Global Cities and the Spread of Infectious Disease: The Case of Severe Acute Respiratory Syndrome (SARS) in Toronto, Canada[1]

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Abstract:

The SARS outbreak in Toronto showed, among other things, a heightened sensitivity of places in the global economy to rapid changes brought on by the acceleration of social and ecological relationships. Such an acceleration has occurred through an extended interdependence of societies and economies around the world. Indeed, it may argued that the spread of the SARS virus is a somewhat predictable consequence of the contemporary globalization of our economies. In particular, this study investigates the issue of how processes of globalization have affected the transmission and response to SARS within the context of the global cities network – an interconnected constellation of metropolitan areas that exert great influence on the world economy. In extant global cities research, little work has been done on the relationship of global city formation and the spread of infectious disease. Arguing that this relationship may be central to understanding the intricate capillary structures of the globalized network, we specifically focus on how pathogens interact with economic, political and social factors in unanticipated ways. We maintain that these relationship exist both in the network and in global cities themselves, thereby posing new issues for public health and epidemiological efforts at disease containment and tracking.

Global Cities and the Spread of Infectious Disease: The Case of Severe Acute Respiratory Syndrome (SARS) in Toronto

To the degree that Toronto articulates the Canadian economy with the global economy, it is Canada's global city (Todd, 1995; Sassen, 2000; Kipfer and Keil, 2002; Keil and Kipfer, 2003). Toronto's regional economy – largely based on high value added automotive manufacturing, finance, culture production, business services, education, health care, biomedical industries, etc – is an important piece of a continentalizing and globalizing Canadian economy. It is Canada's prime destination for new immigrants and tourists; its airport is the biggest in the country. In the study of Toronto as a 'global city' (a concept discussed in more detail below) lies an important key to understanding the social, cultural and geographic dimensions of a public health threat that involved 438 probable and suspected SARS cases, including 44 deaths (Naylor, 2003). Furthermore, the fact that SARS outbreaks in various beta and gamma Asian global cities such as: Beijing, Hong Kong, Singapore, and Taipei (WHO, 2004) brings to the forefront the question of how the interrelation of Toronto with other global cities influenced the transmission of the SARS virus. Such a focus is particularly important in light of Yulong and Hamnett's (2001) finding that rapid economic development in the Asian cities of Beijing, Shanghai and Hong Kong, has led to their increased importance in the global cities network – a development bolstered by the strong and conscious efforts of the Chinese state to integrate these cities into the globalized economy (see also Ng and Hills, 2003). In such circumstances, the relationship between Toronto and other Asian global cities is noteworthy because of the increased prospects of networked

trade between Toronto and China's emerging global cities. Bolstered by the large Chinese-Canadian community in Toronto – Canadian citizens of Chinese origin comprise about 8.7 percent (410,000) of the 4.7 million people living in the Toronto metropolitan area and the city is the preferred destination of most immigrants from Asian countries to Canada (Li, 1998) – increased trade and interaction between Toronto's Asian diaspora community and the newly opened Chinese cities would not be unexpected.

Of course, relationships between the governance of urban areas and the control of infectious disease are not new. Attempts to deal with pandemics such as the bubonic plague in 14th century Europe, as well as other major epidemics of smallpox, typhus, yellow fever and cholera in the 18th and 19th century, served as the impetus for some of the first formally organized efforts to develop international health strategies (Banta, 2001). Historically, the favoured method to contain the spread of contagious diseases involved the quarantine of ships arriving at European port cities. For example, in 1377 laws were passed requiring international ships to remain in British ports for 40 days. Such measures, however, seriously disrupted the flow of commerce and financial transactions of the day and led to tensions in the international shipping trade. Spurred on by the need to address the economic and political consequences of quarantined merchants and sequestered cargo, diplomatic dialogue ensued. This international dialogue was not limited to simply matters of economic security, but also involved issues related to public health protection. As the present analysis

of the SARS outbreak in Toronto demonstrates, the interrelationship between public health and economics is not only of historical significance, but it remains as a concern at the forefront of current responses to disease outbreaks in our globalized world.

Although there are some commonalities with the past, as we shall see, the time-space compression resulting from today's globalizing forces (Giddens, 1990; Beck, 1999; Harvey, 1989) implies that modern disease epidemics have the potential to spread across the world much more quickly than in the past. This increased potential may be accounted for by several reasons. First, the medium involved in the transport of microbes and humans has changed quite dramatically – for example, from slow moving ships to rapidly moving airplanes. Second, the number of people involved in movements between nations and cities of the world has increased dramatically in the contemporary era – for example, in the early part of the 1990s more than 500 million individuals crossed international borders (Wilson, 1995:41). Third, as the nature of the economic and political interconnections between various parts of the world have evolved over time, the potential pathways for the travel of pathogens into populations has also changed. In the time of mercantile capitalism, port cities were particularly vulnerable to disease outbreaks because of the strategic location of these cities on seafaring trade routes. European port cities were linked together in a relatively stable manner through the shipping trade network and the spread of a pathogen could more readily be contained because the long travel times meant that those

infected would develop outward symptoms of the disease and would be quickly identified for quarantine. Today, the situation is different for two reasons. First, the incubation period for many viruses and bacteria is much smaller than the travel time for transcontinental aircraft trips (for example, the incubation period of the SARS virus is between 2 to 10 days (Naylor, 2003)). Thus, in the modern age of air travel those infected could very likely be asymptomatic during their trip and upon arrival to their destination. Second, the routes through which pathogens can enter the populations of cities has multiplied quite because of the emergence of a dynamic interconnected network of what are known as "global cities"— a relatively small number of very large metropolitan areas that exercise a disproportionate amount of political and economic power in the transnationalized context (GaWC, 2004). As air travel amongst these global cities has increased and the number of flights between them continue to multiply (Smith and Timberlake, 2002), the possibilities for the spatial diffusion of a pathogen also multiply, making it more difficult to track the spread of pathogen. This increased mobility of both individuals and microbes implies that the boundaries and structures of the global 'network society' (Castells, 1996) are more fluid than those of traditional societies such as those of the port cities of an earlier era.

