price to be paid for the freedom of all. Sarasin notes that current politics wavers between the leprosy model of complete control and discipline and the smallpox model of partial control and discipline, with an accepted public toleration of some risk. We may, however, be moving toward a convergence in the post-9/11 era, where threats and non-threats are seen in black-and-white terms within the context of the "war on terror" – reminiscent of the leprosy model – while at the same time retaining an overly determined security focus characteristic of the smallpox model. This has significant ideological implications in times of a disease outbreak in contemporary times – as seen, for example, by the racialization of SARS discussed by Keil and Ali, or in the onset of a health scare examined by Hooker (both in Part IV above).

14

SARS as an Emergent Complex: Toward a Networked Approach to Urban Infectious Disease

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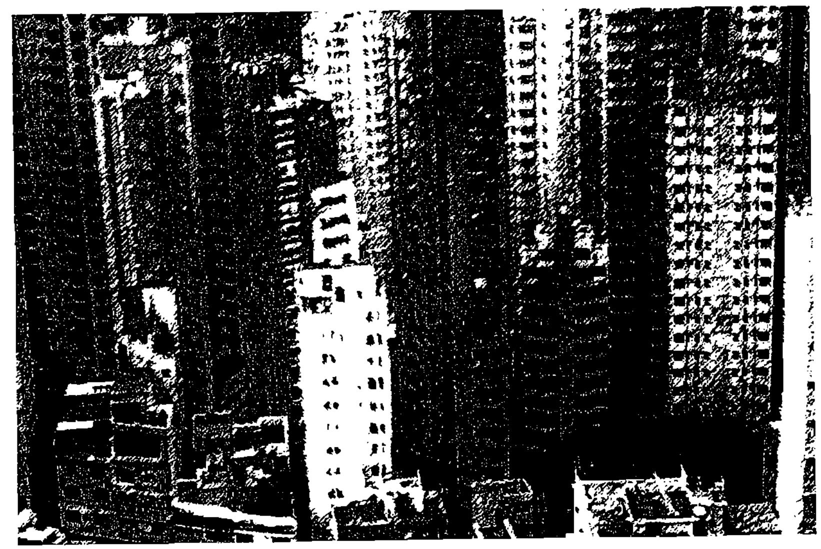

Introduction

According to the traditional model of infectious disease causation – namely, the classical epidemiological triad – a disease outbreak can only occur provided that there is an environment in which an external disease agent is able to come into contact with a susceptible host. The coincidence and interaction of factors related to the agent, the host, and the environment therefore implicitly implies that a disease outbreak is an *emergent* phenomenon. In this chapter I take as a starting point the notion of emergence to develop a Networked Disease approach that conceptualizes contemporary outbreaks and epidemics as socio-environmental phenomena uniquely defined by today's global networks and global flows. To develop this Networked Disease approach, I draw upon elements of complexity theory, Actor-Network Theory (ANT), the "network society" perspective and environmental sociology. What these perspectives hold in common is an emphasis on contingency, emergence, and dynamism. It is argued that because of recent social and environmental developments, such aspects can no longer be ignored in the analysis of modern urban disease outbreaks. Consider, for example, that compared to epidemics of the past, the SARS epidemic of 2003 was notably unique in certain respects. First, the unprecedented speed with which the disease spread highlighted the significant mobility and dynamism associated with contemporary disease outbreaks. Second, the manner in which the SARS Coronavirus (SARS-CoV) spread – through the global cities network – is also unique to our era (Ali and Keil 2006). Such a mode of transmission also highlights how urban–global interactions can produce unexpected, disproportionate, and emergent effects such as those implicated in the spread of the SARS-CoV from rural China to global cities across the world. And third, the nature of the social and political responses elicited by the disease at the urban and global levels were quite different in comparison to the past. This is seen, for example, by the World Health Organization's (WHO) unprecedented action of issuing travel advisories against certain SARS-affected global cities, as well as in the unprecedented degree of collaboration between scientists around the world to identify and genetically characterize a new virus in record time. As we shall see, these responses were in part due to new communications and information technologies, as well as recent social and political developments that define our era – that is, the influences of neoliberal ideology and the forces of economic and cultural globalization. In sum, it is argued that in order to capture the uniquely defined characteristics of the transmission and response to SARS, special attention needs to be focused upon emergent, contingent, and dynamic aspects associated with the interconnectivity of people, viruses, and technologies. The incorporation of these considerations into analysis will, in turn, require new methodological orientations and tools such as the Networked Disease approach that is to be developed here.

