the event and the resilience of the component in the affected society. This chapter describes methods for defining the level of damage, its impact on the functional status of the affected society, and for identifying the needs that result from the damage. Damage may occur to the population, its constructions and its societal functions, as well as to the environment. Societal functions are dependent upon many requirements. Therefore, the root causes of the loss of a function may be difficult to identify. Consequently, choosing the most appropriate indicators that truly reflect the state of a societal function or the satisfaction of specific requirements essential for the societal function and hence, the causes of the dysfunction, is crucial. Needs assessments are essential to establish the link between damage, impaired function, and those requirements to restore the function. Needs assessments must identify those requirements that are not being satisfied, and hence, have led to the impairment of the overall function ***and*** what is needed to meet its specific requirements.

FUNCTIONS, REQUIREMENTS, AND NEEDS

A *function* is a mode of action or activity by which a thing fulfills its purpose.[1] Many functions combine to make up a society. Functions are the result of a production process that converts inputs into functions (Figure 5.1). The production process used to produce a specific function is characteristic for a given function in a given society or population. The production process consumes resources (inputs) and is dependent upon an adequate supply of resources available to produce an output, in this case, a function of the society in which it operates. By definition of a production function, all processes require more than one input. The quantity of each input required to produce a given amount of output for each process is called *efficiency*. There may be many processes that can produce the same function; some are more cost-effective than are others. For example, in one society, 4 liters of water may be required to flush a toilet while in others, a single flush may require 10 liters of water. To produce the same function with 4 liters of water is more *efficient* than doing it with 10 liters. Changes in the production process as a result of damage sustained from an event, could result in the process becoming dysfunctional and produce a need to use a different process for the same output. Thus, the effi-

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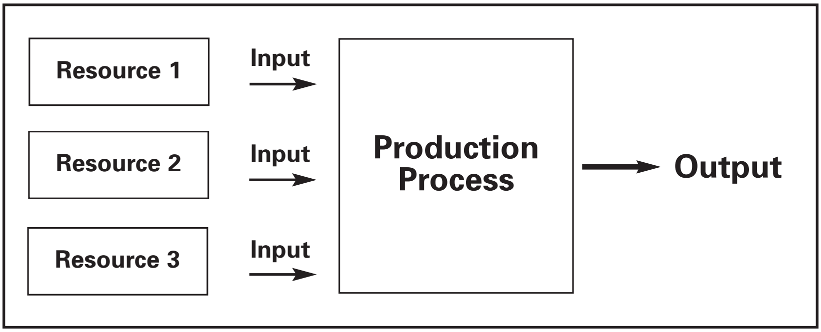

Figure 5.1—A production process. The process converts inputs (resources) into an output, in this case, a societal function.

ciency used to produce the same output may vary with the society in which it is employed or may change as a result of damage produced by an event.

Figure 5.2 illustrates the complexity of production processes as they relate to functions. Larger functions generally are combinations of multiple, component sub-functions that constitute the requirements for the larger functions. Each of the sub-functions has requirements. Failure of the availability of sufficient supplies to meet the requirements of any of the sub-functions may impair the function of the larger function. Sub-functions may have sub-sub-functions, etc., etc.

All production processes are dependent upon an *available* supply of

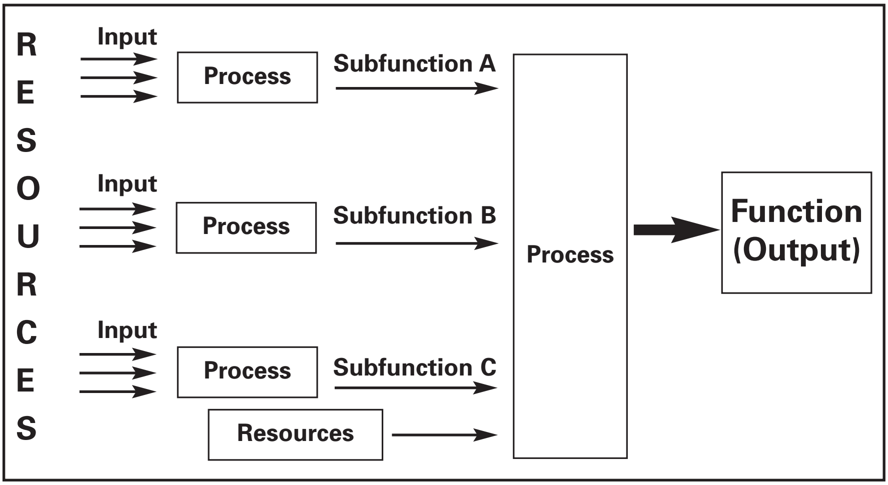

Figure 5.2—Complex production processes. Large functions require multiple sub-functions that are the products of other subordinate production processes.

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each of the inputs (may be single or multiple). The resources that comprise the inputs that are required must be available for *consumption* by the process.

Available Resources = new input + stores – consumption of the resources – inaccessible resources

Resources that are not available cannot be used in the production process. The available resources could be compromised by inadequate provision of new goods or services, decreased stores of the goods or services, or increased consumption without concomitant increases in resources or supplies. Supplies of goods or services that are not accessible for use in the production process result in decreased output, and in the current context, a decrease in the level of function.

A *requirement* is an imperative; something(s) depended upon for fulfillment;[2] a necessity (see *necessity*). A function is dependent upon one or more requirements being available. For example, in order to be transported in an automobile, several requirements must be satisfied: there must be a vehicle with an engine, sufficient fuel for the engine to function, air intake to provide the oxygen, etc. If any one of these requirements is not met, it will not be possible to be transported by the vehicle—it cannot *function*. However, the automobile could function without an ashtray or cigarette lighter, or even windows. Thus, a function *needs* its component requirements (functional requirements) to be present and satisfied. These requirements are satisfied by the provision of adequate *supplies* of goods and/or services. Thus, requirements are the levels of goods and services necessary for function. Therefore, the level of function is a variable dependent on the level of supplies of required goods and/or services.

Every society is dependent on functions. Those functions that are essential for a society to meet its obligations to its citizens are called *basic societal functions* (BSFs). Each BSF has certain requirements that must be met in order for it to function. These requirements consist of goods and services (people, equipment, and/or supplies). In addition, some BSFs have sub-functions that must be operational, and hence, also have requirements that must be satisfied in order to function. If all requirements are not met, the function becomes impaired: it becomes *dysfunctional (impaired function)* or *non-functional* (no function).

The relationships between consumption and supply are illustrated graphically in Figure 5.3 (A, B, C). The area of the circles in each of the three parts (A, B, C) of the diagram represents the domain or total amount of each of the variables that is ***available***.[3] In Part A, the domains of consumption and supply are equal, and hence, consumption and supply are in balance. In Part B, supply exceeds demand, and there is a *surplus*. A surplus is the amount left over when the requirements have been met.[4] A surplus comprises the absorbing capacity, either in the form of luxury or as contingency. A surplus always consume resources, even if it is a commodity stored exclusively for contingency purposes. The opposite holds in Part C, and a deficit exists. A *deficit* is the result of a negative balance between supply and consumption This imbalance may be the result of either increased consumption of resources, destruction of or inaccessibility to existing resources, or a combination of both. Thus, supplies always relate to the level of consumption or use. For example, human resources are not consumed per se, but are applied and become not available to be used for performing other tasks.

