FOSTERING HIGH-RISE HOUSING COMMUNITY RESILIENCE IN TORONTO: A FRAMEWORK AND DISCUSSION GUIDE

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Abstract

High-rise towers characterize Toronto across a low-rise landscape. These towers represent a unique form for North America, and bring a series of challenges for future sustainability targets. Following storms in 2013, the topic of resilience has emerged as an important aspect of long-term sustainability. Storms are increasing in severity making them more difficult to resist. How can residents in high-rise buildings prepare for an uncertain future and demonstrate resilience in the face of hazards? What do condominium boards and apartment managers need to have prepared to mitigate the damage caused by a disaster? This paper analyzes existing literature of high-rise sustainability and desirability, recognizing these as important foundations for social cohesion (Uzzel, Pol, & Badenas, 2002) under the assumption that engagement and partnerships are central to community resilience (Chandra et al., 2011). The final product is a discussion guide for groups aiming to assess and develop their respective community's resilience.

Key Words: resilience; high-rise; sustainability; desirability; community

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Introduction

As a result of policies enacted in 2005 under the *Places to Grow Act,* the paradigm for urban development in Toronto and the Greater Toronto Area (GTA) has shifted. No longer are large swaths of land available for low-rise development. Greenfields are to be protected by zoning new development to existing developed areas. The *Greenbelt Act, 2005*, established a legal boundary around the Greater Toronto and Hamilton Area (GTHA) limiting the supply of developable land. Under the *Places to Grow Act, 2005,* the *Growth Plan for the Greater Golden Horseshoe, 2006,* was created which establishes population forecasts and targets for the region. By 2041, the population of the Greater Golden Horseshoe (GGH) is expected to reach 11.4 million people. (Hemson Consulting, 2013). In 2016, the Toronto Census Metropolitan Area (CMA) remains Canada's most populous, with a growing population of 1.8% per year, or 9.2% between 2006 and 2011 (Statistics Canada, 2012). Estimates now place the population of the Toronto CMA at 6.1 million (Statistics Canada, 2016). This growing population comes from diverse backgrounds, but all have one thing in common: they need a place to live. Without land to develop, the only option is to intensify existing urban areas. One of the ways this is being accomplished is by building high-rise residential condominiums and apartment towers.

And build up they have. In 2015, Toronto City Planning approved 123 projects for a total of 9,848 new residential units, an average of eighty units per project (City of Toronto, 2015a). Between 2010 and 2014, 67,505 dwelling units were completed, which is an increase of 12% over the previous period (City of Toronto, 2015b). High-rise and mid-rise development has become the face of many downtown and midtown neighbourhoods, and despite claims of a slowing market (Sorensen, 2016), projects are still being proposed regularly, especially in the district of Toronto & East York. With policies restricting horizontal expansion, and population projections in the positive, high-density infill seems all but inevitable for the foreseeable future.

The purpose of this research paper is to determine what high-rise communities require to be resilient in the face of hazards from climate change, with a focus on developing community resilience through engagement and dialogue. This is especially important as climate change leads to an increasing frequency and severity of storms and other hazards, including floods (Nirupama, Armenarkis, & Montpetit, 2014), ice storms (Klima & Morgan, 2015), extreme heat waves (Casati, Yagouti, & Chaumont, 2013), and virus transmission (Morin, Comrie, & Ernst, 2013). Sufficient robust, redundant and dynamic resources are required for resilience (Norris, Stevens, Pfefferbaum, Wyche & Pfefferbaum, 2008). Financial or economic resources are often unavailable for many high-rise communities. This paper will explore why high-rise communities are facing difficulties securing economic resources through an analysis of liveability factors and sustainability as they relate to choice of vocation in Toronto. It is important to recognize the structural and systemic factors contributing to this issue as long-term community viability relies on targeting these issues. Lacking economic resources, communities must explore and develop alternative resource bases. Recommendations will focus on developing social infrastructure and community connectivity as a response to the complexity and stress imposed by hazards and other disaster events.

Toronto and International High-Rise Comparisons

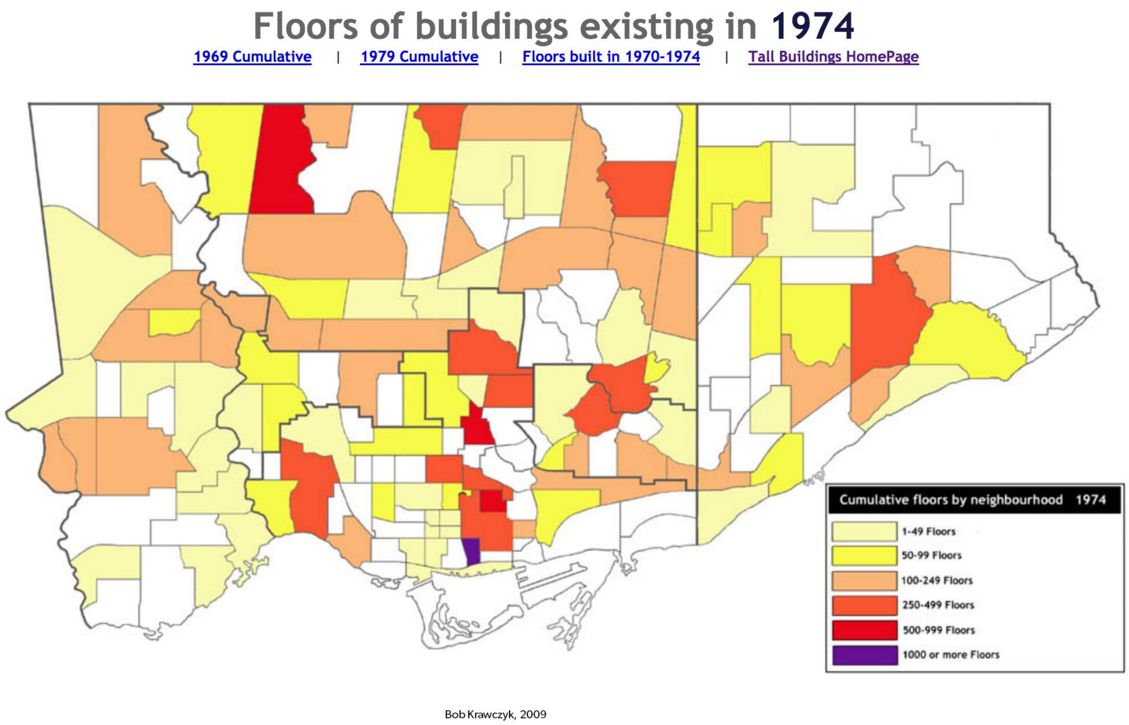

Figure 1: Post-WWII building patterns.