Emergence, Networks, and Complexity

As a possible solution to the realist versus social constructionist quandary, John Hannigan (2006, pp. 148–53) proposes that analysts of environmental phenomena adopt an emergence model of nature, society, and the environment in which the relationship between the social and material is viewed as both interactive (fluid) and material. This analytic orientation has the advantage of enabling us to capture some of the key defining elements of many of

the environmental health phenomena we currently face. In several ways, this perspective is especially suitable to the analysis of emergence. First, this is because it focuses attention on the inherent ambiguous or uncertain qualities of emergent phenomena. This would include, for example, the identification of the unintended consequences of technological interventions into nature noted in Ulrich Beck's (1992) risk society thesis (especially, insidious risks such as those having chemical or nuclear origins). Second, an emergence model will draw attention to the emerging social structures that may form in response to environmental health threats. These may include, for example, new social movement organizations, epistemic communities of scientists, and community groups. Third, the emergence model has the advantage of enabling environmental health phenomena to be analyzed in terms of the flows that come together to give rise to the phenomena in the first place. An emergent flow approach is therefore consistent with the "disaster incubation" approach, which seeks to understand how social and biophysical processes converge in an unnoticed manner to produce a disaster (for the application of disaster incubation theory to the analysis of a waterborne disease outbreak, see for example, Ali 2004). In light of the above, the first task in the development of an emergence model is to identify those flows that converge together to give rise to the emergent outcome. Following from this is the task of understanding the actual dynamics and implications of the networks that emerge from the convergent flows. The first of these tasks is more basic and involves the identification and description of the relevant flows and may be addressed through application of actor-network theory. The analysis and characterization of the flows and emergent network is much more complicated and may best be approached through complexity theory. Let us briefly discuss each of these approaches in turn before turning to the illustrative case of SARS in a more detailed fashion.

As originally proposed by Bruno Lâtour (1987, 1988, 2005) and further developed by others (e.g., Callon 1986; Law 1987, 1999; Murdoch 1997a,b, 1998; Manning 2002), an actor-network is essentially an emergent and dynamic complex that forms when numerous social and material elements become linked together in particular ways. Indeed, from the ANT perspective the world is essentially comprised of diverse networks of association or linkages. Each type of network is comprised of various nodes (e.g., social institutions, technologies) that are connected to each other through flows of various types (e.g., money, information, people, devices, animals, etc.). The process of tracing how the linkages of an actor-network come about are central to the inquiries of ANT. By tracing how the SARS-CoV traveled across the world (i.e., tracing the network connections), and taking into account what particular actor-networks were drawn in by its presence at particular sites, we will be able to, at the very least, gain an accurate descriptive characterization of the SARS outbreak(s) – thus taking the first step toward analyzing this infectious disease as an emergent phenomenon. To a certain extent, this task is made easier in the specific case of a disease outbreak. This is because public health efforts to contain the outbreak are aimed at breaking the chain of transmission through quarantine and isolation. In turn, such an approach relies on the method of contact tracing where data concerning those who have had personal contact with an infected case are collected. Epidemiological data of this type can be used to trace the chain of transmission, thus enabling analysts to chart the spread of the disease through mapping processes. In terms of the conceptualization of an outbreak as an emergent phenomenon, such mapping of the disease represents only the most basic of descriptions. To move beyond this purely descriptive framing toward a more comprehensive account requires a more detailed investigation into the nature of emergent networks and flows – that is, an inquiry process that lies at the heart of complexity theory.