This concept is developed further in Figure 5.4. Again, circles are used

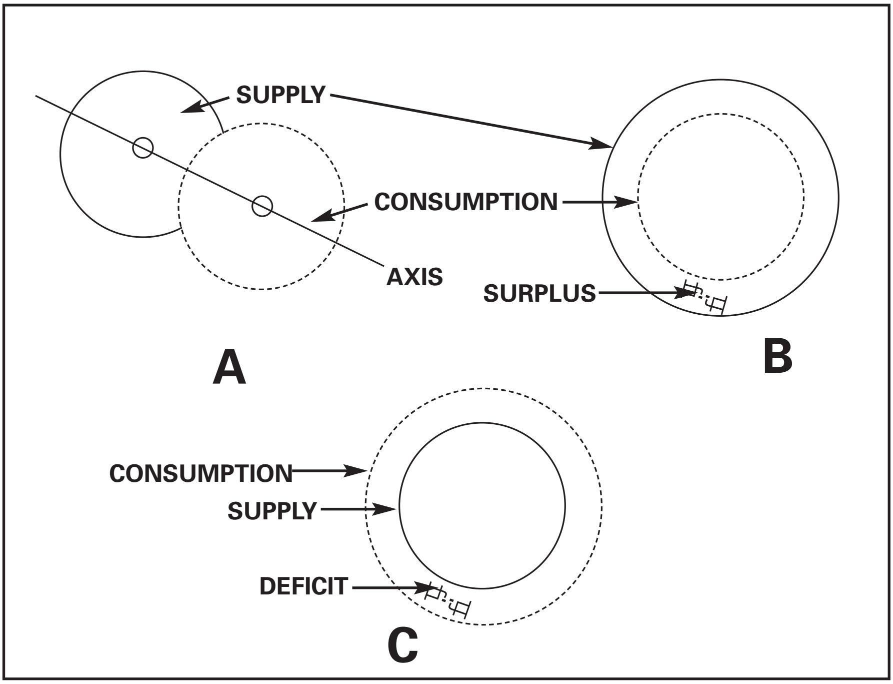

Figure 5.3—Relationships between consumption and supply (dashed circles = consumption, solid-line circles = supply)

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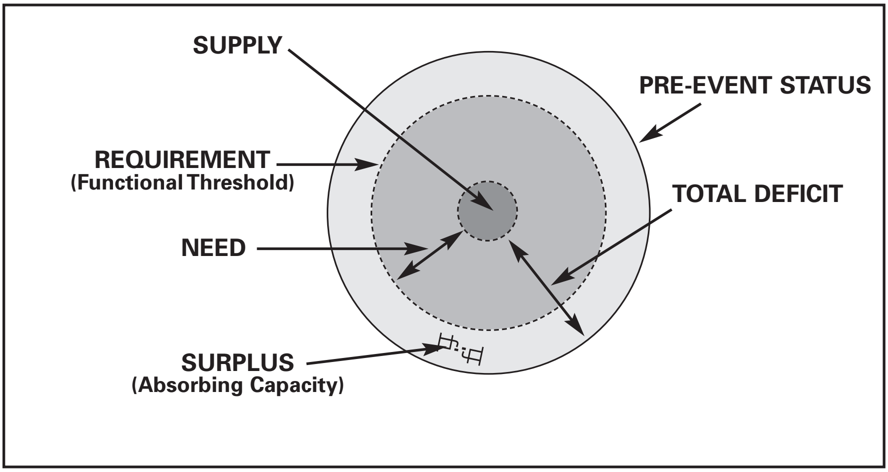

Figure 5.4—Supply unable to meet the requirements to maintain the functional state or the pre-event state.

to represent the domains of the variables. The *total deficit* for a function or component incurred from an event is the difference between the level of supplies of goods and/or services that was sustained before the precipitating event (pre-event status) defined by the outside, solid line, and the supplies available at the time the assessment was conducted (inner, darkest circle). The middle circle (dashed line) represents the level of supply that was required to maintain the function of the BSF or functional component that was assessed. When a deficit exists between the level of available supplies of goods and/or services and a requirement, a *need* exists. This level of supplies necessary to maintain the function of the BSF or functional component, is the *functional threshold.* Any level of supply of that good or service that is below the functional threshold, prevents that component or element from meeting *all* of its required functions. The *functional status* is the level of functioning of the given component at the time of the assessment.

A *need* is to stand in want of or to require; to be without; circumstances requiring some sort of action;[5] a *necessity* is an indispensable thing.[5] Thus, in the context of this discussion and throughout these *Guidelines*, the term "need" will describe the levels of available goods and services that are necessary to meet the requirements to restore basic societal functions. Needs are manifestations of the damage sustained. Damage results in deficits either as a result of destruction of or inability to access existing resources, or of increased consumption (i.e., need for increased medical services). Thus, dur-

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ing and/or following an event, needs can result from decreased supplies due to destruction or inadequate availability of supplies to meet increased requirements. When some of the functions cannot be accomplished, a *functional deficit* of supplies exists, and total (complete) function cannot be restored unless the needed supplies are provided. Thus, the terms functional deficit and needs are synonymous.

Critical Requirements and Needs

If the deficits in the supplies of the goods and/or services for some of the BSFs get to a sufficiently low level, the life of the members of the affected society becomes threatened. For example, when the supply of potable water falls to a level below that required to sustain life, lives will be lost if the minimal requirement to sustain life is not met within a limited period of time. The requirements (supplies) to sustain life are *critical requirements*, and the supplies needed to sustain the lives in the community are called *critical needs*. In such circumstances, critical needs must be provided to avert the loss of lives. When critical requirements are not satisfied, the crude mortality rate (CMR) for the affected population increases.

DAMAGE

The amount and characteristics of the damage and the impairment of functions that results from an event are tempered by the place of occurrence, the society and its culture, the level of development, the degree of preparedness, and the efficiency and effectiveness of the implementation of contingency plans. The extent of the physical damage and the functional deficits that result, determine whether an event results in a disaster. Damage may involve humans, other creatures, and/or the environment. Figure 3.3 illustrates some key determinants for the development of disaster. The damage created by the precipitating event(s) and other cause:effect relationships related to the precipitating event may impair the ability of the society to provide its basic functions. *Damage assessments* are directed at assessing general and specific aspects of the damage resulting from the event. Such assessments seek to define the location, the type, and the extent of the damage sustained. Damage assessments attempt to determine the functional state of the affected society and its infrastructure. Ideally, damage assessments should identify the functional status of each of the BSFs and as many of their respective components as is possible for each area and segment of the population being assessed.

Descriptions of the damage do not define what must be done to return the affected society and the environment to their pre-event states. The damage sustained either must be repaired or the element must be replaced. Either process requires the investment of resources (interventions) in the form of goods and services. Temporary measures may need to be implemented to provide safety for the affected population while recovery is occurring. For example, tents may be required to provide temporary shelter. Such interventions are the result of needs assessments and are above and beyond damage assessments. However, one of the objectives of the systematic use of these Guidelines and Templates is that eventually, damage assessments may be able to predict certain needs, to identify a lowest common denominator of assistance for a given scenario, in an effort to avoid unnecessary delays. For example, if a bus accident occurs, at least one or may be even two or three ambulances are dispatched immediately before the exact need for ambulances is reported from the scene. The same logic is applicable also to large scale disasters in which there likely will be a need of international assistance.

Figure 5.5 illustrates how the needs may vary during and/or following a sudden-onset, destructive event. In this diagram, the dead have sustained

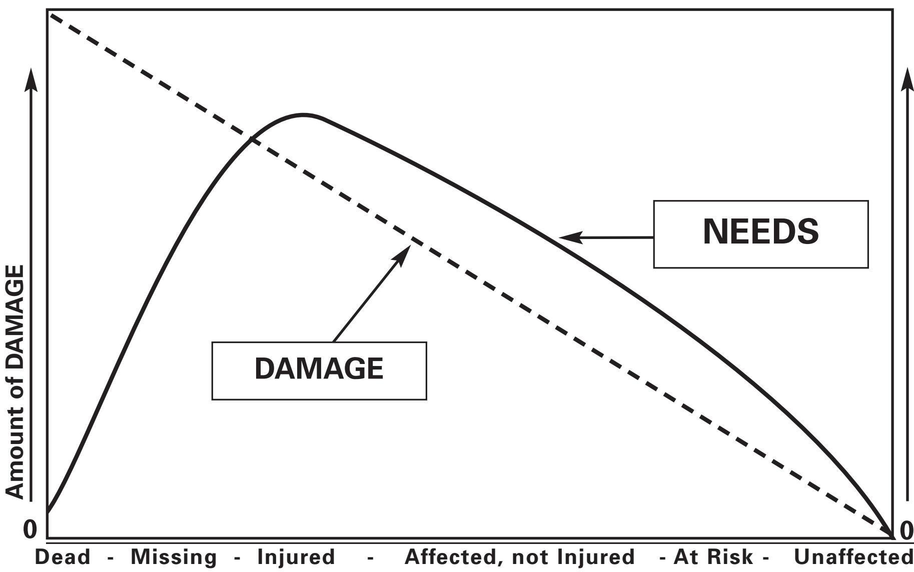

Figure 5.5—Relationship between the respective amounts of damage caused by a sudden-onset event and the needs of five segments of the affected population

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maximum damage and thus, have no needs, although there is a societal need for disposition of the bodies. The missing consume the resources related to search and rescue. The injured have sustained moderate to severe damage and have substantial needs. The uninjured also may have significant needs mainly from public health and other societal functions.[6] In addition, some of those not directly affected by the precipitating event, may become at great risk for secondary events such as flooding and/or mudslides following the impact of a tropical cyclone, and subsequently, will develop other needs.[7-11]

It is the dead, missing, and injured persons that have received the greatest attention from the media. Certainly, in the setting of a sudden-onset disaster, immediate attention is directed toward search and rescue and the identification, assessment, and provision of emergency treatment to the injured. In some slow-onset types of disasters, once the recognition that the impact has occurred, the main response of the affected society may be to meet the increased need for consumption of resources with increased supplies.