In bringing together two, as of yet mostly unconnected literatures – on global cities and on infectious disease (for an exception see for example Neuberg and Rodwin, 2005; Rodwin and Gusmano, 2002) – we argue that the emergence of the global city network may have notable implications for the

nature of the threats posed by infectious disease in the contemporary world in relation to both disease transmission and outbreak response. By considering the case of the spatial diffusion of the Severe Acute Respiratory Syndrome (SARS) virus, we will examine how the nature of the threat of infectious disease outbreaks has changed through the alteration of patterns in microbial traffic, vis-a-vis the global city network. It should be noted that the purpose of this paper is largely conceptual and aims at breaking new ground in creating a potentially productive perspective from which the world city network can be seen in an entirely new light: instead of concentrating on global flows of capital, information and power or global immigration, we view world city formation from the point of view of emerging and spreading infectious disease. We believe such a perspective can provide, in several ways, a new entry point for the already lively debate on connectedness in the global city universe.[2] First, as one way of integrating issues related to the diffusion of disease into existing understandings of globalization processes. Second, by taking into account the important insight of political ecologists of scale that "global flows are necessarily embedded in local processes [and this] prompts a consideration of place not merely as an isolatable physical space but as a dimension of historical and contemporary connections" (Gezon and Paulson, 2005:9). And third, by considering the relationship between the global city network and the diffusion of disease we may be able to take the first steps towards the development of what Gould refers to

[2] This paper is a conceptual opening to a three-year research project on the subject funded by the Social Sciences and Humanities Research Council of Canada. Since we are at the beginning of our project, we have used mostly existing secondary data for the purpose of making our theoretical argument. In a similar vein, Beaverstock, Taylor and Smith, for example, published

as “human disease topographies” that would map “disease spaces” (1999:196). Diseases spaces refers to those ecological niches that pathogens need to exist and reproduce, and such niches include human beings. Thus, disease spaces are: “enormously complex spaces that control the movement of viruses in much the same way that the hills and valleys of the familiar topographical map control the flow of water” (1999:196). In turn, it is hoped that such human disease topographies would eventually lead to the development of more effective ways to halt the diffusion of pathogens.

Conceptualizing the Global City Network

Held et al. define globalization as: “those spatio-temporal processes of change which underpin a transformation in the organization of human affairs by linking together and expanding human activity across regions and continents” (2002:61). And, in this context, they identify several dimensions associated with globalization (Held et al., 2002:1-4). First, globalization involves a widening reach of networks of social activity and power. That is, the *extensivity* of global networks increases. Second, the *intensity* of global interconnections increases as patterns and flows begin to transcend the constituent societies and states of the world order. Third, the *velocity* of global glows speeds up with the development of worldwide systems of transport and communication of ideas, goods, information, capital and people. Fourth, as the extensivity, intensity and velocity of global interactions increase, the enmeshment of the local and global

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conceptual papers to open up a series of empirically based research papers on various aspects of the world city network (1999; 2000).

becomes deepened, such that the impact of distant events is magnified, while at the same time, local events may have global consequences. In other words, the *impact propensity* of global interconnectedness increases. It is against this backdrop of globalization that changes in the qualitative and quantitative nature of urban centres must now be understood and applied to the analysis of disease diffusion in the contemporary world because as Haggett (2000) and Gould (1999) remind us, diseases spread within a specific historical and geographic context.

Debates on urbanization and globalization have, perhaps, most systematically been linked in a growing body of conceptual and empirical work which deals with the emergence of a network of world cities or global cities. Such cities represent the command and control centres of the global economy that are connected with each other through flows of capital, people, information, and commodities (Brenner and Keil, forthcoming; Friedmann, 1986; Knox and Taylor, 1995; Sassen 1991, 2000; Smith and Timberlake, 2002; Taylor, 2004). Accordingly, the global city network facilitates the transnational processes that undergird the globalized economy . From the vantage point of the global cities hypothesis, globalization is seen as producing new linkages among corporations, international organizations, governments, communities, families and particularly cities (Waters, 2001) – linkages facilitated through the technological connectivity available through the new communication technologies (Graham and Marvin, 2001). Such developments have had the effect of extending the interdependence of societies and economies around the world.

It has been suggested that global cities may be organized in a hierarchical fashion or in “cliques,” in which certain distinct clusters or strata of cities are organized according to the economic, political and cultural power they yield on the international scene (Taylor, 2004). Scholars have repeatedly pointed out that such relationships among cities have often had a long history (Abu-Lughod, 2000) and that they have changed over time (Shin and Timberlake, 2000). In what is arguably the most commonly cited – yet highly intuitive -- scheme (see Figure 1), global cities are tiered in three groups: Los Angeles, Chicago, New York, London, Paris, Frankfurt, Tokyo, Hong Kong and Singapore form one tier of “Alpha” world cities, followed by a second tier of “Beta” world cities including: San Paulo, Mexico City, San Francisco, Toronto, Brussels, Madrid, Zurich, Moscow, Seoul and Sydney, while a third tier of “Gamma” world cities consists of (among others): Buenos Aires, Dallas, Houston, Miami, Atlanta, Washington, Boston, Montreal, Amsterdam, Barcelona, Geneva, Stockholm, Hamburg, Rome, Johannesburg, Osaka, Manila, Jakarta, Manila, Taipei and Beijing. These hierarchically organized clusters of cities have been found to be the skeleton of the new world economy and the relatively higher position of a particular city in this hierarchy results in a competitive economic advantage and status for this city in the international context (GaWC, 2004). See also extended as well as in discussions by the GaWC working group on issues of representation at: http://www.lboro.ac.uk/gawc/rb/rb30.html; and http://www.lboro.ac.uk/gawc/rb/rb31.html. In more recent work, the GaWC has

produced more empirically grounded representations of the global cities network(s) as is discussed in Taylor (2004).