The objects of study for complexity theory are those systems that adapt and evolve as they self-organize through time (Urry 2005). The question then is, how do you study and characterize such systems? Complexity theorists address this question by focusing on certain system characteristics or properties. First, the *dynamic* qualities of a system are studied because a system is first and foremost conceptualized as a configuration of constantly interacting parts. The dynamism of the system is generated on the basis of iterative feedback loops of various kinds (between the parts of the system) that will naturally result in a constant state of flux. Second, the emergent qualities of a system receive explicit attention as critical foci of research investigation. Complexity theorists assume that the characteristics of the system cannot be explained by reductionist approaches that consider only the properties of the system's constituent parts in isolation. In other words, a complex system has *emergent* properties. Consequently, a system is in a continual process of spontaneous emergence (Thompson 2004). Third, a complex system is said to exhibit the property of *non-linearity* because it is disproportionately sensitive to small changes in internal and external conditions – particularly with respect to the initial conditions. Consequently, a system will undergo various types of unpredictable changes, such as avalanche effects where an apparently stable system suddenly collapses (for example, a pyramid of sand that will unexpectedly topple when one more sand grain is added), or exhibiting patterns of spontaneous self-restoration and punctuated equilibria (Urry 2005). The classic example of a non-linear effect is the "butterfly effect," where the very small perturbations in air pressure caused by the flapping of a butterfly's wings on a calm day result in unanticipated changes in the initial conditions of a weather system. Such actions, it is argued, may set off a chain of events that amplifies effects on other parts of the weather system (again in unpredictable ways), thus ultimately precipitating an extreme weather event, such as a tornado. Complexity analysis therefore brings to the fore the necessity of studying different patterns of path-dependent development, where the current state of the system is based on past events.

Although originating from the efforts of physical scientists to study complex natural systems, recent efforts by social scientists have expanded the notion of "systems" to include both natural and social constituents, thus enabling them to adapt complexity theory to the analysis of socio-material phenomena. For example, John Urry (2004) uses complexity theory to analyze the "system of automobility," where the car and the driver together – the car–driver – are considered to be a node in a network of automobility that is constantly moving and changing. In this networked system of automobility, material (and environmental) features of the car are inextricably bound to the social and institutional support system that encourages and facilitates travel by automobile (including, for example, the fossil fuel economy, the highway infrastructure, and so on).

Law and Urry argue that the forces of economic and cultural globalization have produced a current social reality that has become increasingly complex, elusive, ephemeral, and unpredictable. As a result, the social realities of "globalization" have transformed, as they are now "less about territorial boundaries and state and more about connection and flow" (2004, p. 403). For example, the contemporary global networks of finance, tourism, information, military power, and terrorism have introduced uniquely defined instabilities that are fleeting, ephemeral, and geographically distributed in such ways that they are suddenly proximate. Such unstable outcomes may be thought in terms of the processes of disembedding and re-embedding that Giddens (1990, p. 21) contends is one of the defining aspects of contemporary globalization. According to this line of argument, social relations are "lifted out" of their local contexts and then restructured across indefinite spans of time and space. Instabilities are further reinforced through the rapid and diverse mobilities of peoples, objects, images, information, and wastes. The complex interdependencies between, and social consequences of, these diverse mobilities also highlight the importance of considering the emergent, dynamic, and non-linear properties of socio-material systems (Urry 2000). And it is for these reasons that Law and Urry (2004) make the case that complexity theory is better suited to meet the new and unique challenges involved in the study of contemporary social and environmental phenomena.

Tracing the Spread of SARS

The first case of what is now referred to as SARS was an individual from Foshan, Guangdong province, who had eaten a meal that consisted of a "wild cat" (i.e., the palm civet) in November 2002 (Zhong and Zeng 2005). A cluster of cases amongst family members and hospital workers exposed to this individual soon followed. Around the same period, workers and food handlers in the wet markets of Guangdong province were also stricken with this mysterious disease of unknown etiology (Guan and Sheng 2003). By December, SARS had appeared in two other cities of the province, and on January 21, 2003, an expert team of provincial and national health officials went to investigate these outbreaks (Knobler et al. 2004). The team recommended that a case reporting system be established to monitor the spread of the disease, but their report did not receive adequate attention from hospital officials in the province, as many were away due to the Chinese New Year celebrations. Furthermore, because much travel occurs during this festive season, the opportunities for the SARS-CoV to spread were greatly enhanced (Knobler et al. 2004). The community spread of the yet to be identified virus was also influenced by the new political economic realities of China – dimensions not usually considered in those analyses based on the classical epidemiological triad (see Ng, Chapter 4, and Baehr, Chapter 8).

