Chapter V
Disaster Promulgation and Collective Behaviors

As mentioned previously, the actions or anxiety moods of others directly affect a person's attitude, especially when the situation is ambiguous and difficult for an individual to assess. The observed actions of others may suggest the situation is more severe. Once an observable anxiety with somatic symptoms is initiated, it tends to be imitated by the population and become a social trend. In this chapter, we quantify the disaster induced possible collective anxiety and estimate population level social productivity and response efforts. We then discuss the application of the proposed models in examining the potential psychosocial effects of an infectious disease like SARS.

MATHEMATICAL DESCRIPTION

Let C be the total population size in the targeted area (i.e., country, region, or state). At any time *t* during the course of the disaster, a person in C may be affected or not. If affected, the psychological damages the person experiences coincide with one of three levels: low, moderate, or high at time *t*. Therefore, the aggregate behavior of the population at each point in time *t* can be summarized by a "state" labeled L(t), M(t), H(t), or N(t), where N(t) denotes a state in which people have not been affected or have recovered by time *t*. That is, at any time *t* of the disaster, any member of the population C will reside in one of four states: N(t), L(t), M(t), or H(t), depending on his or her degree of exposure (i.e., the value of $Impact_i$ in Equation (4-5)).

Therefore, as time passes, people's status in the population may change from one state to another, on the basis of whether (1) the situation becomes more severe, such that collective social anxiety behavior deteriorates over time if ignored, or (2) the individual human body can make self-adjustments to recover through resilience. Since the duration of a disaster is short compared to the life of an individual, the size of the target population is assumed to be constant and the death toll due to the disaster itself is counted in the severe state H. Because the social influence (i.e. a person in one state may be influenced by another person in the same or other state) has been captured at the individual level in equation (4-5), in the aggregate level model, we assume the rate of change per unit time from one state such as N(t) to another state (e.g. L(t)) is proportional to the number of people in state N(t) at time *t* times the state transition rate. For example, to model the quantity N($t + \Delta t$), we check the number of people in state N at time t plus those converted to state N(t) over Δt, but minus the number of people who are affected and transferred to another state such as L(t), M(t) or H(t) during the same time interval Δt. Thus

$$N(t + \Delta t) = N(t) + [\beta_\phi L(t) - (\gamma_\phi + \gamma_\psi + \gamma_\xi) N(t)] \Delta t.$$

If we allow the time interval becomes very small, then in the limit the above equation becomes

$$\frac{dN(t)}{dt} = \beta_\varphi L(t) - (\gamma_\varphi + \gamma_\psi + \gamma_\xi) N(t).$$

For practical purposes, we assume that the impact of the disaster takes place immediately and continuously when the disaster event occurs. Thus, the affected population can be modeled as a four-dimensional dynamic system, as shown in Figure 5.1, in which the four states intertwine over time. The arrows in the graph indicate the changing directions of transitions in state.

This leads to the following differential equation system:

$$\begin{aligned}
\frac{dL(t)}{dt} &= -(\beta_\varphi + \mu_\psi) L(t) + \beta_\psi M(t) + \gamma_\varphi N(t), \\
\frac{dM(t)}{dt} &= \mu_\psi L(t) - (\beta_\psi + \mu_\xi) M(t) + \gamma_\psi N(t), \\
\frac{dH(t)}{dt} &= \mu_\xi M(t) + \gamma_\xi N(t), \text{ and} \qquad (5\text{-}1) \\
\frac{dN(t)}{dt} &= \beta_\varphi L(t) - (\gamma_\varphi + \gamma_\psi + \gamma_\xi) N(t),
\end{aligned}$$

where the initial conditions are $N(0) = C$, $L(0) = 0$, $M(0) = 0$, and $H(0) = 0$ (i.e., $t = 0$); and the equation $N(t) + M(t) + L(t) + H(t) = C$ holds at any time t. The unit for t is any convenient unit of time such as a second, an hour, day, week, and so on. The constants β_ϕ and β_ψ represent the average recovery rates as persons move from low to normal states or recover from moderate to low states, respectively. Similarly,

Figure 5.1. Changing behavior of a population