About here: Figure 1: The GaWC Inventory of World Cities (Graphics: BellefairUrbanistik, Toronto)

Recently, the global city network scheme has come under criticism for portraying a rather static view in which global cities, conceptualized as distinct entities, are locked into a network of linear relationships with each other, at a fixed scale of interaction (Smith, 2003). According to this perspective on global cities, it is argued, that cities are treated as self-evident scalar entities in which specific social relations, localization and territorial concentration serve as the basic and unchanging precondition for global economic transactions (Brenner, 2000). As such, it is suggested that the conventional conceptualization of the global cities network is based on a static scalar perspective that does not appear to take into account the ways in which the global cities are always interactive and constantly in a process of change (Thrift, 1996, 2000). Nor does that perspective give adequate analytical consideration to how the global city is polyrhythmic --"a liquid theatre alive with the unruly times of urban practices" (Smith, 2003). Notably, these "flux characteristics" of global cities are important to consider because of as Capra (2002:121 cited by Smith, 2003) notes, once global financial networks reach a certain level of complexity, their nonlinear interconnections generate rapid feedback loops that may lead to many types of

unanticipated and emergent phenomena. In such a dynamic context, time and place are not fixed:

> Time is not simply simultaneous and multiple, it is with globalization increasingly non-linear and complex. With globalization, any event can have unexpected, disproportionate and emergent effects that are often distant in time and space from when and where they occurred. (Smith, 2003:566)

For Smith therefore, the forces of globalization and the development of global cities are too "intermingled through scattered lines of humans and non-humans to be delimited in any meaningful sense" (2003:570).[3]

It is our contention that the "unexpected, disproportionate and emergent effects" of local-global interactions are not limited to purely economic and financial functions of the global cities network, but that such effects can also be discerned in relation to matters of public health within and amongst the global cities comprising the network. Notably, such unanticipated, nonlinear effects should be considered in assessing the spread of SARS within the global cities network. Thus, for example, an editorial in a national Canadian newspaper noted that:

> Globalization means that if someone in China sneezes, someone in Toronto may one day catch a cold. Or something worse – if, in Guangdong province, 80 million people live cheek by jowl with chickens, pigs and ducks, so, in effect, do we all. Global village, indeed. (Editorial Comment, *Globe and Mail*, 28 March 2003)

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[3] A more detailed analysis of the urban aspects of this problematic can be found in Ali and Keil, 2004a; in a companion paper, we have expanded on the dialectic of fixity (of infrastructures, for example) and movement (of people for example in the global cities network and have suggested that the spread of infectious disease through the global cities network is dependent on both the scaled and rather rigid global system of airports, hotels, etc and the rather unpredictable (and topological) ways in which they are used (Ali and Keil, forthcoming).

This quote highlights the point that in today's world, agricultural practices unfolding in a rural area of one part of the world (i.e. Guangdong province in rural China) may ultimately have unanticipated health consequences for urban areas in other parts of the world -- such as SARS outbreaks in Beijing, Hong Kong, Taipei, Singapore and Toronto. The spread of SARS, therefore, to a large extent can be viewed as a "borderless" problem; one which reminds us that in the contemporary globalized context, infectious diseases cannot simply be considered as a public health issue that is exclusively confined to the developing world or pegged to a particular level of scale (such as the local or national).

In the present analysis, we will build on both, the scalar, networked hierarchy model of the original world city literature, and on the newer, topological view espoused by Smith, Amin, Thrift and others. As such, we contend that the global cities network is characterized by both types of arrangements -- that is, global cities are relatively fixed network nodes, bounded, historical, path-dependent, and rooted in national, regional levels, while, at the same time, they are also global diasporic historical geographies that are fluid, autonomous, self-producing, and "interactive and constantly in process" (Thrift, quoted in Smith, 2003: 562). This double character is a necessary condition for the existence and functioning of the global city under the contemporary social and economic conditions. The global city can thus be characterized as requiring spatial and temporal fixes for functioning in the global economic system, but at the same time, these fixed qualities melt and reform daily, hourly, or even by the minute to conform to the rapidly changing demands of globalized capital. It is the dialectic

of mobility and fixity that is truly characteristic of the urban condition under globalized circumstances. In global cities, one state can not exist without the other. And it is precisely this dialectic that needs to be the focus of attention to understand the spread of pathogens in the contemporary era.

Human Mobility and Microbial Traffic

The classic disease triad of agent, host, and environment is often schematically portrayed as a static triangle, but Wilson (2001) notes that such a perspective inadvertently directs attention away from the dynamic interactions involved amongst the three components. In particular, since there must be appropriate contact with an infected person, animal or object for the transmission of infectious disease, spatial proximity and movement necessarily play important roles in the spread of disease – but, such considerations are de-emphasized by the triad model as it is usually conceived by the medical community. In the contemporary globalized world, spatial proximity and the dynamism of interactions takes on even greater significance than in the past. Thus, Garrett (1996) contends that the post WWII optimism concerning the eradication of all disease-causing microbes that would push humanity through the “health transition” and end the era of the infectious disease was misplaced because it rested on two false assumptions – both of which neglect the dynamic features of the agent-host-environment triad. First, the assumption that microbes are biologically stationary targets has proven incorrect while the notion that

diseases could be geographically sequestered to the area of origin has also proven false, as evidenced by the spread of a whole slew of new and reemerging diseases such as, for example: HIV, Ebola, *E. coli* O157:H7, Tuberculosis, and West Nile virus (Heymann and Rodier, 1997; Garrett, 1994a,b; Haggett, 1994; Drexler, 2003; Gandy and Zumla, 2003). The dynamism of globalization necessitates a rethinking of how issues related to spatial proximity, microbial movement and the feasibility of geographic sequestration are interrelated – particularly, in light of how "relations among all geographical scales are continuously rearranged and reterritorialized" in today's globalized world (Brenner, 2000:361). Under these conditions, one strategy in modifying the classic triad model to better understand disease diffusion under the modern globalizing circumstances is to incorporate concepts such as the network of global cities and mechanisms for pathogenic travel. We have already discussed the former and turn now turn towards the latter.