Spiess (2004) notes that reform efforts to facilitate China's transition to the market economy resulted in the dramatic downsizing of the state sector. As a result, large numbers of displaced workers were forced into the embryonic private sector, where they no longer had the healthcare coverage they once had as state employees (private insurance schemes were yet to be deployed). Consequently, over 75 percent of the population did not have health insurance, and stories started to abound about long line-ups forming in front of hospitals that were demanding payments up front before they would treat SARS patients. Although the government responded by announcing a "medical aid fund for low-solvency patients and farmers" (Spiess 2004, p. 65), the medical treatment problem was compounded by the presence of a vast "floating population" of an estimated 80–150 million peasants who had previously drifted from the countryside to prosperous urban centers throughout China. Because these individuals lacked the legal residency status needed to stay in the city, they were denied education and medical care, while being forced to live in cramped urban ghettoes under the constant fear of arrest and deportation. After the true extent of the epidemic was revealed by government officials, this segment of the population understandably fled the city to return to their native rural towns, thus increasing the possibilities for pathogen spread into the country's vast hinterland. By late May 2003, the SARS virus had spread to 5,000 people spanning over 20 provinces in China (for accounts of the spread of SARS in China, see also Abraham 2004; Kleinman and Watson 2006). Globally speaking, the spread of the SARS-CoV began in February 2003, when an infected doctor from Guangdong province infected 11 guests at the Metropole Hotel in Hong Kong, whereupon the disease spread to other cities including Toronto, Singapore, Hong Kong itself, and Hanoi. By late March 2003, there were 1,320 confirmed cases, with 50 deaths throughout the world (Murray 2006, p. 20).

One of those infected by a traveler from the Metropole Hotel was the Hanoi-based WHO infectious disease expert Dr Carlo Urbani. Dr Urbani officially alerted the WHO about the threat of this highly infectious disease but, tragically, succumbed to the disease himself soon thereafter (Knobler et al. 2004). In response, on March 12, 2003, the World Health Organization (WHO) issued a worldwide alert on this new infectious disease that they named SARS. From this point on, public health officials in the various affected cities quickly began the labor-intensive tasks of contact tracing, surveillance, and organizing quarantine for those infected, while a global network of scientific researchers quickly immersed themselves in the tasks of determining a case-definition to assist the contact tracing and in identifying and characterizing the causative agent of the disease itself. At the same time, various local, regional, national, and global organizations were mobilized to respond to the disease threat itself, including, for example: local hospitals and public health agencies, ministries and departments of health, as well as emergency management departments at various levels, the World Health Organization's surveillance and infectious disease agencies, airports, hotels, and restaurants in the tourism sector, and schools.

SARS and the Global Health Response

During the earlier stages, information about the outbreaks was unofficially transmitted through e-mails, Internet chat rooms, local media outlets, and the electronic reporting systems of the Global Public Health Intelligence Network (GPHIN) and Pro-Med (Knobler 2004). On the basis of information obtained through these channels, on February 10, the WHO officially contacted the Chinese government to verify the information they were receiving through these other sources. Attempts at maintaining some level of secrecy about the extent of the outbreak were altogether abandoned by the Chinese government on February 11, 2003, when the Chinese Ministry of Health formally informed the WHO about the mysterious disease outbreaks in Guangdong province. The Chinese government was quickly criticized by the global public health community for not identifying the outbreak quickly enough, as well as for not communicating any available information through official channels (Heymann 2004).