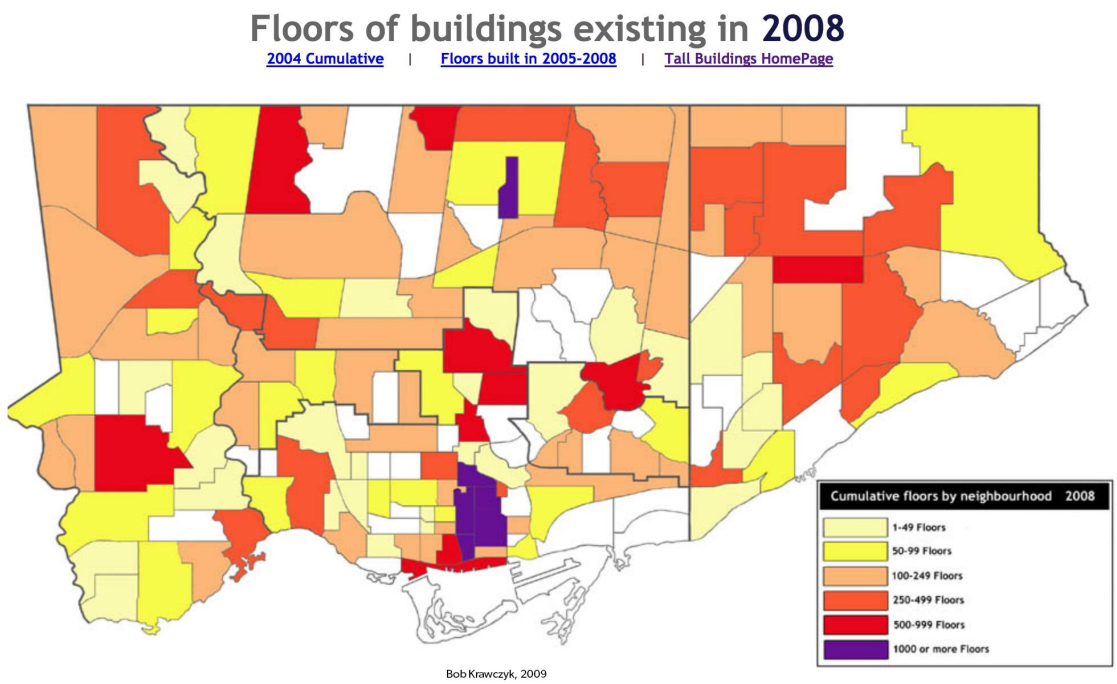

Figure 2: Cumulative building patterns.

High-rise housing is not new in the City of Toronto, as many apartment complexes were built throughout the city in the decades following WW2. This has created a city where urban sprawl is pocketed with clusters of high-rise development across the region. Quantified, Toronto currently stands as the 18th “best skyline” in the world with 2,166 registered completed buildings 12 storeys or higher (Emporis, 2017a). Emporis is a global online community dedicated to tracking the existing and future verticality of cities. This ranking is based on a point value assigned by height in a way that favours taller buildings, so it is not a perfect representation of the number of floors completed. Toronto is also listed 8th for cities with the most skyscrapers (buildings 100 m and taller) with 255 registered completed towers (Emporis, 2017b). Together these two measures indicate that Toronto is a tall city by international standards, and while international studies can support directions for understanding the impact of this form, Toronto must be researched in its own context. While Toronto certainly has a defined skyline and downtown, significant portions of its high-rises are outside the downtown core. Seen in **Figure 1**, post-war development was spread across the city. **Figure 2** shows that this has continued through 2008. This is a fairly unique form, as most tall cities are the result of natural boundaries or spatial restrictions, forcing cities to densify early on as a matter of necessity. New York City, Vancouver and Singapore are classic examples. Kathmandu, Nepal, also demonstrates the impact of physical constraints on building heights, as the surrounding mountains limit available land, contributing to a higher built form than other major cities in the global south. Toronto has few physical constraints apart from Lake Ontario, which makes its history of high-rise development interesting and quite unique. However, Toronto’s uniqueness may normalize, as developing nations have been experiencing their share of vertical expansion. Landowners have been capitalizing on the demand for cities by claiming their air rights, building up when and where possible.

In an international context, cities are embracing high-rise development as a way to manage urban migration, heritage preservation, and public transportation targets. It is a commonly stated phenomenon that cities are increasingly emerging as the economic centres for the global economy, and are rapidly growing in population, with the global urban population growing by 200,000 every day (UN Habitat, 2013, p. 25). Whether this trend will continue is still being debated, but there are compelling reasons to believe it will. For example, research suggests that people from rural regions move to cities to escape the volatility of global food prices; manufacturing jobs in cities do not show the same erratic trade patterns as agrarian jobs. In a way, moving to urban areas can be thought of as a form of insurance against the risk present in the globalized food market (Peolhekke, 2011). This is demonstrated in rich and poor economies alike. Residents will and continue to settle into low-rise slums, as high-rise development is more expensive than low-rise development, but where demand, land restrictions, and permissible policies combine, building heights will climb. It is important to understand global trends in development as cultural expectations for housing affect contextual rates of satisfaction (Yuen & Yeh, 2011). As new people immigrate to Toronto, their expectations for housing may align with the high-rise form, or they may not. Either way, high-rises are increasingly one of the only housing form options newcomers have. As Toronto continues to see high-rise development, it is important to establish conversations about the liveability and sustainability of the existing and future stock as they directly relate to the long-term health of the residents and communities they inhabit.

Is High-Rise Living Desirable for Residents?

Hong Kong and Singapore are famously built-up cities, and have been the focus of much of the modern research into high-rise living. One of the most comprehensive analyse in the field explores the history and policies leading to the high-rise built form of Hong Kong and Singapore, following up with survey data to identify the lived experience of the high-rise built form. One point that is demonstrated throughout the book is the impact of context on the responses received from participants. Hong-Kong and Singapore are the densest cities in the world, with persons per km^2 at 5,385 and 6,000 respectively. This is not a fair representation however, as both cities have concentrated development surrounded by open space, meaning localized figures climb to 26,950 and 9,500 respectively. Hong Kong is staggeringly dense in Mongkok when observed at the block level, with figures as high as 400,000-600,000 persons per km^2. Both cities are geographically constrained, and under strict central control regimes which limit development to specific areas over time. The outcome is a set of cities that are very alike with height and density as the only major variables. Hong Kong is much taller than Singapore overall, so the impacts of height can be compared (Yuen & Yeh, 2011).

Figure 3: High-rise housing in Hong Kong from Victoria Peak (TheBrandsmen, n.d.)