As part of the attempt to analytically capture the dynamic nature of globalization in the spread of disease, the concept of viral traffic"(Morse, 1993), or more generally, "microbial traffic" (Mayer, 2000) will be useful. Microbial traffic refers to the movement of pathogens in populations as well as the mechanisms involved in such movement. This includes a consideration of: cross-species transfer; spatial diffusion; pathogenic evolution (or change in the structure and immunogenicity of earlier pathogens); and changes in the human-environment relationship. The

notion of microbial traffic can be used to re-situate the static triad model in a more dynamic context -- a context that takes into account the phenomenon of the urban-global dialectic- by emphasizing the movement of pathogens and humans, as well as by recognizing the changing features of the environment – all of which occur within the larger context of globalization. The first two features of microbial traffic are especially relevant to the case of the global spread of SARS.

Cross-species transfer (from animals to humans) appears to be a mechanism common to the spread of many emerging and resurgent diseases, such as: HIV from the simian (mangabee monkeys) population, Creutzfeldt-Jacob disease from the bovine population (bovine spongiform encephalopathy); and more recently, the avian flu virus. Similarly, the SARS coronavirus is believed to emanate from palm civet cats or raccoon dogs that populated the live animal markets in Guangdong Province, China (Naylor, 2003:23; Peiris et al., 2003; Guan et al., 2003; Martina, et al., 2003). Such “exotic” animal species are used in both food and traditional medicine in Southern China, but contact with these species in live animal markets facilitates the zoonotic transfer (i.e. diseases that transfer from animals to humans). The unsanitary conditions commonly found within these types of marketplaces are particularly conducive to the cross-over because they provide a breeding ground for new flu strains (CIA, 2003:7; Webster, 2004; Guan et al., 2003), thus increasing the probability of zoonotic transmission. The live animal market therefore

provides an ideal setting for the convergence of the agent, host, and environment for the SARS infection to occur. Furthermore, since these live animal markets presumably supply the food for those in the city, they provide an important contact point or interface for the urban and rural subpopulations to converge. As a spatial site, it would be expected that such types of urban/rural interfaces will have some significance in the transmission of newly emergent and resurgent diseases in the future as functional relationships between the rural and urban adapt to the globalizing forces that demand the convergence of these two scales of existence.[4] The significance of the rural/urban interface becomes even more critical in the situation of rapidly emerging urban areas as an expanding urban population base increasingly extends into the hinterland. For example, it has been noted that in the Pearl River Delta of Southern China (where the SARS virus is said to have originated), the differences and boundary between the urban core and the rural periphery appear to have diminished or become blurred with market reforms (Lin, 2001 cited by Orum and Chen, 2003:129).

In terms of the known tracking of the spatial diffusion of the virus, the first documented case of SARS (then known only as atypical pneumonia) was a rural farmer from the Pearl River Delta area of southern

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[4] The importance of the site of convergence of the urban and the rural for disease diffusion can be illustrated by other instances of disease as well, for example, the recently emerging threat of *E. coli* O157:H7. It has been shown that certain sites devoted to intensified livestock operations situated relatively close to urban areas may serve as a trigger point for

Guangdong Province who became ill on November 16, 2002 (Spiess, 2004:60). By mid-December the disease spread to Guangzhou, a city of more than ten million and the disease diffusion situation worsened shortly thereafter with the Chinese New Years celebrations of February 2003. By January, Guangdong health officials had correctly identified the highly contagious nature of the disease and recommended quarantine as well as the use of masks by health care workers. In consultation with officials from Beijing, however, it was decided that information concerning the disease was to be conveyed through a limited-circulation bulletin to medical staff within the province only (Spiess, 2004:60). Information about the disease would not be disseminated to the general population or to the international health community until about a month later and it was only on February 11, 2003 that the Chinese Minister of Health formally notified the WHO of the epidemic. This openness was shortlived as the information blackout was resumed on February 23.[5]

In the meantime, the SARS coronavirus began its international spread as an infected senior professor of medicine from a university in Guangzhou (where he was treating SARS-infected patients) traveled to Hong Kong to attend a nephew's wedding on February 21, 2003. During his stay in the Metropole Hotel, the ailing professor infected at least 12 other guests who were visiting from other countries. This infection of a

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disease outbreaks in Canada, particularly if the pathogen enters the food processing and food distribution chains (Ali, 2004).

relatively large group of individuals by just one person illustrates what has been referred to as the superspreader" phenomenon (CDC, 2003a; Gostin, Bayer, Fairchild, 2003). That is, certain individuals, for unknown reasons exhibit an enhanced infectivity. The presence of a superspreader in an aircraft or in a crowded area of a global city represents an important dimension of the microbial flow within and between global cities and as those exposed in the Metropole Hotel returned to their homes, the disease spread to other cities such as Toronto, Hanoi, Hong Kong and Singapore. The dynamics of the international diffusion of the SARS virus from Metropole Hotel also highlights the importance of air travel for the diffusion of the pathogens in the contemporary era.

Air Travel and Microbial Traffic

Grubler and Nakicenovic (1991) studied the average distance traveled by the French over the 200 year period from 1800 to 2000 and found that spatial mobility has increased more than 1000-fold. Similarly, Haggett (1999) makes the case that relative to the past, on average the distances traveled by individuals in the modern world is much greater with each successive generation. Citing a study by the distinguished epidemiologist D. J. Bradley (1988), Haggett notes the range of personal travel has increased roughly tenfold with each generation. For example, Bradley found that while his great grandfather had limited his travel to the

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[5] The decision not to inform the international community about the SARS epidemic was politically biased and may have been based on the intention of

40 km square around his village in Northamptonshire, England, his grandfather's travels took him within a 400 km square area surrounding his home village (including visits to London). In contrast, Bradley's father traveled widely in Europe, while Bradley himself, was a world traveler – a status made possible by the increasing use of airplanes in the modern era.