By mid-March, the WHO-supported Global Outbreak Alert and Response Network (GOARN) established a virtual network of 11 leading infectious disease laboratories from across the world. These laboratories would communicate and share information through a secure website and daily teleconferences. In an unprecedented manner, temporarily putting aside competitive aspirations, the world's scientific might was united in its efforts to fight one disease (Stohr 2003). One month later, three laboratories within the WHO network had independently identified a novel coronavirus as the causative agent of SARS (Peiris and Guan 2005). And, as one medical international medical specialist notes, before the advent of the Internet, such a process would likely have taken months (Omi 2005).

The rapid identification of the SARS-CoV, its reservoir, and the subsequent delineation of its genetic code – all within a one-month period – was hailed by the WHO as the hallmark of global scientific collaboration and highlighted the importance of international informational networks, and especially the Internet, in global infectious disease response (Heymann et al. 2005). In the terminology of ANT, such platforms as GPHIN, GOARN, and Pro-Med, on which the informational networks were based, served as *obligatory points of passage*; that is, sites through which flows must pass through during their journey through the emergent actor-network. The funneling of information through these specific types of networks was obviously important for the nature of the SARS response at the public health and medical levels. For this reason, a premium was placed on relevant information of various sorts, including epidemiological, clinical, and laboratory data such as data gathered from the contact tracing carried out by local public health agencies and hospitals. Such data were compiled by the WHO from sources around the world, and in this regard, the WHO's Executive Director of Communicable Diseases noted that:

> I think that it would be fair to say that this is the first global outbreak where there was a 24 hour availability of information and information was continuously coming in through networks of doctors, of clinicians, of virologists, of epidemiologists. And that information provided the evidence on which day to day evaluation of recommendations could be made and changed. In other words, first off there was just a recommendation to be careful. Second there was a recommendation to screen passengers because SARS was spreading internationally. And when that didn't work there was a recommendation to avoid travel. And finally they worked. So this was evidence-based information available in real time to make the recommendations. (Interview, WHO official, Geneva, September 28, 2005)

SARS and Complexity

The global outbreak of SARS can be conceptualized as the emergent outcome involving the convergence of at least three specific types of flows: viruses, people, and information. It is in analyzing the movement and interactions of these flows that we may attain a clearer understanding of the dynamic, emergent, and non-linear properties of SARS as a networked system. As the brief review above reveals, there were specific networks associated with the spread and response to the SARS-CoV respectively.

In terms of the spread, mounting evidence indicates that the SARS-CoV originated in the palm civet cat reservoir (Guan et al. 2003). The crossover of the virus from this animal to humans most likely occurred in the "wet markets" and restaurants of Guangdong province, as supported by the fact that roughly one-third of the earliest cases of the disease were found to be in those who handled, slaughtered, sold and/or prepared the civet cat for consumption (Guangdong Province Center for Disease Control and Prevention, unpublished data, cited by Breiman et al. 2003). In terms of network theory, therefore, the wet market represents a nodal point where two types of flows – humans and animals – converged. Furthermore, it is worth noting that the wet market may be thought of as a liminal node that exists at the interface of rural and urban flows. Such liminal nodes are of significance to spread of new and emerging diseases, because they represent those points at which human beings first come into contact with previously untouched nature, including contact with new viral species living in animals and insects (Abraham 2004, p. 7). The potential for a particular nodal site to act as a "tipping point" in the spread of a disease may increase by social conditions and circumstances. For example, the socially informed hygienic practices associated with butchery in the live animal market may have resulted in pools of blood and remnants that served as ideal breeding grounds for viruses such as the SARS-CoV (Wang and Jolly 2004; Zheng et al. 2004). At the same time, changing cultural preferences in consumption may have also played a triggering role in the SARS outbreak. It has been noted that the growth of the affluent class in China has led to an increased demand for meat, thus leading to increased activities in wet markets (Bell et al. 2005; Omi 2005; see also Jackson, Chapter 17). What these changing social conditions illustrate are the important roles that contingency and path-dependency play in transforming a nodal point of a network in such a way as to increase the potential for disease spread. It is in reference to such an insight that the scientist who discovered the SARS-CoV as the causative agent of the SARS makes the following remarks:

> A disease outbreak such as SARS probably happened many times before, but what would have happened is that it would have affected a few people in a village; a couple of people would have died and it would have burned itself out then. But now, what's the situation? We now have these animals brought together in these big markets because there's a huge demand for exotic foods. So, it's not one type of animal, may be in a small village market. Now, we are having hundreds of them. The size of markets has increased; the interaction of the human population has increased. Okay, so the amplification in the markets is one factor. (Interview, Hong Kong, December 30, 2005)

The contingent yet path-dependent aspects of the SARS emergent complex are also apparent in the manner in which the viral and human flows traveled through the global cities network as well as within particular global cities themselves. Urry (2005) notes that today, one of the characteristic features of globalization involves the ephemeral nature of ever-changing social and material relations due to global fluids, as illustrated by, for example, world money, social movements, digitalized information, the anti-globalization movement, international terrorism, and smart mobs. According to Urry (2005, p. 246), although global fluids may travel along various predefined routes, they may also unexpectedly escape these pathways on occasion, thus leading to unanticipated effects and adding to the emergent, dynamic, and non-linear qualities of the phenomenon in question. This would be seen, for example, when a person who is unaware that he or she is infected inadvertently spreads the disease – as was the case with the travelers from the Metropole Hotel.

The unpredictable, dynamic, and non-linear nature of the spread of SARS was amplified in the case of this particular disease for several reasons. First, the accelerated speed of airline travel coupled with the two to ten day incubation period of the SARS-CoV meant that infected, yet unsuspecting and asymptomatic individuals, could elude screening measures (such as thermal scanning at airport entry points) and inadvertently spread the disease (Keil and Ali 2006). Second, SARS involved what is known as the "super-spreader" phenomenon, where an individual with enhanced infectivity will infect a much higher number of people than would normally be expected. This was seen for example, in the spread of SARS amongst the 11 guests of the Metropole Hotel from one infected "super-spreading" individual (CDC 2003a; Gostin et al. 2003). The presence of a super-spreading individual in a crowded airport, airplane, or the capillary system of a city will undoubtedly lead to multiple and unpredictable routes for a virus to travel. Third, as the SARS-CoV spread through the global cities network, the probability of transmission is much higher due to the higher population densities of major urban centers – as evidenced, for example, by the suspected environmental spread of SARS to over 200 people in the Amoy Gardens apartment complex in Hong Kong.

Finally, it should be noted that the dynamic and non-linear effects associated with the diffusion of the SARS-CoV are even further exacerbated by the role of chance circumstances, such as the particular living and familial arrangements of an infected individual. For example, although Toronto and Vancouver were affected nearly simultaneously in March 2003 by a SARS-infected traveler, by June, Toronto had more than 209 probable cases, while Vancouver had only four (Meyers et al. 2005). The difference has been attributed the chance circumstances related to the differing contact patterns and familial circumstances of the infected individuals. Specifically, the Toronto case involved an individual who was the matriarch of a large extended family, and who had contact with an extensive number of family

members and friends, while the Vancouver case involved an individual who lived alone with his wife, thus limiting the opportunity for spread (Meyers et al. 2005).

SARS and the Network Society

Spaargaren et al. (2006) suggest that one important avenue of research that could be pursued in their proposed "sociology of flows" perspective would be a focus on the social relations and networks that give rise to, or accompany, environmental flows. In this context, the aim would be to identify and analyze the new networks, arrangements, and infrastructures that both constitute and govern different sorts of environmental flows. Such an analytical emphasis on emerging social structures is also found in Hannigan's (2006) emergence model of environment and society. Taking the cue from these perspectives, we can see that perhaps the most noteworthy aspects of the global response to SARS was the development of one such emerging social structure – namely, the emergence of an international network of scientists who shared epidemiological, clinical, and laboratory data in a concerted effort to contain the disease. As discussed above, the network of collaborators was extremely effective on several fronts: in identifying the causal agent of SARS; in developing a universal case definition for this disease; in the worldwide epidemiological tracking of the disease; and in genetically characterizing the disease – all in an unprecedented span of one month (Heymann et al. 2005). What can account for such success in the case of SARS? The answer lies in part in the nature of the networks implicated in the disease spread and response. To understand how this is so, I turn to Manuel Castell's (2000) work on the "network society."