Table 2.2 Comparison of satisfaction of living height

	Too high		Not high enough		Too low		Just right		Don't care/never thought about it		Total	
Present floor level	Hong Kong (%)	Singapore (%)	Hong Kong (%)	Singapore (%)	Hong Kong (%)	Singapore (%)	Hong Kong (%)	Singapore (%)	Hong Kong (%)	Singapore (%)	Hong Kong (%)	Singapore (%)
1–5 floor	–	0.0	13.0	17.2	62.0	44.8	15.7	24.1	9.3	13.8	100.0	100.0
6–10 floor	–	1.7	31.6	25.0	21.8	15.0	34.6	55.0	12.0	3.3	100.0	100.0
11–15 floor	–	0.0	33.9	19.6	10.2	0.0	52.0	73.9	3.9	6.5	100.0	100.0
16–20 floor	2.4	14.8	10.7	14.8	1.2	7.4	82.1	59.3	3.6	3.7	100.0	100.0
21–25 floor	1.3	15.6	15.2	9.4	0.6	3.1	74.7	65.6	8.2	6.3	100.0	100.0
26–30 floor	9.7	8.3	8.8	12.5	1.8	0.0	72.6	79.2	7.1	0.0	100.0	100.0
31–35 floor	9.1	–	6.6	–	3.3	–	72.7	–	8.3	–	100.0	
36–40 floor	9.3	–	5.6	–	3.7	–	64.8	–	16.7	–	100.0	
41 floor or above	18.4	–	7.9	–	2.6	–	60.5	–	12.1	–	100.0	
Total	4.1	5.5	16.7	17.9	12.8	11.5	58.1	59.6	8.3	5.5	100.0	100.0

Table 1: Floor height and satisfaction for Hong Kong and Singapore (Yuen & Yeh, 2011, p 15).

In both cities, residents reported satisfaction with their living environment. However, when figures were compared on a per floor basis, the results were significant (see **Table 1**). Fifty and sixty storey apartment complexes are more common in Hong Kong than Singapore, and as a result, are more palatable in Hong Kong. 38.7 percent of Singaporeans surveyed reported that living above the sixteenth storey was “too high” (the sample classes ended at 30 storeys for Singapore). Comparatively, for the same classes, only 13.4 percent of Hong Kongese felt this was “too high”. Additional data focusing on perception of building height showed similar findings: a forty storey building was a “very tall” building to 30.5 percent of Singaporeans, but only 17.7 percent of Hong Kongese agreed with this assessment. In other terms, by 40 storeys, 60.5 percent of Singaporeans felt a building was “very tall”. In Hong Kong this figure was only 22.7 percent, meaning for 77.3 percent of respondents, a building had to be above 40 storeys to be considered “very tall” (2011, p. 17). The authors note that in western cities with low-rise suburban forms, buildings above five storeys were considered “very tall” (2011, p16). Finally, the study asked residents to list their highest preferred floor level. Results followed the trend in that “15.3% of the respondents in Singapore were willing to live above the 31st floor, whereas this proportion has jumped to 37.4% for Hong-Kong” (2011, pp. 17-18). This last point is the most important as it directly relates to the City of Toronto. It demonstrates that expectations for living environment depend on the surrounding existing built form of the city.

Numerous studies have supported the notion that residential satisfaction depends on personal, social, and cultural influences (Zumbo & Michalos, 2000; Jenks & Dempsey, 2005; MacDonnell, Robinson, Mikadze, McDonough, & Meisner, 2011). Social expectations of low-rise housing in the Greater Toronto and Hamilton Area (GTHA) may be a factor in the level of satisfaction high-rise residents experience with their environment. In *Vertical Poverty* (MacDonnell et al, 2011), elderly residents are found to be more satisfied with their living conditions compared to younger residents and parents living with children. This may be due to cognitive restructuring over time, though a study from 2014 found this to be only weakly associated (Sylvia, 2014). The stronger reason offered was lowered aspirations over time. This may also suggest why residents in Singapore rated high levels of satisfaction with their high-rise homes despite rapid urbanization; the likelihood of living a low-rise home became impossible (Housing and Development Board, 2010). Social and cultural expectations for single detached homes (Fulford, 1996) might lower high-rise residents' self-esteem in their perceived inferior living conditions, creating a disincentive to continue living in high-rise buildings.

It is important to note that Singapore high-rise housing is designed to be liveable, with large units by international standards at $90m^2$ for a 3-bedroom (968 square feet) on average (Yuen & Yeh, 2011). In Toronto, older apartment towers were designed with spacious units compared to what is being offered in newer developments. One of the most enjoyable elements of high-rise living explored in *Vertical Poverty,* a comprehensive study of post-war high-rise apartments in Toronto, was "Amount of space" (MacDonnell, et al., 2011). Post-war high rises were designed with large units and ample common space. Newer projects are eschewing this feature, designing smaller living spaces with fewer rooms (Bascaramurty, 2015). This current trend of shrinking spaces may become a major issue in the future. New Toronto residents might not be willing to accept very small units even in an environment where low-rise housing is unaffordable, deciding to locate in the outer suburbs or other cities altogether where more space is still available. Without tenants to pay for future maintenance bills, this could lead to an eventual decline in the state of repair in the new stock of towers. If the GTHA hopes to be a desirable area in the future, small unit sizes may become a problem. Overcrowding is major concern for residents, which will be explored in the next section.

While the topic is not extensively researched, there are a number of studies that show support for high-rise living as a healthy form of living (Fischer, Baldassare, & Ofshe, 1975; Yuen & Yeh, 2011; Cheng, Wang, Tang, Chu, & Chen, 2014). Unfortunately, there are just as many studies that conclude it is not (Cappon, 1972; Angrist, 1974; Conway & Adams, 1977; McCarthy & Saegert, 1978; Gifford, 2007). The most damning conclusion comes from *Vertical Poverty* that states that high-rises have a tendency to concentrate poverty, (this is somewhat qualified by the general decline in income across Toronto) (MacDonnell, 2011). In general it appears as though there is more evidence against high-rise living as a viable housing form. Many negative conclusions are based heavily on overcrowding; the physiological and psychological impact from an overload of proximal others (Stokols, 1972; Gifford, 2007). There are two types of density crowding: personal space density and external space density. Personal space density can be thought of as the number of people in the home and working spaces. External space density is the more frequently expressed measures of density, for example: people per square kilometre. Personal space density crowding has been found to be much more straining on individuals than external space density crowding (Stokols, 1972). Here again it is shown that reducing the average size of units might prove to be a major problem in the future. However, it is not all bad news. There has been a study that found the sense of overcrowding was inversely related to height (Schiffenbauer, Brown, Perry, Shulak, & Zanzola, 1977), a conclusion supported in Yuen & Yeh (2011). If a resident is on a higher floor, they are likely to have a better view, more sky in their view, less noise from the street, and cleaner air entering their unit. Design also plays a factor in the sense of crowding; subdivided rooms and soundproofing can provide much needed privacy (Yeh, 2000). Also, in a review of highly regarded public housing developments in the UK, there was found to be no relation between resident satisfaction and density (Darke & Darke, 1979). It is not possible to say high-rises are good or bad; there are many factors involved that it can be argued high-rises are neutral. The design and maintenance play such a major role in the future of each individual building that even the most thorough analyses conclude in the neutral position (Ng, 2010; Yuen & Yeh, 2011).