In addition, local resources (supplies and personnel) may be destroyed or damaged by the event (either primary or secondary). Moreover, the possibility to supply resources may be profoundly compromised by damage to the societal infrastructure and other basic functional components of the affected society (i.e., destruction of bridges, transport capabilities, etc.). The availability of resources and their optimal utilization, both human and material, may be compromised further by failures in the coordination and control of the multifaceted problems associated with the damage. The effects of damage to society can be attenuated by good management of resources and vice versa.

THRESHOLDS

A threshold is a limit below which a stimulus causes no reaction; a limit below which no reaction occurs.[12] In physiological terms, crossing a threshold evokes an *all-or-none* phenomenon: it either is on or off (e.g., neuronal transmission, muscular contraction). This concept can be applied to functions of a society as well (Figure 5.6): in other words, the function is either on or off. When the level of supplies vs. consumption of a specific good or service is below the "threshold", e.g., at Point A, no function occurs, and when the level of supplies given the same level of consumption is above the "threshold", e.g., at Point B, full function occurs. The provision of supplies in amounts that are less than the threshold amounts will not produce any func-

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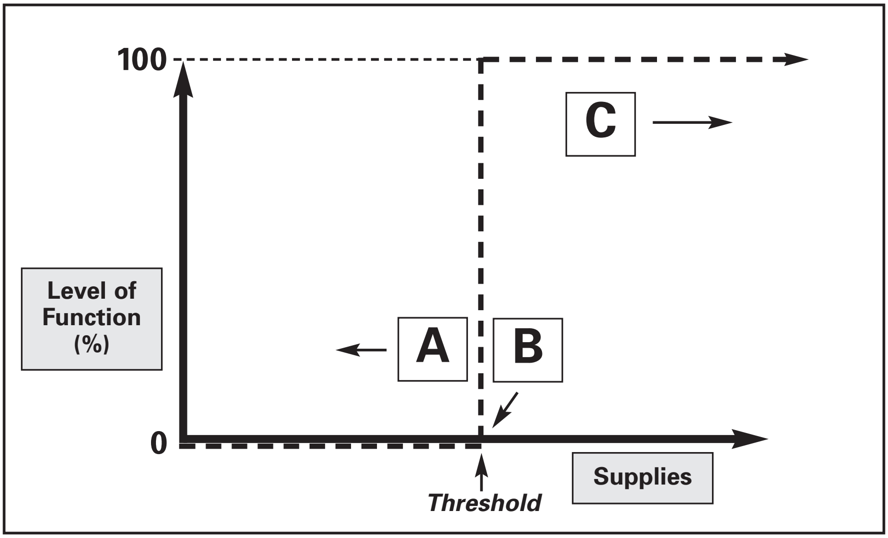

Figure 5.6—A threshold as an all-or-none relationship. At supply levels below the threshold (A), no function occurs, and at supply levels above the threshold (B), full function occurs. Provision of supply levels above the threshold (C) produces no further improvement of function.

tion. Furthermore, when the level of available supplies is greater than the threshold amount, no further augmentation of function occurs. The function either is 100% or zero. Examples of all-or-none functions include the supply of electrical energy: if supplies cannot meet the requirement, light bulbs are dark, motors do not turn, and radios do not function, and vice versa.

In terms of the functions of a society, it is not likely that its functions either are off or on. Societal functions are complex and have many requirements. Several responses to increased levels of supplies are possible, some of which are plotted in Figure 5.7. The relationship between the level of function and the available supplies described by Line 1 indicates that the level of function increases linearly with increasing levels of supplies ($y = ax$, where a is the slope of the relationship). The increased level of function associated with an increase in the available supply of the good or service is the same from 0 to A as it is from C to D. There is no threshold and no upper level of function. This is an unlikely scenario for the functions of society.

When the level of function relates to the level of available supplies follows the relationship described by Line 2, there occurs a greater increase in the level of function when the available supplies are increased from 0 to A than occurs from Level B to Level C when the available supplies are increased

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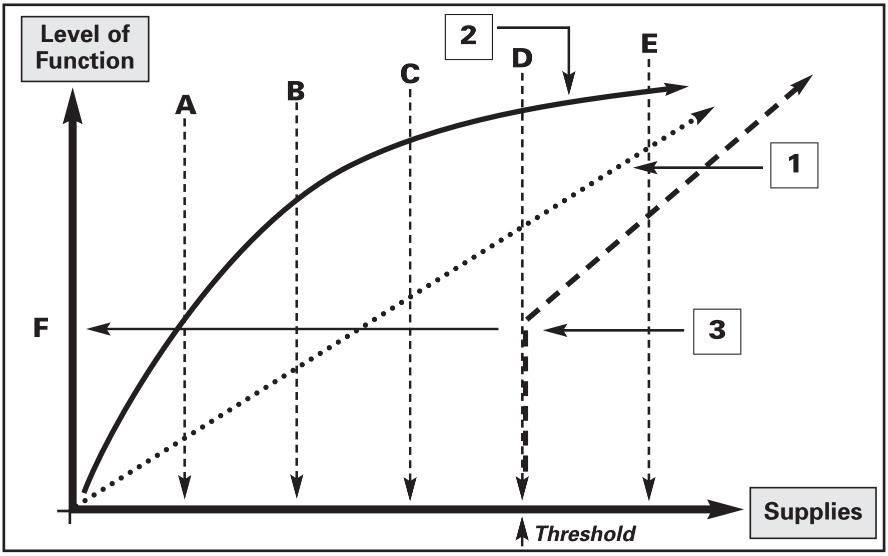

Figure 5.7—Additional possible relationships between the level of available supplies and function. In Lines 1 and 2, function increases progressively as the level of supplies increases. Neither exhibits a threshold. Line 3 has a threshold, but it is not all-or-none as only partial function returns as the threshold is exceeded.

the same amount. Thus, further increments in available supplies result in progressively smaller increments in function (diminishing returns). Eventually, further increases of supplies produce no further improvement of function. There is no threshold.

When the relationship between available supplies and function is described by Line 3, no function occurs with successive increments in the available supplies until the supplies reach level D (threshold): no function occurs with increasing supplies until the accumulated supply reaches the threshold. However, unlike the relationship in Figure 5.6, as the level of supplies exceed the threshold, only a portion of the total possible function occurs (F). Supplies that exceed the threshold continue to result in an increase in the level of function. As supplies increase above the threshold, the level of functioning could increase in a linear fashion as in Line 1 or with diminishing return as in Line 2, or could not increase until another functional threshold is reached, and so on.

As noted above, for some functions, if the available supplies are too low, it is not possible to sustain life. The threshold below which available levels of supplies are too low to support life is the *critical threshold.* At supply

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levels that are less than the critical threshold, the crude mortality rate (CMR) in the society rises. Thus, by definition, the *critical threshold* is the level of function below which the Crude Mortality Rate (CMR) starts to increase. Thus, the critical threshold is the minimum level of supplies required to sustain life. The amount of supplies that must be made available to return the function to its critical threshold is the *critical need*. For example, under basic normal physiological conditions, it is not possible to sustain life with supplies of potable water of less than between 2.1 and 2.3 liters/person/day provided you also get food, and between 2.3 and 2.5 liters/person/day without the water produced from food metabolism.[14, 15] Consequently, at sustained supply levels of less than 2.5 liters/person/day over a period of time, people are unlikely to survive, and the CMR will increase. Most organizations do, however, operate with higher minimum standards ranging from 5–15 liters per person per day and CMR may increase at levels >2.5 liters/ person/day, dependent upon scenario and time frame, as levels of available supplies of water also impact upon the preparation of food and personal hygiene.[15-17] Currently, these recommended minimum standards have been established at consensus conferences, but the large variations of different thresholds for bodily and societal functions and morbidity, will benefit from more substantiated research for different scenarios.