Dodge and Kitchin (2004) note that travel by air was a necessary prerequisite for the economic restructuring of globalization and the emergence of the network society. The amount air travel has therefore intensified in parallel with increasing globalization and this has important implications for microbial traffic. First, the absolute number of international travelers has increased, thus increasing the probability of contact with an infected traveler. For example, 30-40,000 international air passengers leave Toronto's major airport each day (St. John, 2003). Related to this, the increased size of the modern aircraft also increases the probability of contact with someone with an infectious disease. This is illustrated by a simple mathematical model proposed by Bradley (1988 cited by Haggett 1994) who found that doubling the size of an aircraft increases the risk of infectious disease fourfold. Thus, on a 200-seat aircraft the risk factor is calculated to be about 4, while on a 400-passenger aircraft the risk factor dramatically increases to 16. Furthermore, it would be expected that the risk of infectious disease would be higher for respiratory diseases such as SARS. This is because conservation efforts spurred on by the oil crisis in the seventies led to the construction of tightly sealed aircraft cabins in

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limiting economic impacts.

which existing air is re-circulated throughout the cabin. The problem is that the resultant ambient conditions serve as ideal settings for the rapid dissemination of microbes. Consequently, because everyone on board an airplane shares the same air, it is easy for one ailing passenger or crew member to pass a respiratory microbe to many, if not all, on board in an expeditious manner (Garrett, 1996). Recent studies have revealed, however, that more research will be needed to conclusively determine whether SARS or any other infectious disease can readily be spread amongst passengers in flight, as some contrary evidence has been found (Breugelmans et al., 2004; DeHart, 2003).

A second implication of air travel for microbial traffic concerns the increased speed and reach of air travel which has had the effect of accelerating the spread of SARS (Naylor, 2003). Critical to the examination of this factor is the temporal dimension. Dodge and Kitchin (2004) note that the aviation industry generates its own time-space which takes precedence over the “natural” cycles of the body, the seasons, organisms within the body, and the local “clock” times on the ground. In this sense, travel becomes an “out-of-time experience.” Such experience may obfuscate the epidemiological tracking of an infectious disease because travel times to and from major cities has decreased so significantly that, as mentioned previously, a person is in the infectious stage of a virus fever may not exhibit overt and recognizable symptoms of the disease and will likely assess him/herself fit to travel. Furthermore, from a public health perspective, the increased speed of travel that leads to the rapid movement of people may make

it more difficult to contain the disease itself. For example, Haggett (2000) notes that that the pivotal point for the introduction of measles in Fiji during the period of 1879 to 1900, was the switch from slow-moving sailing vessels to faster steam ships used to carry migrant workers from India. This was because the former involved voyages of 50 to 90 days thereby demanding too long a measles infection chain (around 5 or 6 generations) to allow the virus to reach Fiji. In contrast, the use of steamships resulted in a voyage time of around 30 days (about two virus generations) and this meant that half the vessels which left Calcutta or Madras with measles on board still had infected cases when Suva, Fiji was reached. Haggett's historical research highlights the importance of what Janelle (1968) calls "time-space convergence" for the spread of disease. That is, the time required to traverse the distance between two given cities has steadily decreased over the century with the improvements in transportation technologies. Thus, for example, of the 4,028 airports in the world today with regularly scheduled links between cities, Gould (1999:203) found that no two airports were separated by more than 36 hours of flying time; a time-space convergence which has great implications for the microbial traffic of pathogens with short incubation times, and therefore, for the global transmission of disease.

The Microbial Traffic of the SARS virus and the Global City

As alluded to above, the overall population travel flux and the international movements of passengers has accelerated over the last few decades and global cities have served as nodes in this network of travel

(Smith and Timberlake, 2000).Thus, not only do global cities serve as nodal points for the flow of information, commodities, financial transactions, and cultural goods that are commonly associated with global city functions, they also serve as nodal points for the transmission of disease with the airports in the global city serving as interchanges. Impressively predicting this type of scenario well before the international outbreaks of SARS, Peter Gould notes that:

> Even if a new and deadly virus starts in the global equivalent of Peoria, Illinois (where, not incidentally, it is most unlikely that it will be diagnosed), we know it will work its way up the air equivalent of a capillary feed road, until it comes to an interchange giving it access to one of the global arteries or superhighways. (1999:204)

As we have seen, this sort of transmission chain was indeed observed in the case of SARS, as the disease originated from rural Southern China, then moving to major cities in China via live animal markets, to eventually find its way to the major global city of Hong Kong, which then served as an important interchange site for its global spread.

The above account of the movement of the SARS virus has illustrated the hierarchical diffusion of the disease between global cities. Gould (1999:199) found that the international spread of HIV, was controlled by hierarchical diffusion, but was followed by a slow spread to smaller places from the major regional epicenters through spatially contagious diffusion. The case of SARS does seem similar to HIV with

respect to hierarchical diffusion within the international context, however, the viral outbreak was contained within the City of Toronto and did not spread to smaller spaces. For this reason, in order to complete the picture with regard to the spread of SARS, we must consider not only the network configuration of global cities (i.e. hierarchical diffusion), but the nature of global cities themselves because the latter will influence local microbial traffic patterns.

As Canada's global city, Toronto shares certain attributes associated with other global cities, such as an increase in large-scale immigration (Sassen, 1991; Samers, 2002). Indeed, Toronto is known to be one of the most multicultural cities in the world and is home to many different diaspora communities (Driedger, 2003; Balakrishnan and Selvanathan, 1990). Thus, the relationship between Toronto and other global cities in the network is not based purely on economic, communication and resource flows, but one involving cultural and familial linkages between Toronto's diaspora communities and their respective ancestral communities. In this context, Urry (2004) observes that a critically important aspect of the social life of members of diaspora communities occurs during 'occasioned encounters', in which, individuals travel in order to be physically copresent with one or more others for specific periods of time, and in specific places (Boden and Moltoch, 1994). Thus, Urry notes that:

> [T]he proliferation of transnational communities or diasporas has extended the range, extent, and significance of all forms of travel for far-flung families and households. Dispersed people, once separated from homelands by vast oceans and political barriers, increasingly find themselves in border relations with the old country thanks to a to-and-fro made possible by modern technologies of transport, communication and labour migration. (2004 citing Clifford, 1997:247)

These types of ethno-cultural linkages provided by occasioned encounters also has implications for the microbial traffic of the SARS virus – both in relation to the microbial traffic between global cities, as well as to the lateral spread of the disease within particular local diaspora communities commonly nestled within global cities. Examples of both types of spread were found with reference to Toronto.