Maintaining a state of good repair is of critical importance in high-rise buildings. Deteriorating physical conditions demand greater resource allocation, which can consume earmarked funds away from system replacement towards reactive maintenance. This leads to an increased frequency and length of failures. In *Vertical Poverty,* one of the most commonly cited issues was elevator breakdown, with one third of residents reporting breakdowns occurring more than once a month (MacDonnell et al., 2011, p. 54). Without higher-order funding for system replacement, this cycle of repair and malfunction has become the norm. There is also reason to believe this issue is not limited to older stock high-rises either, as rain and flooding caused all elevators to fail in a new high-rise at Yonge and Gerard in downtown Toronto (CBC News, 2016). This is part of growing trend of elevator breakdowns across the country (Perkel, 2016). Elevators are not simply a matter of convenience; they are a critical piece of infrastructure for hundreds of thousands of people in the City of Toronto alone. They play an integral role in the liveability of high-rise buildings, being referred to as "the Achilles heel of modernist dreams of mass social housing in vertical towers" (Graham, 2014, p. 244). It must be recognized as a vital piece of the equation for high-rise community health. Essential and costly maintenance leaves few financial resources for the upkeep of common spaces or amenities, reducing the desirability of the building (MacDonnell et al., 2011).

Research also confirms the cyclical nature of poverty, where the deterioration in one neighbourhood aspect triggers the decline in another; poor conditions encourage people to leave (MacDonnell, et al., 2011, p. 62). High-rise towers exist within urban systems, so a decline in housing conditions can fuel a greater neighbourhood decline. Residents with disposable income are necessary to support local businesses, and without those local businesses' eyes on the street, neighbourhood character and safety will decline (Jacobs, 1961). Past a certain threshold, poverty becomes "durable", and any future changes are likely to be "in the direction of becoming increasingly poor" (MacDonnell, et al., 2011, p. 130). What is explained here is the link between proper maintenance and neighbourhood vitality. Maintaining desirable living conditions are integral to maintaining the long-term economic vitality of a building, and by extension, the neighbourhood around it.

There are many overlapping issues that relate to the desirability of high-rises; social expectations, unit sizes, state of repair, and economic vitality of the neighbourhood have been explored in this section. These issues are interwoven and contextually expressed, meaning they must all be considered at the local level for proper management. One issue that appears to be of special attention is the sense of privacy among residents. As explored earlier, the amount of space allocated to each unit relates to the sense of privacy among residents. Buildings with higher ratios of people per bedrooms may experience issues relating to the social cohesion, which could jeopardize efforts at engaging community members in resilience planning. There are ways of alleviating these issues to a certain degree. The literature supporting this issue will be explored in the following section.

Space Issues in High-Rises

It is important to understand the basis for why spacial restraints can become a major problem. In a classic study (Calhoun, 1962) that involved rats in a controlled environment away from predators, with unlimited food but limited space, order was happily established and maintained, and their population stabilized at 150 without any intervention. This order included natural grouping and isolating of the vulnerable; pregnant and young rats were protected from the crowds. Somehow, the rats knew what their ideal number of inhabitants was for the space provided, given no other variables. This all changed when the researcher intervened by doubling the population. In a short period the social order was lost, and violence broke out. Females were harassed, were unable to complete their nests, and failed to carry their foetuses to term. It seemed as though there was a minimum amount of space required to function as a society. Calhoun deemed the negative pathology related to overcrowding "behavioural sink". Of course there are many more factors that contribute to social order among humans, but this concept has been used to describe similar experiences with people in rapidly densifying cities. In response to the implications of the behavioural sink, architects and planners have explored the impact of building design on crime. A theory to explain the behavioural sink was developed by Oscar Newman based on research that showed crime was occurring in the indoor circulation spaces, instead of inside the dwellings or outside of the building. He concluded that there was an issue with the design of the towers, not their height that was the culprit (Newman, 1973). From his research he developed the theory of "defensible space", the idea that crime occurs most frequently in the spaces that are occupied by many people, but where residents feel no sense of personal ownership or control, such as corridors or entrances. Architects have responded to this theory by reducing the overall defensible space in their designs, but this has come at the expense of communal gathering space. In Singapore, it is common to leave the ground floor void of housing, instead offering public gathering spaces and shelter from the frequent rains.

Figure 4: Void deck in Singapore (Ryan Ong, 2016).

These “void decks” are critical to the desirability, sustainability, and the sense of community within the high-rises (Yuen & Yeh, 2011). Reacting to defensible space by eliminating it may be the wrong decision. Instead, there may be a way to improve the security of the spaces by providing passive surveillance. For example, housing units rarely have windows into their corridors that would offer a sense that there are “eyes on the street” (Lawson, 2010). These windowless corridors offer greater privacy to residents, but it comes at the expense of their security (Lawson, 2010). Evidence suggests that people who are provided with clearly demarcated private spaces are more likely to be social and less likely to be withdrawn (Lawson, 2010), but this does not imply that measures to improve visibility into hallways will overly compromise the sense of privacy. There appears to be challenge, but also an opportunity in designing high-density living spaces for desirability. Community space is necessary for the development of social connections, despite the dangers implied by defensible space theory.

High-density living does not lead to social breakdown in and of itself, but rather overcrowding in the personal space is more likely a major culprit.

Are High-Rises Sustainable?

Searching for material on high-rise sustainability, it became clear that sustainability could not be talked about in isolation from desirability. This is because sustainable spaces and places are demonstrably more desirable for people to live. This connection will be explored in this section.

Sustainability first entered public dialogue following the Bruntland Commission; *Our Common Future* (1987), which defined sustainable development as that which meets the needs of today without compromising the ability for future generations to meet their needs. Robinson and Dale (2012) explore the evolution of the responses to the call for sustainable development in Canada, describing two time frames with the emergence of a third beginning after 2005. First responses are characterized by conversations and debates aiming to establish an end goal of sustainable development. The economic, environmental, and community factors emerged as the central pillars of sustainable development, with the private sector seeing trade-offs between the three. This was also a period of government led, top-down organization. Second generation responses emerged in light of research climate change to primarily human causes. There was deepening understanding of the dynamic nature of socio-ecological systems, which demanded approaches through public engagement, collaboration, and deliberation (Robinson & Dale 2012, p 17). Government leadership structures were rigid at a time when the need for adaptability and collaboration was emerging. Adaptive capability needed to be coupled with a process of creating opportunity, which is what gave rise to the phrase ‘sustainable development’ (Holling 2001, 390). This need for adaptability led to the disbanding of many top-down organizations, as community-based organizations were better served to address the contextual demands of sustainable development. Unfortunately, retreating government involvement stalled the implementation of second-generation responses, as there was a lack of political will to implement necessary large-scale policies. Third generation responses attempt to ground policies written for the goal of sustainability in place-specific contexts, through widespread community engagement (Dale and Robinson, 2012). Sustainable development demands flexibility to fit dynamic contexts, which is the people who live in these places must be involved in the planning and development of their communities.