Figure 5.8 illustrates another variation of the level of function vs. available supply relationship. Using the available supply of potable water again as an example, as long as the available supplies of water are <2.5 liters/person/day, the crude mortality rate increases. When the supplies available to the population reach levels ≥2.5 liters/person/day, the CMR related to the supply of water decreases, as the critical threshold for water is exceeded. But many of the uses of water that are important to the affected society still cannot be accomplished (e.g., body washing, cooking, etc.). As the supplies of water increase further, these important functions that are dependent upon an adequate supply of water will be possible: the functional state increases progressively, but not necessarily as a linear relationship; depending on the function and its buffer capacity, increased supplies could follow a pattern of diminishing return or other variations. For example, it may become possible to perform hygienic tasks such as hand washing and other measures to contain the spread of disease associated with fecal-oral contamination, followed by the ability to clean foods, and then, to cook them. As available supplies are increased further, other functions are added.

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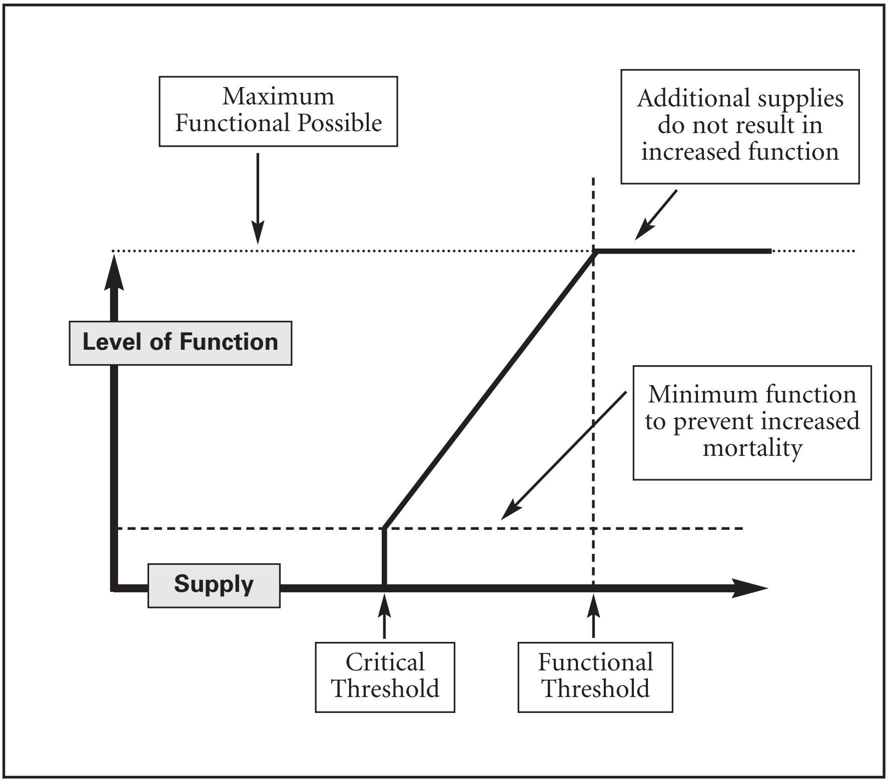

Figure 5.8—Diagram illustrating a critical threshold for the supply of potable water. As the supply of water increases beyond the critical threshold, there occurs a progressive augmentation of the functions that can be provided (e.g., cooking, personal hygiene, washing of clothes, cleaning of shelter, etc.). Further increases in the supplies of water beyond a certain level will not provide any further augmentations of functions within the affected society.

The *functional threshold* defines the level of supplies at which **all** of the essential aspects of the function are operational. All of the functional requirements are being supplied. At levels of supplies below the functional threshold, some of the function(s) is/are lost. Most elements and components of the BSFs have a functional threshold.

At supply levels above the functional threshold, improvement of required, essential function will not occur. Using the supply of water again as the example, supplies in excess of the amounts required for the society to provide essential functions, in some societies, may allow other non-essential functions such as watering the grass and plants, washing the automobile, fill-

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ing swimming pools, etc. These functions are not essential for the function of the society and are called *luxuries*. The provision of luxuries are a benefit in developed societies, but an inability to use water for these purposes does not compromise the ability of the society to function: it merely represents an inconvenience. Once the maximum possible function of water is reached, further increase in the amount of water provided does not result in any increased level of function. Such supplies allow the accumulation of water, i.e., there is a surplus of water. Surplus supplies of water contribute to the absorbing capacity of the society.

Given the complexities of societal functions, it is not likely that thresholds will be defined by a sudden and complete change in the functional state. Rather, some elements comprising a larger function may become dysfunctional or non-functional, but the overall function, although compromised, continues to meet some of the requirements of the function: its functional state is decreased. The relationship depicted in Figure 5.9, describing the level of functioning as dependent upon the level of supplies, suggests one potential mechanism for defining the respective thresholds. Thresholds are defined by that point through which the change of the slope between two tangents at a given delta-x has its largest angular change.[i] This becomes more clear when the function/supply relationship is viewed as a continuum. Damage created by an event may result in decreased supplies and moves the relationship to the left; repair and recovery move the relationship to the right.

Lastly, it is important to recognize that the thresholds discussed and how they relate to a disaster depend on the denominator. For certain situations, they are constant for a given society and ambient conditions. For example, the critical threshold for the supply of accessible water is determined physiologically. It may vary only slightly given the ambient temperature and humidity. A greater accessible supply of water may be required in a hot and dry climate than in a cold and wet climate. The functional threshold is the level below which supplies cannot fall without rendering that commodity or a dependent function insufficient to serve its society. This often is observed during disasters when resources are destroyed. However, if there is a temporary need for a higher level of function for one societal function or sub-function, this will dictate a re-orientation of the use of the resources needed for that function, according to the priority allocated by the

[iv] In mathematical terms, this point is called the derivative of the curve.

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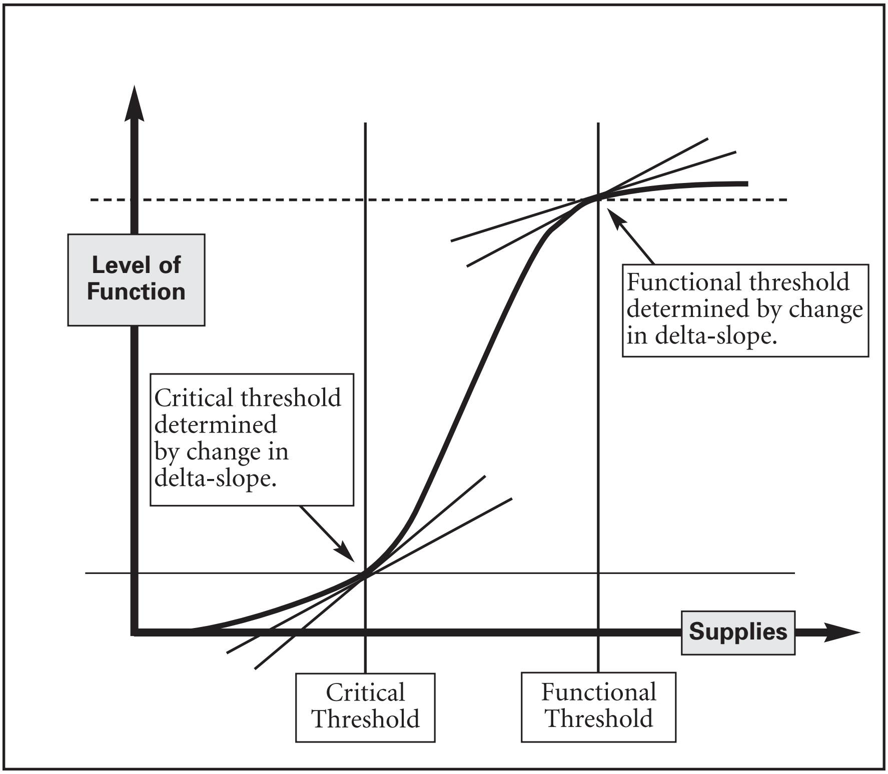

Figure 5.9—Conceptual method for identifying thresholds. The most protuberant parts of the curves are defined as thresholds. They are identified by that point through which the change of the slope between two tangents at a given delta-x has its largest angular change. This may be the only way to identify a functional threshold. Critical thresholds coincide with the point at which the crude mortality rate begins to increase.