According to a national inquiry into the Toronto SARS outbreak, the first recorded case of SARS in this city (i.e. the index case) was a 78 year old Chinese Canadian woman who became infected during her stay in the Metropole Hotel in Hong Kong. A place she traveled to in order to visit relatives. Upon return to her Toronto home, her 44 year old son soon also became ill and visited a local hospital for treatment. On March 5, 2003 the woman died while her son passed away two days later. It has been documented that during their hospital stay, many patients and staff were unknowingly exposed to the SARS virus through various pathways (Naylor, 2003) – a situation made worse through the employment of certain medical procedures. For example, the medical procedure of intubation – which involves the insertion of a tube with an attached ventilator through the mouth and into the trachea to assist breathing – may have spread

the virus because of the significant droplet production associated with this procedure (Naylor, 2003:25). Further, it was noted that staff shortages in Toronto hospitals may led to their overcrowding, thus an infected person was more likely to remain in a publicly accessible common emergency area for prolonged periods of time. Under such circumstances, it was not uncommon for some respiratory patients to wait in the emergency area until beds became available (due to a shortage of beds). In the meantime, such patients would be given oxygen and vaporized medications to assist in breathing. This practice, may have also increased the potential transmission of the SARS virus to others in the common area by transforming infectious droplets into an infectious aerosol thereby exposing those present in the waiting rooms (Naylor, 20003:25).[6]

Another leg of the microbial traffic of the SARS virus within the global city network involves a ”leap” from Toronto to Manila; again an occasioned encounter involving the familial connections of a diaspora community in Toronto with another global city. In late March 2003 a Toronto nurse’s aid contracted SARS through contact with roommate’s mother (whom she was caring for). The mother had become infected from a visit to a Toronto area family clinic (Scrivener, 2003; Toronto Star, Sept 27/03). Three doctors and several patients (including the mother) in the family clinic contracted the disease through exposure to family

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[6] Within the month of the index case, there were in total: 13 SARS related deaths, 97 probable cases, and 1,137 suspected cases in the Toronto area. By the following month, the total number of cases appeared to reach a plateau and on May 16, 2003 the official pronouncement was made that SARS had been defeated in this city (Naylor, 2003). One week later, however, a second wave of SARS patients appeared in a Toronto-area hospital as five patients were quarantined. The exact chain of events that led to this second outbreak (referred to as SARS II) remains unknown (Naylor, 2003).

members of a person who had been infected at the index hospital. In early April, unaware of the seriousness of her illness, the Toronto's nurse's aid traveled to Manila to tend to her father who was suffering from colon cancer. The next day after arrival she attended a wedding with 500 guests and for several days subsequent she traveled around the Philippines (while coping with her worsening illness) but passed away from the disease soon thereafter.

A second transmission chain associated with the occasioned encounters of a diaspora grouping involved a Toronto charismatic religious group whose parish membership largely consisted of individuals of Filipino descent. Many parishioners attended a funeral of an elderly member who had contacted SARS from the index hospital (at the time it was not yet known that the deceased had died from SARS). Once the possibility of exposure to SARS became known, 500 members of this religious community were ordered into quarantine by health officials, but one person who attended the funeral visitation (a 44 year old man) had already passed away from the disease. As such, the infection of a member of a tightly knit Toronto religious community, whose very existence appeared as the epitome of parochialness, had now been another link in a health crisis of global proportions, thus exemplifying the dynamic nature of microbial traffic in today's globalized world.

Certain issues involving stigmatization, surveillance, civil rights and racism arose in relation to the manner in which the SARS outbreak in Toronto was handled, but these questions are treated in another analysis (Ali and Keil, 2004). What can be noted for the present analysis is that the microbial traffic of a virus is

clearly influenced by the changing relationship of urbanization to health of the contemporary era. Thus, urban processes such as the establishment/destruction of neighbourhoods, the in and out migration of people, and changes the racial/ethnic composition of certain areas of the city may influence the spread of disease at the local scale of interaction. Furthermore, since many in the diaspora communities retain links with family and friends who remained in the country of their origin, the interactions and developments unfolding at local scale of one particular city (for example, SARS in Toronto) is more likely to have some connection in some (unanticipated) way with interactions occurring in another city (for example a wedding in Manila or Hong Kong). It is precisely these types of unexpected, multiplying, and rapid interactional effects that contribute to the "unexpected, disproportionate and emergent effects" of local-global interactions.

The Public Health and Economic Response to the SARS Outbreak in Toronto

This paper began with a brief historical statement of how, in the age of mercantile capitalism, initial efforts were made to develop international health strategies aimed at addressing both the public health and economic consequences of disease outbreaks. As an analysis of the City of Toronto's response to the SARS outbreak will illustrate, both these overlapping dimensions continue to exert significant influences on the response to disease outbreaks in the contemporary era – a response that can only be understood by considering the interdependence of global

cities economies as the contextual backdrop of Toronto's political response. We begin with a brief overview of the public health response within the city, which will then be followed by a discussion of how the adoption of certain local public health measures appeared to be influenced by global political-economic forces.