Accordingly, policies guided by community engagements that advance the ecological, economic, and social viability of a building will also advance overall desirability. In Singapore this appears in the form of abundant green space and fixtures, large unit sizes, and extensive social housing programs (Yang, 2005; Yuen & Yeh, 2011). In Hong Kong, housing is made desirable and sustainable by tying every megastructure development to higher-order transportation, maximizing green living space on podiums, and in some cases, building new accessible connections between neighbourhoods (Karakiewicz, 2005; Lau, Wang, Giridharan, & Ganesan, 2005). United Nations figures support the ecological sustainability of these forms, estimating low rates of metric tons of energy consumption and carbon dioxide emissions per capita compared to other developed nations (see **Table 2**) (United Nations, 2013). Compared to Canada per capita, Hong Kong and Singapore are using less energy and emitting fewer tons of CO_2. Japan in an interesting comparison as its level of density falls in between Canada and Hong Kong, as do its energy and emission figures. While there are other factors contributing to these figures, there is supporting evidence that greater population densities are associated with reduced rates of carbon emissions (Timmons, Zirogiannis, & Lutz, 1016). In striving for desirability and spatial efficiency, Hong Kong, Japan, and Singapore have demonstrated lower rates of energy use and carbon dioxide emissions.

Country	**Energy Consumption per Capita in Gigajoules** (As % of Canada)		**CO_2 Emissions per Capita in Metric Tons** (As % of Canada)	
	2012	2013	2012	2013
Canada	299 (100)	296 (100)	13.8 (100)	13.5 (100)
United States	282 (94)	286 (97)	16.1 (117)	16.1 (119)

Hong Kong	81 (27)	82 (28)	6.1 (44)	6.3 (47)
Singapore	199 (67)	207 (70)	10.3 (75)	9.4 (70)
Japan	149 (50)	149 (50)	9.7 (70)	9.8 (73)

Table 2: Energy consumption and CO_2 emissions per capita (United Nations, 2013)

The notion that high-rise living can be sustainable is not new, studies have purported to this aspect for decades (Real Estate Research Corporation, 1974). However, there are critics who state the opposite, that in a life-cycle analysis, high-rise living consumes more energy than suburban-low rise living, even if private car ownership is factored out for the high-rise residents (Du, Wood, Stephens, & Xiaoyu, 2015). High-rises have extra demands for elevators, lighting and climate control in public spaces that are rarely if ever turned off. These do increase the carbon footprint of high-rises substantially. Researchers have not reached a consensus on this topic.

While the structure of the building may be slated to last 100 years, climate control and elevation systems are only built for 20-50 years. Replacements are necessary but not always feasible. The result is a scenario where energy is in greater demand to keep conditions liveable, especially in hot and cold months (MacDonnell, et al., 2011). The major pull factors for LEED rated developments are the cost-savings in the long term (Nyikos, Thal, & Michael, 2012). The inverse is then of course true; an inefficient building is going to cost more in the long term. More capital spent on energy means less spent on facility maintenance, social programming, and other nice-to-have upgrades. Over time, repairs come at the expense of the operating budget for common areas, even though these spaces are frequently used and essential for the vitality of the resident community (MacDonnell, et al., 2011, pp. 74-75). Without common spaces, new community connections are strained, leading to deteriorating social sustainability.

A major factor that is prevalent in much of the literature on sustainable high-density design is the impact of extreme heat waves on resident health. Persily and Emmerich (2016) show that “From 1979 to 2003, more people in the U.S. died from extreme heat than from hurricanes, lightning, tornadoes, floods, and earthquakes combined." The figure is 3,442, which includes 1,363 people between the ages 15 to 64. While extreme heat may not compare to the physical and economic damage caused by the latter hazards, the toll on health is comparatively dramatic. For this reason, much of the literature related to designing sustainable density in cities often takes a direct focus of the airflow patterns related to building form (Ng, 2010). The majority of existing literature focuses on Hong Kong and Singapore, which have subtropical and tropical climates respectively. Planners in these climate zones have the advantage of being able to essentially ignore winter, or any extended cold periods. This allows them to organize their plans to maximize the effect of prevailing winds for ventilation - the windier the better (Ng, 2010). This contrasts with Toronto and other Canadian cities that have to plan for potential extreme heat waves in summer, and frigid cold months in winter. Planners cannot rely too heavily on research from Hong Kong and Singapore when establishing design guidelines, as it is missing the crucial attention to the effect of wind chill in winter. As a result, present and future residents will all have to rely on energy consumption to regulate the internal temperature of their units. Maintaining and upgrading climate control systems will keep energy consumption to a minimum, which improves the affordability and sustainability of high-rises in the long term. This is of course dependent on the ability of boards and agencies to afford these upgrades. When a system is not maintained, it costs more to operate, provides less satisfactory service, and hurts the larger structure's overall desirability and sustainability. If upgrades cannot be afforded, the long-term risk is durable poverty (MacDonnell et al., 2011). Communities experiencing durable poverty are more vulnerable in the face of a hazard due to their lack of economic capacities (Norris et al, 2008). How can these communities leverage their community capacities to face hazards with resilience?

Are High-Rises Resilient?

The final section of this review is to establish the factors involved in high-rise resilience, specifically looking at how the community within the high-rise is implicated. In order to assess the resilience of high-rises, we must first understand what resilience is and how it can be achieved. Resilience is a concept taken from physics, originally being used to describe a system that can "store strain energy and deflect easily under a load without breaking or being deformed" (Gordon, 1978). Over time, the definition and use of resilience in planning has grown to reflect its relation to human systems and disasters, with a commonly cited definition of community resilience being "*A process linking a set of networked adaptive capacities to a positive trajectory of functioning and adaptation in constituent populations after a disturbance."* (Norris, et al., 2008). When communities face a crisis or hazard, they have three potential processes leading to different outcomes as defined by Norris et al., (2008) (see **Figure 5**). The first is full avoidance or resistance (not to be confused with resistance defined by Kahan, Allan, George and Thompson, 2009 in the following pages). This occurs when the shock is not major, and resources are sufficiently robust, redundant, or rapid that no dysfunction is experienced, and the outcome is a return to the pre-event quality of functioning. The second is vulnerability, where the shock is so severe that available resources are insufficient to rebuild out of transient dysfunction, and the outcome is persistent dysfunction. Finally, the third process is resilience. Resilience occurs when sufficiently robust resources manage a shock that is severe enough to cause transient dysfunction, and the outcome is an adapted functioning in an altered environment. Resilience implies some degree of change, but no long-term damage (Norris, et al., 2008).