Coordination and Control function for the disaster, at the cost of other functions requiring the same resource. If the increased need consumes the absorbing capacity, other functions have to fall below their functional threshold, if the function at question is given priority. Putting out forest fires and consumption of both water and extra personnel serve as an example. Temporarily increased need for ambulances in a mass casualty situation is another.[18] A temporary increase in the needed level of function is defined as *a conditional level of function*. If the conditional level of function becomes a permanent situation, it may constitute the new adjusted functional threshold for that society, or the condition could be classified as a chronic disaster. Furthermore, functional thresholds constitute the requirements for a given

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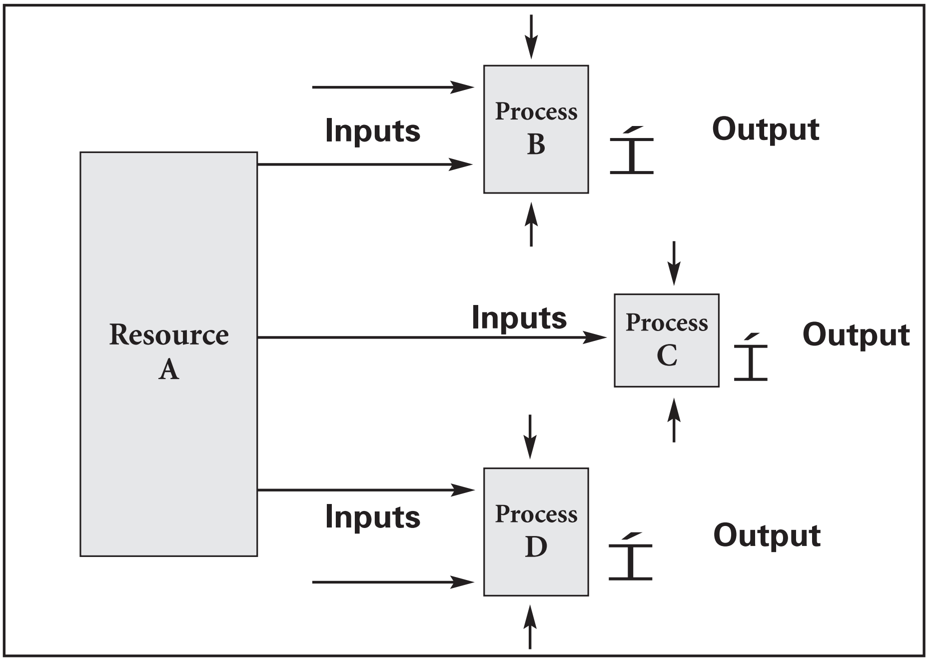

Figure 5.10—Schematic diagram depicting how several processes may depend on one key commodity in addition to other resources needed as input for a specific process

production process with a given level of efficiency. Given the denominator, the only way a functional threshold can change is through a change in the efficiency of the production process it serves—damage to the process may require the use of a new production process in an effort to preserve the function. Thus, the consumption of the resource (input) is reduced, since another process substitutes to provide that function (e.g., latrines replacing water toilets). The substitute process has other requirements. Function is dependent upon available supplies of the inputs required.

RELATIONSHIPS BETWEEN DAMAGE, SUPPLIES, AND FUNCTION

Supplies of goods and services are dynamic as is the consumption or use of such goods and services. In developed societies, supplies and consumption are held in balance and often surpluses are created to satisfy luxury demands and/or contingencies. This applies not only to supplies of goods and equipment, but also to human resources.

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Significant events may cause damage that may destroy or make unavailable the supplies that were available in the pre-event period, and/or damage may create an increased consumption of resources to prevent further damage from occurring and/or for the repair of the damage created by the precipitating event.

When the needs assessment indicates that an available supply is reduced to levels that are below a threshold, then this component is rendered dysfunctional or even non-functional. Furthermore, a combination of dysfunctional elements, all of which may be above their respective critical thresholds, but, below their functional threshold, may impair the functional state of the component or functional state of which they are a part and, as a result, bring the output of the function as a whole below its critical threshold. Severe damage to one functional component, such as transportation, may result in impairment of many other components sufficient to render the affected society unable to meet its overall functional requirements (Figure 5.10). Thus, insufficient available supplies that result in impairment of one function may create a cascade of cause-effect relationships that render other functions and/or sub-functions below their respective thresholds. Further, the same resource/commodity may be required by several functions or sub-functions. This was demonstrated during the Soviet diesel embargo towards Afghanistan during the winter 1990/1991. Diesel constituted the top priority energy resource. Without it, practically all functions suffered and had to be curtailed. Ambulances ran on diesel, and all private cars requiring diesel were docked. Eventually ambulance transport also was rationed. Public electricity depended on diesel as did heating (directly and indirectly). Temperature in the operating rooms dropped to 10–15°C. Oxygen production depended on diesel, ground water pumps were running on diesel, etc. Consequently, the whole society and especially the hospitals became dysfunctional due to an inadequate available supply of one commodity.

In many societies, the functional threshold and the pre-event functional status are the same. In other societies, the pre-event situation is better than the functional requirements. This difference is surplus; *surplus* is the difference between the supplies of goods and services that are required to function and the supplies to allow restoration of the pre-event functional level. Surplus includes supplies used for luxuries and/or to build and maintain resources to meet contingencies and/or for development. *Luxuries* are those goods and services that are enjoyable, but not required; goods and

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services that are desirable for comfort or enjoyment, but are not indispensable.[19] Luxuries include the use of resources for mending your lawn, maintaining a swimming pool, showering every day, sustaining room-temperature between 22° and 24°C, driving an automobile for pleasure, etc. *Contingencies* consist of resources that are accumulated for use in a future event or circumstance regarded as likely to occur or for influencing a present action.[20] Contingencies include planning to cope with an anticipated event and the education and training necessary to implement such an activity/plan. Surpluses of goods and services can be destroyed without the basic function of the element being compromised. Along with the resilience of the environment, surplus comprises the absorbing capacity of the society and environment for an event (Chapter 3). Thus, for those societies without surplus, vulnerability to damage caused by an event is great, i.e., there is little, if any, absorbing capacity for the given function.

INDICATORS OF FUNCTION

To indicate is to point out, to make known, to show, to show to be necessary.[21] An indicator is a thing that indicates.[21] For the purpose of this discussion, indicators of function are signs or markers that indicate the functional status of a specific component or element of the affected society. Such indicators may be numeric or descriptive. In order to judge the impact of an event upon the function of a basic societal component, it first is necessary to identify some marker or indicator that accurately reflects the functional status of the component in serving the affected society. In evaluation and research, changes in the value or level of a specific indicator reflect the impact of the event or the effectiveness of the response. Some indicators of function that describe the functional status for some of the basic components of a given society have been identified and are outlined in Appendix A. However, many still need definition. It is important to note that the indicators needed to assess the functional status of a BSF or its constituent elements are distinct from most of the indicators outlined in the Sphere Project.[15] For example, the Sphere Project uses “access to a range of foods” as a Key Indicator for nutritional status. Actually, the function is nutrition, which is assessed by identifying the nutritional state of the affected population—“access” relates to the supply and not to level of function.

Indicators are used to assess the damage sustained and the impact of the event. They also are useful for assessments of the effectiveness, efficacy,

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efficiency, benefit, and cost of the responses. However, indicators of damage and for the subsequent immediate needs may not be identical, even if they are closely related. Destroyed houses are described as such, whereas the needs are indicated in the number of tents or adequate temporary shelters. Also, the indicators for what benefits the population may differ from the indicators of efficiency and effectiveness meant to measure the function providing that benefit. Selection of a "best" indicator that most accurately reflects the functional state of a basic societal function or one of its components or elements is crucial. Great care must be exercised in identifying the most appropriate indicator of the function being assessed.

Figure 5.11 illustrates the relationship between function and available supply using a hypothetical model with available water supply as the independent variable and crude mortality rate (CMR) and an undetermined indicator (X) of function as the dependent variables. Levels determined by actual assessments are indicated by the small black circles. The CMR was not affected by the event until the available supply of water/person/day was below the critical threshold.

At the time of the first assessment, although the operational state of this component was impaired, levels of function were not impaired to a degree that would compromise the overall function, i.e., the level of function remained above the functional threshold (85% of the pre-event level), since the society initially was able to absorb the impact of the event without the supplies reaching levels that resulted in dysfunction. However, when the element was in this state of function, the use of water by the affected society needed to be curtailed for those functions that were least important.

By the time of the second assessment, the available supply of water had fallen to 5 L/person/day, twice the amount required to sustain life. Although the available supplies of water had fallen to 25% of the pre-event levels, the level of function (X) was maintained at 65% of the pre-event level for the society. At this level, 35% of the function (X) provided by the water supply became compromised, but only one fourth of the essential functions (falling from 85% of pre-event level, constituting the functional threshold, down to 65%). The least important function for which water is an essential input had to be curtailed, e.g., body washing, laundering of clothing, etc. The water supplied was sufficient to sustain the life of the members of the affected population.