The various government inquiry commissions established to investigate the SARS outbreaks were all in agreement that outbreak containment and management was successful largely because of the efforts of public health officials to strictly administer proper infection control precautions in hospitals including isolation, contact tracing and quarantine (Naylor, 2003; Walker, 2003;). In the public health context, the term "isolation" refers to limiting the movement of those who exhibit the symptoms of the disease (i.e. they are patients), while "quarantine" applies to restricting the movement of healthy people (Walker-Renshaw, 2003). In other words, once cases were identified by the screening procedure they were *isolated* while those found to be in contact with the cases were *quarantined*. In addition, those who had entered the epicenter hospital after March 16 were asked to adhere to a ten-day home quarantine. By the end, Toronto public health had investigated 1,907 separate reports in addition to 220 cases of probable or suspected SARS cases (Naylor, 2003:35). It is interesting to note the fortunate fact, that such containment measures were successful despite the many obstacles met in implementing them,

including: a lack of surge capacity in the clinical and public health systems; the absence of protocols for data or information sharing among different levels of government; the inadequate capacity for epidemiologic investigation of disease outbreaks; and weak links between the public health system and the personal health services systems that provide primary care and home care (Naylor, 2003).

At the international level, during the third week of April, 2003, the WHO took the unprecedented step of issuing a travel advisory to Toronto and other areas such as: China's Guangdong and Shanxi provinces, as well as the cities of Beijing and Hong Kong – recommending that all visitors postpone all but essential trips to these areas. These warnings represented "the toughest travel advisories in its 55-year history" (Gostin, Bayer, Fairchild, 2003). One week later, an indignant delegation that included Toronto public health officials, the provincial health minister and the public health commissioner visited the WHO headquarters in Geneva. In response to the delegation's ostensibly urgent request, the travel advisory to Toronto was lifted after the WHO was given assurances that the city would intensify the screening of travelers to and from Canada. It was clear that such action was taken by the City of Toronto to counter the consequences of lost revenue in the hospitality/tourism and other economic sectors within the city as it was estimated as early as April 26, 2003, before the second wave of infections hit the city, that Toronto lost about $2.1 billion (CDN) due to the SARS outbreak (Van Rijn, 2003;

Ferguson, 2003) and it remains to be seen at this point if the loss of revenue has since been regained.

The unusual action of sending a local delegation to persuade the WHO to reverse its travel advisory decision could be construed as a somewhat understandable action when considering the need to maintain a good standing in today's global city hierarchy. The stigmatized status of a global city can have similar effects to the environmental stigma (Edelstein, 2004) experienced by other types of communities whose status falls because of the presence of an undesirable environmental features such as a landfill, brownfield, contamination by toxic chemicals, radioactive fallout and so on. As Edelstein (2004) notes, such "contaminated communities" face serious economic consequences from environmental stigma and must deal with particular hardships, such as those related to attracting new industries to the area or dealing with the mass exodus of residents. Similarly, in a hierarchy of global cities, a loss of status may give other global cities a competitive economic advantage for both the short and long terms. This is perhaps why it is often difficult to obtain accurate outbreak information from countries and cities that are dependent upon foreign investment and/or tourism (Naylor, 2003:199;Garrett, 1996) and such concerns may help account for China's initial reluctance to disseminate information about SARS to the international community (CIA, 2003; Spiess, 2004; Fidler, 2004) . Under the stigmatizing conditions, it is perhaps not surprising to learn that the

City of Toronto (backed by provincial and federal funding) invested a great deal of time, effort and money in attempts to restore its untarnishced world city status in the eyes of global public opinion in general and investors and visitors in particular. A total of $150 million (CDN) was set aside by Canada's three levels of government for marketing and advertisement which resulted in an internationally publicized concert featuring the Rolling Stones in the summer of 2003, hospitality deals offering cut-rate airplane, accommodation, and hotel fares, a plethora of television commercials that bolstered the image of Toronto as a wonderful tourist destination, as well as entertainer Conan O'Brien hosting his show for several days from Toronto in February 2004.[7]

Some, such as those involved in the federal and provincial inquiries (Naylor, 2003, Walker, 2004) have argued that the City of Toronto's haste to reestablish its reputation in the international community may have led to the premature declaration that the outbreak was over – and evidence for this argument was provided by the fact that a week after the pronouncement, a smaller outbreak of SARS occurred at another Toronto area hospital (i.e. SARS II). Another indication that economic concerns may have taken precedence over concerns of public health were noted by the provincial Safety and Security Commissioner (Young, 2003). The Commissioner observed that from a risk communication perspective, that during the time of the outbreak, there appeared to exist two contradictory messages, one message urging those Torontonians

[7] It should be noted that although Toronto's Chinatown was perhaps the most economically devastated area of the city, it did not specifically receive any

who are ill to stay at home under self-quarantine, while at the same time, another message that conveyed the view that "Toronto is safe" for tourists. Thus, the message for the internal (urban) audience appears to be different from the externally-directed message for the international community.

The episode between the City of Toronto and the WHO raises important issues and questions concerning the governance aspects associated with scale in the global city context. For example, how was the capability of a local government to maximize its prosperity and stability, while protecting the health of it's population affected by the politics of a globalized city that appears to now be directly influenced by policies originating in international agencies? Although this question cannot of course be answered in a conclusive manner, we can provide some initial observations as they relate to Toronto's observed SARS response.