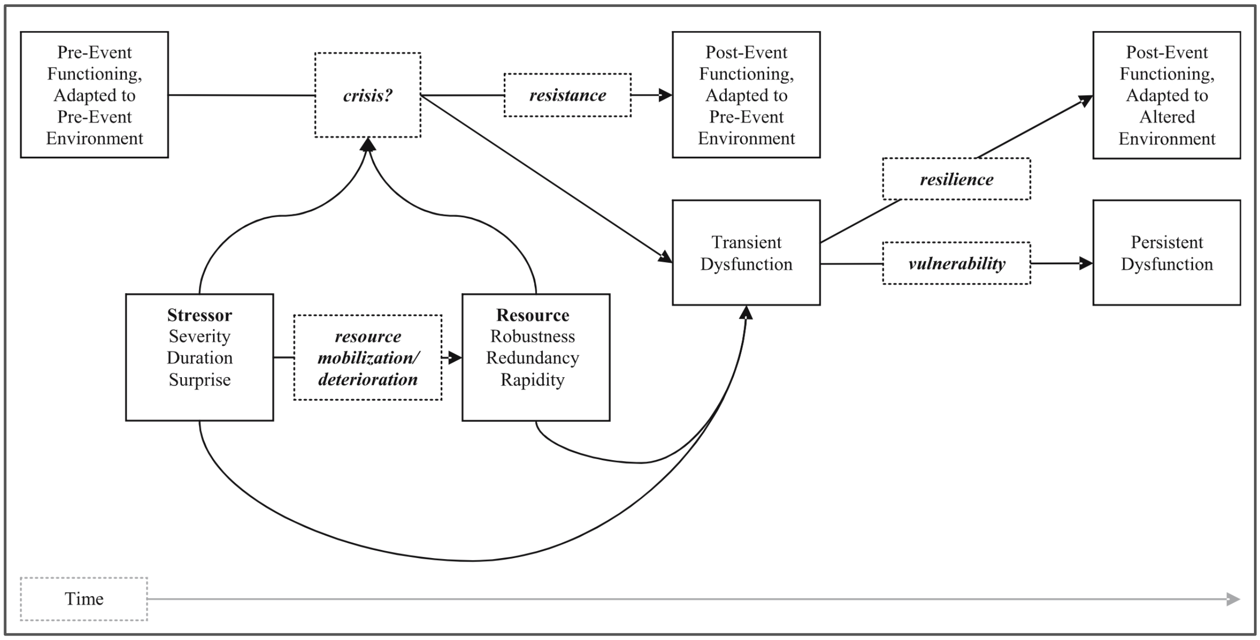

Figure 5: Model of stress resistance and resilience over time (Norris et al., 2008 p 130).

Resilience can be achieved in various forms. A community can be said to have demonstrated resilience if the response to a crisis is any combination of the following: *resistance, absorption,* and/or *restoration* (Kahan et al, 2009). These three objectives are further expanded into *active* and *passive* modes by the authors. The goal of resistance is to limit potential hazard damage. Active resistance is focused on relocating people away from harm's way; and passive resistance is the inverse: moving or directing the hazard away from human settlement. In circumstances where full resistance cannot be achieved, these countermeasures help reduce the amount of absorbing and restoring that must be completed later.

The goal of absorption is to contain and reduce the impact on the quality, equity, and functionality of a system (Kahan, et al., 2009). This applies specifically to key functions and structures, recognizing that a change has or is occurring in some regard. Active absorption includes preparing for an imminent threat by securing important system components, or mitigating damage before it spreads to other systems. Passive absorption is implemented through damage-resistant design; fire and waterproof IT systems, for example.

Finally, the objective of restoration is to rapidly return a system to an acceptable level of functionality (Kahan, 2009). Restoration is commonly understood to be the capacity for a system or community to “bounce back” from a hazard. Active restoration measures include permanent reconstruction, or replacement of all systems or components damaged. Passive restoration measures seek to support active restoration measures by facilitating delivery of resources. Pre-establishing agreements with organizations and vendors, or community asset mapping ahead of a hazard are forms of passive restoration, as these connections will prove invaluable in the aftermath and confusion following a major crisis. Resistance, absorption, and reconstruction are interrelated and reinforcing, and a community demonstrating resilience will likely act along all three objectives.

Passive reconstruction can also be understood by another name: social infrastructure. Developing formal and informal resource networks within and between communities before a hazard is a critical piece of the resilience equation. The importance of social infrastructure is further explored in research that analyzed responses from five Canadian health-care communities (O’Sullivan, Kuziemsky, Toal-Sullivan, & Corneil, 2013). This study utilized complexity theory to unpack and identify points of intervention, attempting to fill a gap in disaster management literature; that being the lack of evidence based components for disaster management at the micro, grassroots level, with attention to the how the dynamic elements of social infrastructure relate to community capacity. Complexity theory is based on the recognition that disasters are uncertain and require immediate action and collaboration between multiple systems and sectors (O’Sullivan et al., 2013). The basic tenets of complexity theory are similar to those of third generation sustainability responses: emergence, self-organization, nonlinearity, adaptiveness, and connectivity. These were used to frame the recommended core themes and action recommendations. The core themes are listed and described in **Table 3.**

Core Themes	**Description**

Managing dynamic contexts	Community context changes in response to restructuring, political pressure, emerging hazards, new information, changing human and physical needs, and increased situational awareness. Disasters reveal gaps in community systems.
Situational awareness and interconnectivity	Awareness and connectedness are the foundation for a resilient community; potential connections with organizations may not always be evident.
Pliable planning and open mindset for adaptive response	Complex plans can become rigid. Plans are good for considering the 'what ifs', but must not overprescribe actions as contexts are dynamic and require creative responses.
Active engagement and the challenges of collaborative work	As resource demand increases, collaboration becomes necessary. Non-traditional stakeholders may offer new solutions as existing systems become overwhelmed.

Table 3: Core themes of resilience at the micro, grass-roots level (O'Sullivan et al., 2013)

These core themes are paired with a series of seven action recommendations that are based on managing complexity. They are listed and briefly described in **Table 4**.

Action Recommendations	Description
Recognize the good/bad news	Good news is the wealth of community assets; bad news is the complexity of managing their integration, especially in a power failure.
Information to navigate the matrix of uncertainty	Ensure essential information is available, but not overwhelming. Simplify where possible.
Let the community teach the responders	Find community members with expertise among the population, encourage them to participate in the planning and training for the response community.
Training beyond the job requirements	Build redundancies within the system, this helps meet the demands of uncertainty when typical responders are absent.
Fine tune the guest list without ruffling feathers	Establish who is involved in the response network; meaning not everyone is invited to the planning table. Ensure this is done inclusively.