When the third assessment was conducted, the available water supply had fallen to 1.7 L/person/day. Given the critical threshold of 2.5 L/per-

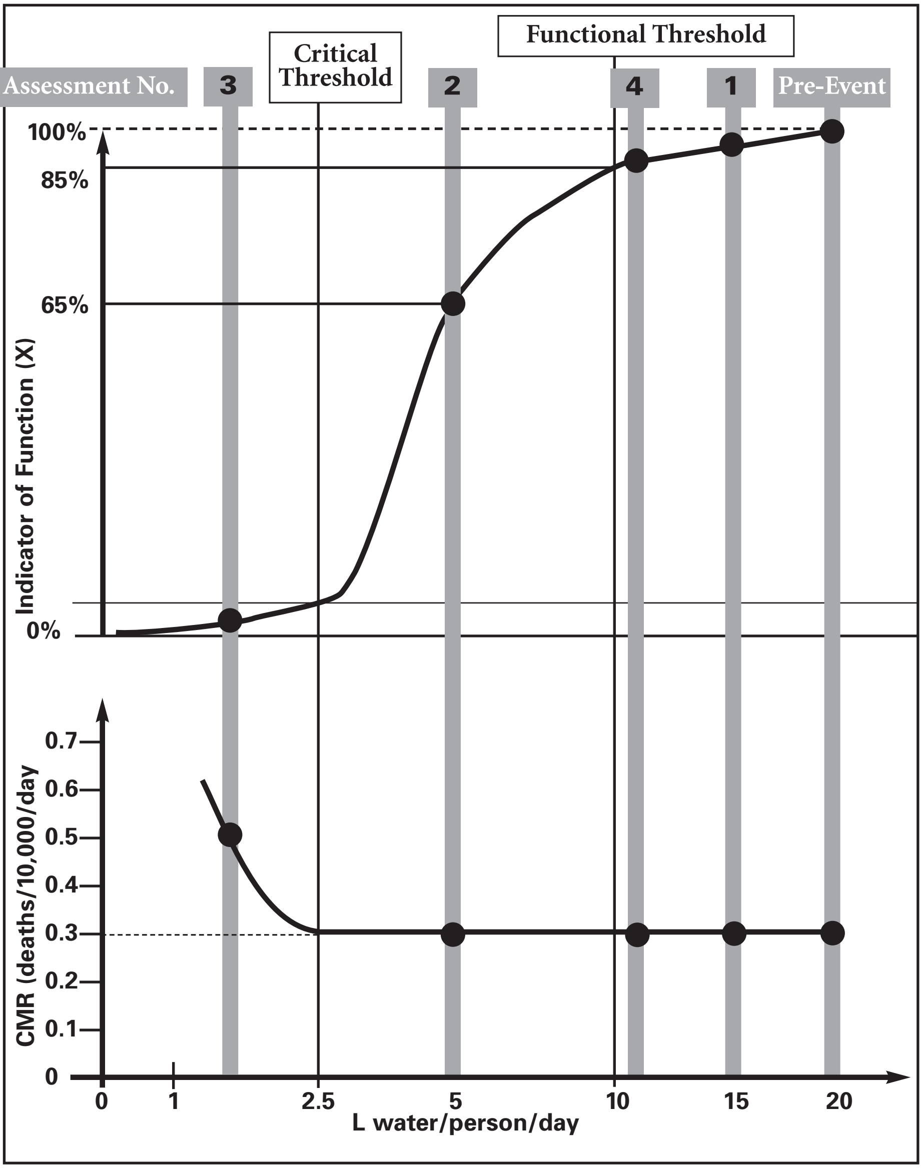

Figure 5.11—Conceptual, hypothetical model depicting the different sensitivity of one generic indicator (X) and the ultimate hard endpoint indicator, Crude Mortality Rate (CMR). Indicator (X) signals alarm before the CMR begin to increase. Five assessments were conducted, one prior to the event and four subsequent to the event. Crude mortality rate show no change until the available water supply fell below the critical threshold. The upper ordinate has no specific indicator of function. Assessment 4 indicates full recovery of essential function.

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son/day, the crude mortality rate (CMR) began to increase. There existed a critical need of 0.8 L/person/day to return the CMR to pre-event levels. This constituted a medical emergency.

At the time of the fourth assessment, the available supply of water had returned to 11 L/person/day, slightly above the functional threshold; essential functions had been restored, and the society now was able to meet not only the minimum levels for normal function of the society, but also some of the non-essential uses of water for that society could be provided. Still, the damage sustained had not been corrected completely and recovery was incomplete. By definition, the society had not yet recovered from the disaster. If this example was happening in a developing country, international assistance still would be justified. However, if this occurred in an industrialized country, the additional response should be covered by the affected society and not as part of the external disaster response. If possible, resources originally used to restore one element back to its functional threshold, could be reallocated and their use adjusted to bring other compromised functions back to their respective functional thresholds. *The functional threshold is specific for the society affected.*

The question remains as to what would be a good indicator of the decrement in function that resulted from the event and the activities conducted to restore the societal function back to its pre-event status. Such indicators of function could include: (1) access to quantities of water to maintain adequate hydration; (2) the ability to cook food; (3) the ability to reconstitute dried foods; (4) the ability to wash clothes; (5) the ability to body wash to prevent fecal–oral contamination; (6) the ability to wash food; (7) the ability to irrigate crops; (8) the sensation of not feeling thirsty; (9) the number of water borne infections; (10) the ability to flush toilets; (11) the ability to fill and maintain a swimming pool; (12) watering lawns; (13) the ability to wash an automobile; etc. The exact priorities for this list of potential indicators of function are not clear.

INDICATORS FOR SUPPLIES

Other ways of using these same data are illustrated in Figures 5.12 and 5.13. The figures are extrapolations from Figure 5.9, and such displays may be useful in disaster management. The indicator used in Figures 5.12 and 5.13, is the actual amount of water available for distribution to the affected population in terms of the volume available per person per day. It generally is

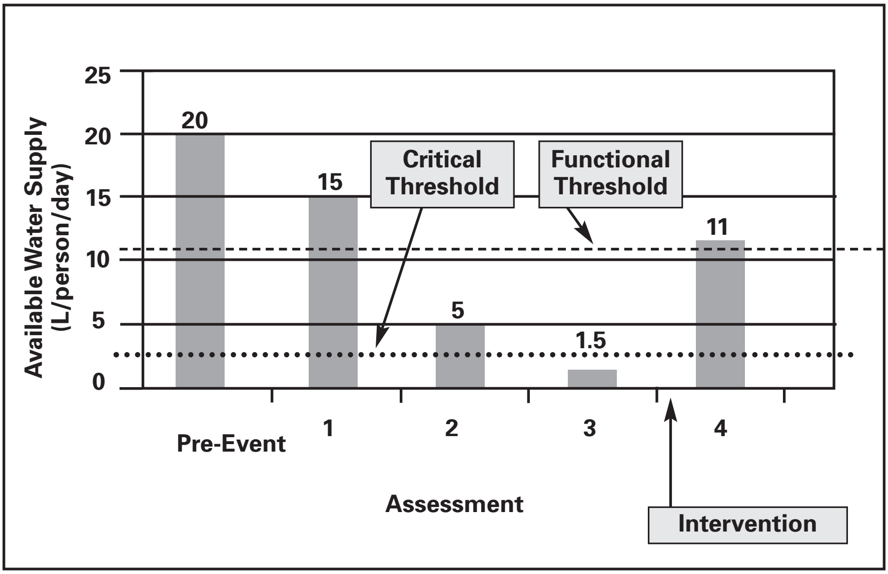

Figure 5.12—Plot of available supplies detected on consecutive assessments. At assessments 2 and 3, the available supply of potable water is less than the amounts required to sustain essential functions. By the third assessment, the level of available water has fallen to levels less than the critical threshold. Recovery of the basic pre-event function was restored by the last assessment (4).

accepted that in temperate conditions, the average human requires a minimum of 2.5 liters of drinking water per day just to survive. This does not include the amount of water required for cooking, rehydration of dried provisions, washing, sanitation, etc.

The indicators for the quantities of supplies are distinct from those used to describe the function provided by that supply. The requirements of supply to support a specific level of function may vary somewhat depending upon the efficiency of the production process(es) employed to produce that function. Also, the requirements (functional thresholds) may vary between societies and cultures. The amount of water required for food preparation may vary between a society in the tropics compared to one in the arctic.