Castells (2000) argues that globalization and information technologies have triggered a new type of institutional configuration or constellation that has resulted in a new kind of time–space organization of social practices. Such organization is predicated on what Castells refers to as the "space of flows" – a space comprised of the material infrastructure and virtual components that enable sustained real-time interactions between people over vast distances. Castells further contends that with the advent of the Internet, the "space of flows" has increasingly become more and more influential, to the point that it now dominates or replaces the traditional logic of the "space of places", where social organization was historically rooted and dependent upon purely localized experiences because of the necessity of having to contend with the obstacles of traversing large distances over long periods of time. In a network society organized along the space of flows, geographical proximity is no longer an element of space, because interaction based on the exchange of information can occur instantaneously. A further implication of the space of flows is that "time is timeless," in comparison to the space of places, where social practices are still based on clock time (that is, time is organized on the basis of the rhythms of nature or as social constructs of a culture). As will now be discussed, these distinctions in the operations and operating logic of the space of places versus the space of flows have significant implications for the manner in which the global SARS response unfolded.

The environmental sociologist Raymond Murphy (2004) notes that extreme environmental events and acts of nature may act as a stimulus for "improvised response"; a type of action that Hannigan (2006) sees as integral to the development of emerging social structures. This is because under the conditions of an extreme event, existing certainties wash away, making it possible for new actions and formations to develop, at least temporarily. Thus, in the case of the SARS, the urgent and compelling need to respond to a potentially global pandemic prompted usually competitive scientists from around the world to put aside narrow career interests and collaborate and share data via the formation of newly formed information networks.

The manner in which the SARS information network formed also exemplified a certain networking logic. It is a characteristic of networks that when one node is not responsive (or not functioning), then it no longer contributes to the movement of flows. Such a node in essence is no longer part of the network. When this occurs, alternative routes spontaneously develop to circumvent the damaged node, thus restoring the flow. Such a dynamic unfolded when the Chinese government refused to officially share information about SARS with the global public health community during the earlier stages of the outbreak. In reaction to these circumstances, the flow of information concerning SARS in China occurred through the establishment of unofficial channels, such as public health websites and personal blogs on the Internet. The role of the Chinese government as a node in the global public health information network was therefore by-passed. Networked developments such as these help illustrate how the spaces of flows comes to dominate the space of places in the modern era.

A second example in which the global SARS response can be understood in terms of the distinction between the space of flows versus places is to consider the speed at which viruses and people spread relative to the speed of information travel. Rosa (2003, p. 4) notes that one of the impacts of globalization is seen in the development of accelerated societies, in which acceleration penetrates every nook and cranny of societal development, including technological acceleration, the acceleration of social change, and the acceleration of the "pace of life" (cited by Jensen 2006, p. 332). And as alluded to above, jet travel has accelerated the speed at which viruses can now traverse the globe. Nevertheless, the speed of flows through mechanical and biophysical systems is limited by physical parameters, such as the maximum

speed at which aircraft can travel or the rate at which viruses are able to multiply (i.e., the imposed limits of the basic reproductive number and incubation period of a particular virus). These limits are minor in comparison to the speed at which information can travel in the digital age (i.e., in essence the speed of light). This difference was used to an advantage during the global SARS response, since the sharing of information via the instant time of computer networks vastly outpaced the biologically defined time of viral reproduction and travel. For this reason, whether one is to speak of the accelerated speed of viral traffic between global cities via aircraft, or the viral traffic involved in the interpersonal contacts of those infected (i.e., the transmission rate of the disease), the latter speeds are no match for the speed of information exchange via digitalized information networks. As a consequence, by "outpacing" the virus, the scientific establishment was able to break the chain of transmission of the SARS-CoV quite handily – an outcome that was no doubt assisted by the presence of other fortuitous factors. For example, one characteristic of SARS was that a person was most infectious at that point when he or she was the most ill. The likelihood was therefore much higher that a SARS-infected individual would admit him or herself to a hospital (and be subsequently identified and quarantined or isolated there) at the exact time he or she had the greatest potential to initiate a community outbreak. Unfortunately, this also meant that the spread of the disease was largely nosocomial; that is, largely confined to healthcare workers (NACSPH 2003).