Invest time and effort in relationships … with haste	Trust is the foundation for collaboration, communication, mobilization of resources, and knowledge exchange, invest in this vital resource by working together whenever possible. Trust grows when people see competencies in others.
Identify who is at heightened risk, but respect their anonymity	A database of vulnerable people and their needs may be effective, but also presents a potential invasion of privacy. Formal and informal connections between community groups and response organizations are preferable.

Table 4: Action recommendations for building community resilience (O'Sullivan et al., 2013)

The importance of community in resilience is well supported in the literature (Sherrieb et al., 2010; O'Sullivan et al., 2013; O'Neill et al., 2016). A resilient community is one that is ready or able to respond to a shock, and recover optimally. In the case of long-term power failures, the community in the building must take some form of responsibility for its most vulnerable members. Social infrastructure or an engaged and connected community, however described, is the best line of defence against sustained vulnerability. Communities emerge and self organize in the face of disasters and their resultant complexity, but the extent that this emergent community can tap into their social capital depends on the pre-existing community connections and knowledge bases. Connectivity is the solution to complexity.

In order to be resilient, communities require sufficient *and* dynamic resources that are robust, redundant, or rapidly accessible. Norris, et al, (2008) label and categorize these types of resources as adaptive capacities. They fall into four categories of related networked resources (see **Table 5**). In order to assess the potential resilience of a high-rise community, an effective strategy can be to consider the existing networks of resources, recognizing that financial capacities are only one of four adaptive capacities. If a high-rise community is unable to secure financial resources, there are still likely to be opportunities for connecting and developing the social infrastructure of the community.

For example, communities can reframe their current context of economic vulnerability as one of ongoing resilience. For many, immigrating to Canada and building a life is a monumental achievement that proves their ability to confront and surmount adversity. Communities understand themselves and find meaning through narrative, and act in ways that draw upon these narratives (Sonn & Fisher, 1998). If there have been disasters in the past that have been overcome, stories from these events can be incorporated into public art and dialogues, which can grow the social recognition that there are capacities that have, and continue to exist within their community (Norris et al., 2008). Discussions alone can build community resilience, but only if people are at the table to talk. How a community can engage its members to participate in a discussion of their social and community capacity will be the focus of the following section.

Adaptive Capacity	Networked Resources
Economic Development	Resource Volume and Diversity Resource Equity and Social Vulnerability
Information and Communication	Systems and Infrastructure for Informing the Public Communication and Narrative
Social Capital	Network Structures and Linkages Social Support Community Bonds, Roots, and Commitments
Community Competence	Collective Action and Decision-making Collective Efficacy and Empowerment

Table 5: Interconnected adaptive capacities as the basis for predicting community resilience (Norris et al, 2008)

While much of the literature surrounding resilience has focused on cities, very little has been written about high-rise resilience directly. The dialog of resilience has evolved in a large part in response to terrorism and the push for added security in critical infrastructures (Coaffee, 2013). It is only in the last few years that resilience has expanded to include natural hazards, and the literature has predominantly focused on larger systems and shock resistant building design.

Generations of Resilience Approaches

Resilience has emerged as recognition that shock avoidance and prevention is not possible to a complete degree (Kahan et al, 2009). Instead, designs should anticipate shocks and try to mitigate their impact. This recognition took root after major hazards shook the Western world just after the turn of the millennium. Coaffee (2013) traces the growth of resilience in planning through four generations, beginning with a shift in public security policy. It should be noted that Coaffee follows the progression of policy in the UK, which does not align perfectly with Canada. However, he demonstrates that planning entered the realm of public resilience through highly visible shocks that had international implications for policy among Western nations. The specific policy changes he cites are not reflected in this review, instead, efforts have been made to extract the evolution of planning as it relates to global events.

Originally planners were only implicated in hazard prevention by managing defensible space in private settings, whereas the security of public spaces was managed through state security services. But as terrorism shifted from targeting critical infrastructure to everyday urban public spaces, planners began to be included in the realm of public safety and emergency management strategies. This was the genesis of planning resilience, which evolved over time to include resiliency planning for all varieties of hazards.

Following 9/11, there was a rapid shift towards reducing the impacts from targeted attacks by designing physical redundancy and robustness. It was understood that preventing attacks was not possible, as witnessed in real-time by millions of school children, parents, employees, and elected officials on September 11th, 2001. After the planes hit the World Trade Centre, everyone recognized that stronger designs could have prevented the collapse of the towers, which would have saved thousands of lives. In short order, designs were built with designed-in security features, which constituted the first generation of resilience responses (Coaffee, 2013). Planners reworked site plans to include crash-rated bollards and obtrusive design elements, which can be seen in Toronto at the base of First Canadian Place, for example.

Figure 6: Terrorism resistant design measures at the Titanic Belfast museum double as public furniture (Kirsty Hammond, 2012).

Second generation responses emerged when planning policy evolved to focus on the ability of larger systems to absorb shocks and take preventative actions (Coaffee, 2013). This was heightened by urban terrorist attacks in London on July 7th, 2005 when the Tube system was targeted. In response to the growing threat of urban terrorism, built environment professionals were forced to consider their responsibility in protecting the people who would gather and congregate in their spaces. Stadiums, malls, and public squares were now vulnerable, driving governing bodies to consult planners, architects, and designers who could offer skills in protective design measures, particularly in new-builds. It was also at this time that Hurricane Katrina made landfall over Louisiana causing one of the worst environmental disasters in United States history. The New Orleans levee system could not absorb the storm surges, resulting in collapsed walls and widespread flooding and destruction of low-lying areas, many of which have never fully recovered (Kennedy, 2015). Katrina was a harsh lesson in both the importance of redundant and robust physical design, and the complexity of resolving dysfunction. The flooding happened locally, but it was clear that local responses were inadequate given the extent of the damage. It is now recognized that a system designed to accommodate storm surges while safeguarding critical infrastructure would have mitigated the disastrous effects of the hurricane (Waggonner & Ball Architects, 2013). Katrina was instrumental in demonstrating the importance of vertical policy alignment in responding to hazards.

Third generation responses followed this by incorporating anticipation measures in the everyday activities of businesses, governments and communities. Coaffee describes this period as the “symbiosis of the socio-economic, political, and technical aspects of resilience” (2013, p 332). Responses were designed to be proactive, flexible, and adaptable, demonstrating a wider approach that responded to the complexity characteristic of hazards. Norris et al., (2008) published their work exploring resilience in Canadian communities at this point, outlining the importance of community engagement to the resilience equation. Kahan et al., (2009) followed closely with their official report for the Department of Homeland Security defining the three objectives of resilience. Both publications framed resilience as an integrated; systems based approach requiring community and governance involvement.