However, within a given society at a constant ambiance, unless the efficiency of the processes changes, the requirements per unit for function should remain the same. Therefore, the indicators used should have some index of distribution included in the units, e.g., amount/person/day, amount/10,000 population, quantity/proportion of the population, num-

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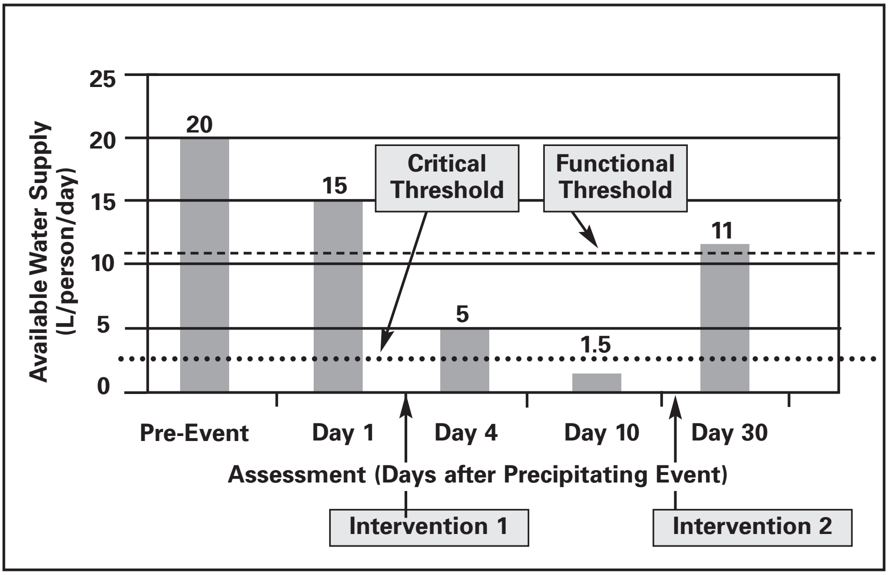

Figure 5.13—Plot of available supplies detected on consecutive assessments at Days 1, 4, 10, and 30 following an sudden onset event. At Days 4 and 10, the available supply of potable water is less than the amounts required to sustain essential functions. By Day 10, the level of available water has fallen to levels less than the critical threshold

ber of ambulances available/10,000 population, etc. Thus, if the total consumption of a good or service increases due to increased need in the function or needed increase of that function, there is less of the resource available for other functions within the same population that requires that good or service. The requirements for other functions remain the same per unit. When the supplies consumed exceed the surplus (absorbing capacity exhausted), the supplies are insufficient to meet the requirement (functional threshold), and function becomes compromised until the available supplies are supplemented.

Figure 5.12 is a description of the supplies of water available during consecutive assessments of the supplies. It demonstrates a progressive decline in the available supplies of potable water with successive assessments until the fourth assessment was conducted. Thus, the damage resulting from the event resulted in impairment of the delivery of adequate supplies of water until some time between the third and fourth assessments. Such presentations may be useful in disaster management for evaluation of the effectiveness of interventions directed at restoration of adequate supplies of water. They relate to function only in relation to the thresholds that are indicated on the diagram. The available supplies were below the critical threshold during Assessment 3, but the duration of this state is not clear from the diagram. The diagram helps us to realize that when the levels of supplies of water fall below the critical threshold for water, more frequent assessments must be made in order to address this critical deficit. The presentation constitutes a tracking methodology as to the status of water supplies and nothing else. The intervention applied between Assessments 3 and 4 may have contributed to the recovery. At the time of the 4^{th} Assessment, the supplies of water had returned to functional threshold levels, but the pre-event level of functioning is not provided. An intervention directed towards restoring the water supply to at least the functional threshold may have been successful. As the diagram demonstrates a return to a level above the functional threshold, it is not clear as to whether the intervention applied was responsible for the improvement in the available water supply. This is of interest particularly since the intervals between the consecutive assessments is not known.

The situation infers that something was deteriorating and that an intervention should have been implemented after Assessment 2 before the available supplies of water reached the critical threshold (Figure 5.12). However, since assessments/surveillance systems have not been institutionalized, the need for interventions often are realized only after a situation becomes critical. Famines are examples of the latter.

Figure 5.13 is a plot of the same data, using the day post-event that the assessments were conducted. This plot provides a better relationship between the supply of water and the time interval following the event. Two interventions directed at restoring adequate supplies of water to the affected population were implemented: the first between Day 1 and Day 4 and the second at some time between Days 10 and 30 after the precipitating event. Here, the situation was interpreted correctly and actions deemed appropriate were initiated. Despite implementation of Intervention 1, the available supplies of water continued to decline. But, it is not appropriate to assume that Intervention 1 was ineffective in restoring the supply of water, as it may have delayed the decline of the supply from reaching levels below the critical threshold. The same can be said for Intervention 2 as for the intervention applied in Figure 5.11. Thus, one must exercise great care in assigning the value of an intervention on the basis of such plots. The evaluation of the effectiveness, efficiency, benefits, and costs of interventions is discussed in subsequent chapters. With water supplies approximating the critical threshold, assessments must be conducted more frequently than indicated in Figures 5.12 and 5.13 and, if possible, implementation of additional interventions should be adjusted after recognition of the decline.

The foregoing discussion presumes that all of the population receives less than the critical threshold for water. The impact of the distribution of supplies of available water within the affected population on this factor is not considered in this threshold.

DISTRIBUTION OF SUPPLIES

The definition of the critical threshold assumes that the distribution of the supplies is uniform across the affected population. It would be rare that such equal distribution of limited supplies would occur. The indicator used (L/person/day) does not provide an indication of the distribution of the available water, and a large segment of the population still may not have sufficient amounts of water to survive. Thus, a combination of the most appropriate indicators to assess needs may be essential. Another indicator for the availability of water could be the proportion of the affected population that has access to a specific amount of water per day. For example, 50% of the population could be receiving 4 liters/person/day while 25% of the population affected could have access only to 1 liter/person/day. Both of these measures would be indicators of the need for water. Thus, using this indicator, it would be possible to assess the distribution of scarce resources. The latter also are indicators that are required for Coordination and Control and for Logistics.

One additional issue bears discussion. For many of the functions and especially of those for which a critical threshold is applicable, the distribution may be based on the principles of solidarity: if there is just enough water so that survival is not threatened, the supply is shared equally. Given these principles, if the available supply of water falls below the critical threshold, sooner or later everybody will die. When the principles of triage are implemented, instead of supplying everybody with too little, supplies are distributed so that those persons designated to receive water receive quantities above the critical threshold; those selected to be unfortunate get no water unless further supplies are made available. Appropriate triage should identify those lives most able to be saved. Therefore, when triage is applied, some people are sacrificed at the benefit of those more likely to survive. (See Chapter 8; Ethics). During a disaster, this analysis of outcomes relative to actual supplies received could serve as a mechanism to help identify the critical thresholds with greater accuracy.

Figure 5.14 is a theoretical model depicting the impact of Events A and B of different magnitudes on a given society. Each event produces damage that creates deficits in available supplies from the pre-event state. Event A results in Damage (A) (decreased levels of available supply) that renders