SARS and Networked Inequality

It should be noted that although the effects of the dominance of the space of flows over the space of places contributed to the success of the global SARS response, such dominance may also mask certain issues related to the unequal distribution of resources required to effectively respond to diseases in the Network Society. Mol and Spaagaren (2006, p. 69) note that within a sociology of flows perspective, new inequalities may be defined in terms of relative *access* to resource flows. In the context of the present discussion, "access" refers to both direct access to the flows of a particular network as well as the ability to influence the flows in terms of speed, direction, intensity, and so on. Thus, Mol and Spaargaren (2006) note that access to information flows via the Internet, to flows of capital, or to the skills of people moving around the world will distinguish those better-off individuals, groups, and cities from their marginalized equivalents. In light of these insights, it is quite fortunate indeed that, in the case of SARS, the space of places – as manifested in the flow of viruses and peoples through and in the global cities network – coincided with the space of flows. That is, because the SARS viral traffic implicated global cities, the information and technology infrastructures and resources needed for an effective response were already in place and accessible. Furthermore, the fact that the outbreaks occurred in cities of great economic significance most likely politicized the outbreaks more than would otherwise have been the case. This would ensure, for example, that any possible access problems would be quickly addressed. In line with this, one WHO officer notes that:

> Certainly Hong Kong, Singapore, Toronto ... these are, you know, well developed cities where people are coming and going all the time and it carries a different connotation because of that ... And because these places are very important in terms of economics, important in terms of global movement of people and goods, this became a very politicized outbreak. People were alerted to the danger and people actually thought, well, I'm quite likely to go there, I might need to go there, and so we were very quickly being put under a lot of pressure to provide information on travel safety, on safety of goods, and those kinds of questions, which given that it was a completely new disease, are quite difficult to answer until you've got a bit more information. (Interview, WHO Headquarters, Geneva, September 27, 2005)

As such, the rapid reactions and responses by global public health officials (and the world community in general) to SARS may not have as readily occurred had the viral traffic pattern implicated cities of less influence in the global economy. Such issues of access inequality will likely be particularly important issues of concern with reference to future epidemics, because the emergent, dynamic, and non-linear characteristics of a disease outbreak may mean that next time, the disembedding and re-embedding mechanisms of an infectious disease may implicate cities of the global South.

Concluding Remarks

The global outbreak of SARS was the emergent product of a complex of flows involving viruses, peoples, and technologies. The interactions between these flow types was unpredictable and non-linear, largely because of the large and diverse number of factors that could influence the interconnectivity and directions of these flows in any number of directions, including, for example: changes in culinary preferences and socio-economic conditions; airline travel paths and speed in association with the incubation period of the virus; the phenomena of "super-spreaders"; and the contact patterns and familial arrangements of those infected.

In light of the above, the SARS outbreak as emergent networked phenomenon appears to exhibit all the properties of a complex system (such as dynamism, emergence, and non-linearity), and therefore appears to be quite

chaotic and unpredictable. Despite this, however, the global response to SARS was generally successful, a fact that I have argued was due to certain foundational developments of the network society. The hallmark of this response was the rapid formation of a virtual network of international scientists who joined forces to identify the causal agent of the disease, develop a universal case definition for the disease, and characterize the genetic code of the virus – all within the span of one month. These impressive results highlight the significance of the space of flows over the space of places in the contemporary era, as informational exchange could occur at a faster rate than that of viral diffusion. When considering future outbreak scenarios, however, questions regarding the efficacy of the response remain. This is because of issues related to access to networked resources. As the international spread of SARS occurred largely through the global cities network, access to such resources was not problematic, but this may not be the case if future outbreaks occur in less developed cities.