The WHO has a mandate to regulate international health matters, including the prioritization of various global health initiatives, the international coordination of health surveillance systems, and emergency response to outbreaks (Price-Smith, 2002:134). At the same, the WHO faces certain restrictions in the exercise of its power, as it must deal with the sensitive area of national sovereignty within the international context. For example, it cannot intercede in an epidemic without first receiving consent from the afflicted nation-state (Garrett, 1996). Furthermore, only three diseases – cholera, plague, and yellow fever – are subject to international regulation wherein the WHO has power to dispatch United Nations officials to help regulate the movement of goods and

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financial assistantship from any level of government (Ali and Keil, 2004).

people in an effort to limit cross-border epidemics (Garrett, 1996). Although, the WHO cannot directly involve itself in the governance of a sovereign state (that would be a violation of the right to national sovereignty), the case of SARS in Toronto demonstrates that the international body can in fact influence domestic actions indirectly by using the threat of a travel advisory as leverage – and as we have seen, the travel advisory threat has significant clout in a world economically organized along a networked hierarchy of global cities. Thus, in the case of Toronto, the WHO only rescinded the travel advisory only under the condition that the city would increase the level of monitoring of passengers at its major airport (as well as at other major airports in the country). In response, the City of Toronto acquired several expensive thermal scanning monitors (to detect elevated body temperatures). By August 2003 over 5,232,000 inbound and outbound persons were screened at the six major international airports, with approximately 8,700 referred to the screening nurses (St. John, 2003). The number of SARS cases identified by such means was nil, thus leading some to question the efficacy of such surveillance techniques (Naylor, 2003; Walker, 2003; Garrett, 1996). This was not an unexpected result, because, as noted by the federal SARS inquiry commission (Naylor, 2003), screening fails to detect those who may be incubating the disease but who may not exhibit any of the symptoms. It seems, therefore, that Toronto officials were forced to adopt rather misguided and costly surveillance techniques to satisfy an external international body. And, on a related note, the Director of Health Canada's Centre for Emergency Preparedness and Response noted that since all SARS infected

patients in Toronto became ill only after arrival and sought help in the city's hospital emergency rooms, the new "border" for infectious diseases should now be considered the hospital doors of the city and not the airport (St. John, 2003) – an observation that highlights the increasing importance of studying the role of hospitals in the contemporary global city.

At the same time, if such costly surveillance efforts were not adopted, the city would run the risk of being seen by the international community as irresponsible. For example, a report by a panel of experts commissioned by the United States Central Intelligence Agency (CIA ,2003:8) rebuked Canada and Toronto for their indignation over the WHO's travel restrictions on Toronto because such actions could have endangered the lives of the international public. The delegation sent to Geneva insisted that they were not endangering the public because in their assessment the city was determined to be safe, as the strategies of voluntary quarantine seemed to be effective as no new cases were appearing (until the second outbreak of SARS in a Toronto hospital several weeks subsequent).

Action taken by the City of Toronto, such as sending a delegation to WHO headquarters in Geneva lobby for the lifting of the travel advisory, and the purchase of thermal monitors to screen Toronto airport passengers, illustrates well a point made by political ecologists of globalization. Namely, that the global and local should not be reified as separate analytical categories (Gezon and Paulson, 2005). Rather, they should be

thought of in terms of intersecting scales of analysis. That is, the global should be conceived as simply one aspect of a localized site in which the "people in any given zone of interaction act within parameters of policies, authorities, and material conditions that have sources outside the reach of their immediate local networks" (Gezon and Paulson, 2005:10).

Concluding Remarks

Epidemiological analysis and mathematical modeling that describe patterns of disease by person, place and time, may inadvertently miss important features of temporal and spatial scales that influence the spread of an infectious agent (Wilson, 2000:287). In this light, the value of global cities research and approach is that it enables the economic, socio-political as well as biophysical context to be taken into account – so that neglected features of the spatial diffusion of disease can be identified and studied. As we have seen in the case of SARS, many of the causal pathways would be difficult to discern because of their complexity, the indirect nature and multivariate causality of the disease transmission – all of which resulted from the interconnection of social, biological and cultural factors. For example, as reviewed above, the SARS virus was transmitted from rural regions in China, to major urban centres within that country and then ultimately to global cities around the world. Such transmission was influenced by cultural practices such as the presence of live animal markets that reflected local culinary tastes. At the same time it would be reasonable to expect that live animal markets would become much busier with the rapid

expansion of cities such as Guangzhou in Guangdong Province – an expansion that are the direct results of changes in economic policy as China moves towards a market economy. At another level, jet travel allowed the virus to jump from one global city to the next. Furthermore, particular social (diaspora) groupings and occasioned encounters between family members within the global city network also played a role in the spatial distribution of SARS, as illustrated by transmission of the virus from Guangzhou to Hong Kong to Toronto and then from Toronto to Manila.

In making a plea to take more seriously the role of the environment in infectious disease transmission, Wilson (2000:284) notes that the extent of contagion can be altered by the abundance of pathogens or the frequency and nature of infectious contacts, thus necessitating the need for such consideration. The case of SARS illustrates that such consideration should not be limited solely to the biophysical environment, but to the social, political and economic dimensions of the environment as well. In line with this, Mayer (2000) states that we need to “alter the concepts of the causality of disease from a purely biomedical concept to one that also incorporates the unintended aspects of human action”. As such, Mayer advocates a merger of concepts of traditional disease ecology with those from political economy and we would argue that one such way to do this is through the global cities approach. Such an approach would also help move us towards addressing in greater detail a question we could not address at the present stage of our ongoing research, namely, if the

movement of disease is facilitated through the various flows between the global cities we have discussed in this paper, why did SARS not appear in many more global cities than it did? That is, what happened to stop the outward march of the virus? Again, answers to these types of questions would undoubtedly involve considerations of both disease ecology (such as, for example, the seasonality of the virus in terms of its ability to survive in different climates and niches and the infectivity of the virus) as well as the local policies and politics of different global cities (thus perhaps necessitating a cross-comparative approach of the local political economies of various global cities) and such questions will be pursued in the future.

In sum, the advantage of utilizing a global cities approach in the study of disease outbreaks in the contemporary world, is that such a perspective is, at least as a starting point, well-suited to the analysis of an increasingly complex, interdependent world, characterized by the flux and the movement of individuals and microbes in seemingly unanticipated ways. Furthermore, since it is projected that within the next thirty years, two-thirds of the world population will live in urban areas (Vlahov and Galea, 2002; Wilson, 1995), a perspective which takes into account the nature of cities and the relationships amongst cities – such as the global cities network approach – will likely become increasingly important for future analyses and insight into the future diffusion of “new and emerging diseases”.

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Figure 1: The GaWC Inventory of World Cities (Graphics: BellefairUrbanistik, Toronto)