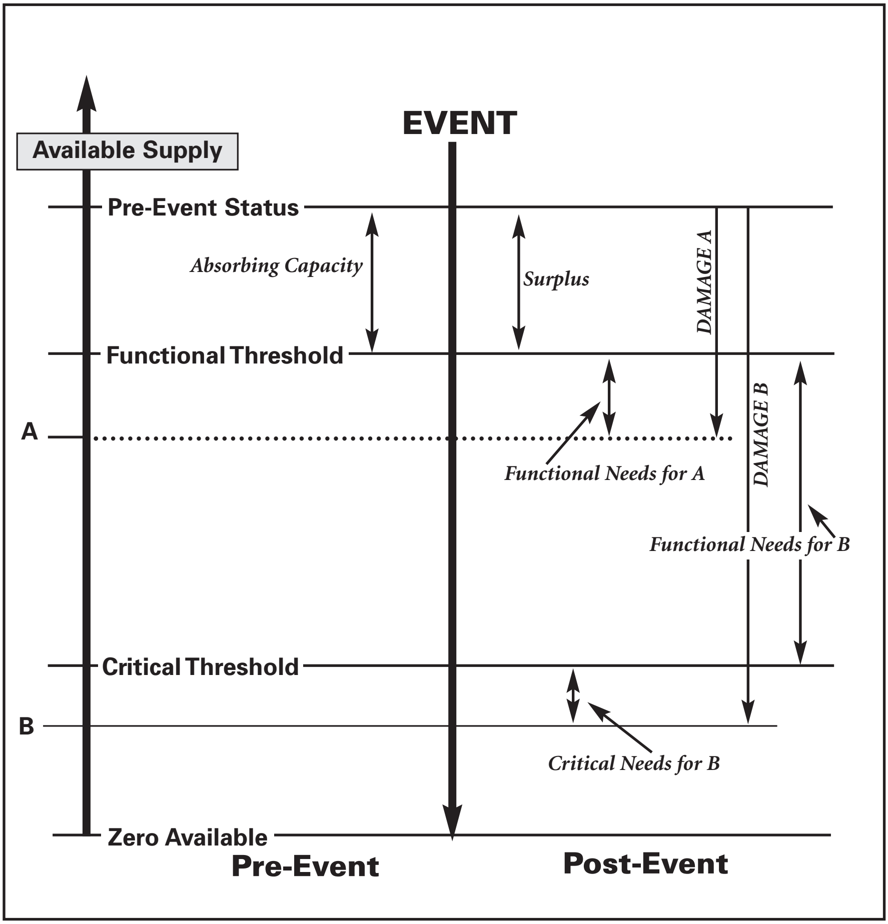

Figure 5.14—Theoretical model depicting the impact of Events A and B of different magnitudes on a given society. The broken lines are the levels of function after damage from the events (A and B) as detected by the indicator (none specified). This figure does not take into account conditional needs or a possibility for increased consumption that may have resulted from a response to the event. If the absorbing capacity is not consumed, there is no disaster.

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some element of the BSF to a level below the functional threshold (requirement). In order to return this element to the functional threshold, the Functional Deficit A will need to be repaired. Thus, supplies of the element will need to be brought to a level sufficient to return the function of the element to that minimum level (functional threshold) that allows the element to meet the functional requirement for that specific good/service in the affective society. In order to return the element to its pre-event functional state, the total deficit will need to be repaired (functional deficit + surplus). In Figure 5.14, the damage created by Event B renders the element assessed to function only at levels (B) below the critical threshold (requirements) when at least a portion of the affected population will not survive, and hence, result in an increase of the crude mortality rate.

CHARACTERISTICS OF NEEDS

Needs assessments differ from damage assessments in that needs assessments are used to define what must be provided to meet the requirements. Some needs must be addressed immediately, while others may be delayed, some for a relatively short period and others for substantial periods. Examples of *immediate needs* are those resources required to sustain the life of those injured and the search and rescue needed to find those missing. *Delayed needs* are those needs that *emerge gradually*. Therefore, the supplies required to meet delayed needs can be provided following more deliberate planning. The priorities for providing the needed supplies vary between geographic regions. In the arctic, shelter represents a more immediate need than does water. In the tropics, the situation may be opposite. But, the concepts of critical and functional requirements (thresholds) apply for both immediate and delayed needs. For proper management such delayed needs should be met when needed (and not before). These principles apply to all disasters, regardless of their type of onset.

SEVERITY SCORING

The judgment of the severity of the amount and character of the damage resulting from an event is a qualitative estimate. A severity score attempts to assign a numeric value to the severity of the damage. Generally, the weights attached to qualitative judgments have been derived from achieving consensus from panels of experts who assign a Likert-type value[22-23] to their judgments of severity, based on case reports or upon their respective knowledge of the science associated with the topic.[24] The weights then are adjusted based on further experience with their use.

Severity scoring has been shown to be valuable in the assessment of trauma management.[25-29] It has enabled us to compare outcomes for victims with similar severity of injuries, and has helped to identify factors in treatment that, when implemented, have resulted in improved outcomes.[24,30-34] Similarly, Ischemic Heart Disease Severity Scores have been of value in comparing the effectiveness and efficacy of interventions for patients with the same level of severity.[24] In the example illustrated in Figure 5.15, the survival of patients with moderate severity of ischemic heart disease was enhanced after the staff of community-level hospitals had participated in training in an advanced cardiopulmonary life-support course compared to when they had not been so trained.

For the purpose of rapid assessment and also to serve as a point of reference for evaluation and research, Disaster Severity Scores have been developed. Severity scores for grading of the severity of disasters (Disaster Severity Score and Health Disaster Severity Score) are proposed and will be discussed in this work. Repeated assessments of severity provide an overview of how things are

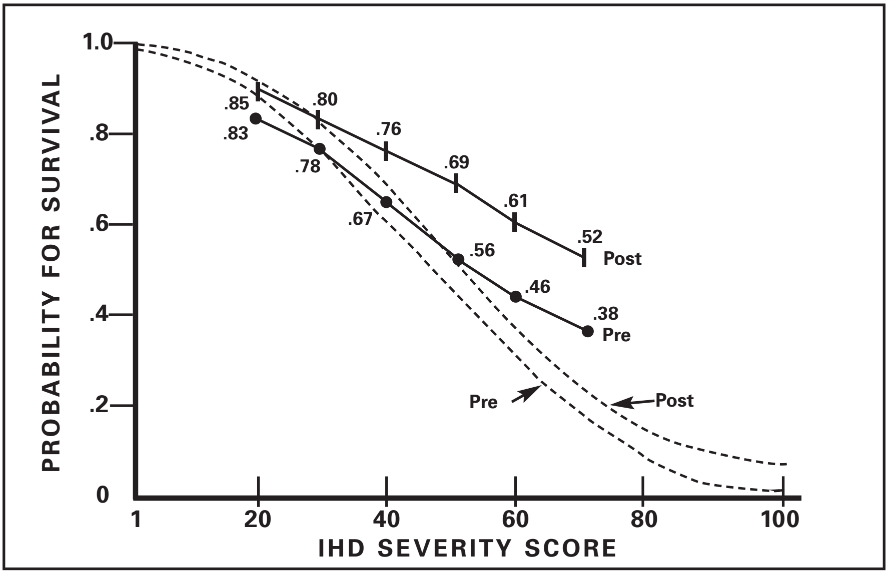

Figure 5.15—Logistic regressions of severity scores and survival for patients with ischaemic heart disease (IHD) before and following training in advanced cardiopulmonary life support

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progressing and whether overall recovery is proceeding as anticipated.

The use of severity scores also should facilitate comparisons of similar and dissimilar disasters, and hence, help identify common factors for otherwise dissimilar events. This will be important in the development of enhanced, standardized assessment instruments that, in turn, will provide an increased amount of similar data for comparison and ultimately, projections as to the resources required for preventing future problems, mitigation of some of the effects, and/or enhancement of appropriate responses.

DEVELOPMENT

Lastly, in terms of function, the responses to a disaster may leave the stricken society in a better, more advanced functional state than it was before the precipitating event. Since the objective of disaster response is to return the affected society to its *pre-event* state, additional gain is not part of recovery, but is development. *Development* occurs when the responses to the disaster render the level of function of a component above its pre-event functional state.

SUMMARY

Damage creates needs for resources. If a component of a function falls to levels below what is needed to maintain 100% function (functional threshold), the component becomes dysfunctional and a functional need exists. Whenever a resource for a societal component or function falls to levels below the critical threshold, a critical need exists. If the critical need is not corrected, persons at risk will die, which will be reflected by an increased crude mortality rate. Not all functions have thresholds, but of those that do, some must be identified using these Guidelines; some must be obtained from known physiological standards (water, ambient temperature, nutritional state). The threshold level that denotes the occurrence of a disaster varies between different societies and stages of development. Often, societal development raises the threshold levels.

Thus, damage is different than needs. Needs are resources required to restore the functions of the affected society. Both damage and needs are identified and defined through assessments. But, it is important to separate damage assessments from needs assessments. Damage assessments determine the amount of damage sustained, but do not necessarily define what is needed. Needs assessments attempt to identify what and how much in terms of resources are required to keep a society functioning, return the society to its

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functional state, and/or to restore the pre-event status of the affected society. Resources required to meet the defined needs may be personnel, supplies, equipment, or a combination. Whereas the post-event functional status is determined by damage assessments, needs assessments determines what is needed to restore impaired functions. Both damage and needs assessments must be repeated at frequent intervals in order to identify positive and negative changes in the supply of goods and services.

Indicators of function are important tools in assessing the damage and the functional status of the basic components of a society. Further, indicators of supply are necessary tools to give purposeful meaning to the term thresholds. Appropriate indicators are essential to the conduct of evaluation and research. Indicators must be developed and tested. For the most part, it is the status of both the indicators of function and supply that are sought during damage and needs assessments. The degree of impairment of the functions of a societal component is judged by the deviation from the pre-event status, and by the seriousness of deviation from the functional threshold as reflected by an indicator. The degree of recovery is judged on the basis of the pre-event status of the indicator(s) chosen.

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