Finally, Coaffee outlines the progression towards a fourth generation of resilience responses, which are characterized by governing bodies stepping back from control to support positions. It is recognized that hazards are experienced locally, and require adaptive, networked responses. Hurricane Sandy in 2012, and major storms in the Toronto region in 2013 acted as major alarm bells that there is much to be done in connecting people, resources, actions, and policy to place in a timely manner following a shock. Planning has also taken on a long-term view of risk assessment and mitigation strategies, with an increased focus on building adaptive capacities within communities. There is an aspect of placemaking to foster community stewardship and connection. The goal is to support the social infrastructure of communities with policies that allow for adaptation and connectivity through all processes of a shock.

Dialogue, Art, and Narrative

The above research aims to contextualize the various, interwoven components of high-rise and high-density desirability, sustainability and resilience, with factors ranging from global trends to local contexts. All further steps will be grounded in the context of complexity in order to anticipate where and how interventions can occur at the local level. Decision makers must recognize how their actions fit within the broader scope of desirability, sustainability and resilience, so they can recognize new challenges and opportunities as they arise. The intention of this research paper is to develop a tool that high-rise boards and agencies can use to assess their level of resilience, and recognize where to focus their resources for the greatest impact. It will also help them think of their own context as strength, independent from financial conditions. Context matters in planning matters, so this guide will need to be adaptable. In order to reach the greatest number of users, readers must be able to recognize their stake and place in the recommendations. It is the hope of this author that the components of the literature review can be parsed down while still maintaining an educational piece on large-scale desirability, sustainability, and resilience. Every section will contain a short primer of key terms and concepts before outlining provisions and proposals. This format is used in another discussion guide for stakeholder feedback on new property regulations in Alberta (Service Alberta, Consumer Programs, 2015). This format allows for a baseline of research to inform decisions and conversations, and provides scope for what is possible and what is not. Developing resilience at the city scale is beyond the scope of this paper, but there are opportunities for condominium boards to be more prepared in the face of shocks and system failures.

The following sections will establish categories and their related themes. From these themes, a series of questions or discussion statements will be established for condominium boards to use as a checklist to assess and their baseline resilience, and recognize what can be done in the short, medium, and long terms to improve this metric. Primers will help frame the discussion so that participants are not asking *why* they must do something, and will instead focus more on the *how.* The methods section will involve developing a series of interconnected questions that encourage dialogue and reflection on what a disaster would look like in their community. Responses to crises are always context specific, and do not follow a plan. The intention is not to create a plan of direct actions, but rather to *plan for not having a plan* (Norris et al., 2008). High-rise communities face a specific set of vulnerabilities that are interconnected, cyclical, and durable. These vulnerabilities can erode the ability of a community to avoid a crisis, but these vulnerabilities do need to inhibit the ability of a community to demonstrate resilience during and after a crisis. Talking about disasters will not stop them from happening, but it can help a community resists, absorb, and restore.

Discussion Guide Framework

The discussion guide is deconstructed by hazard type. Each hazard contains a short synopsis of the three resilience objectives (Kahan, 2009) in how they apply to the type of threats imposed. The discussion questions focus on the requisite adaptive capacities set out in Norris et al (2008). There is overlap in the questions posed, just as there are similarities between the impacts of different hazards.

	Resilience Objectives			Adaptive Capacities			
Hazard	**Resist**	**Absorb**	**Restore**	**Economic Development**	**Information and Communication**	**Social Capital**	**Community Competenc e**
Flooding							
Ice Storm							
Extreme Heat							
Pandemic							

Table 6: Analysis framework for discussion guide, based on Kahan et al, (2009) and Norris et al., (2008).

Methods

The four hazard scenarios selected represent historic hazards that Toronto has faced and will continue to face in the future. Terror attacks were not included as a deliberate manoeuvre as the scope of this guide is designed to focus on climate change; research suggests reminders of global climate change can have peace-building properties (Pyszczynski, Motyl, Vail, Hirschberger, Arndt, & Kesebir, 2012). Each scenario is examined against the objectives of resilience in Kahan et al., (2009) and the adaptive capacities in Norris et al., (2008) considering reports from past hazard scenarios, City of Toronto emergency preparedness material (City of Toronto, n.d.) and other literature outlined in the previous sections. For the objectives, active and passive considerations are presented as opportunities that can be implemented to build resilience within high-rise buildings and communities. The adaptive capacities section is presented as a form of discussion questions that aim to support the implementation of the objectives. The framework then supports the guide by organizing considerations, allowing for common themes to emerge alongside hazard-specific considerations. These themes are paired with relevant research and information to establish the primer, followed by discussion questions. General considerations are presented first, and can be read independently. The subsequent hazard sections present scenario specific considerations that support the general considerations.

Findings (Discussion Guide Content)

The discussion guide content is included in this section. The analysis **Tables 7** and **8** are included at the end of this section on pages **45** and **46**.

<u>Overview</u>

The purpose of this guide is to help high-rise communities at any economic position assess and develop community connections and capacity as a response to the complexity and urgency imposed by hazards.

High-rise residents rely on elevation systems for access, and climate control systems for health. In the event of a long-term power failure, backup power systems will be unable to meet the needs of residents, which could lead to social and community vulnerability and dysfunction. These effects are compounded in high-rise communities that struggle to afford replacements of systems that have aged out, as these systems are more vulnerable to shocks.

Deteriorating housing and maintenance conditions lead to a form of 'durable' poverty that stems from a loss of desirability and sustainability. Sustainability refers to the ecological, social, and economic health of a community, recognizing the importance of community engagement in the resilience equation. Many communities in Toronto are facing the issue of enduring economic uncertainty, and research suggests these communities are at a greater risk of dysfunction following a hazard (Kahan et al., 2009). However, this does not imply they are unable to responding with resilience. This guide is based on an exploration of three objectives, and four adaptive capacities of resilience, which serve to grow community connections, and capacity. The aim is for boards and community groups to recognize their collective assets, and plan to not have a plan in the face of a major hazard.

Four hazard scenarios are considered: Flooding; ice storms; extreme heat; and epidemic/pandemic.

Fires were not included as there are legal parameters for responding to fires that must already be included in building operations, and are outside the scope of this paper.

Analysis Structure

Each hazard scenario contains a primer of key points to contextualize the issue, followed by a series of questions and considerations that align with the following objectives and capacities.

Resilience Objective (Kahan et al, 2009)	**Adaptive Capacity** (Norris et al, 2008)
Resistance	Economic Development
Absorption	Social Capital
Restoration	Information and Communication
	Community Competence

General Considerations

For all hazard scenarios there are a number of common considerations that will apply. Please consider the following points as they apply to your building community.

- Socioeconomic factors are an important component of community resilience (Sherrieb et al, 2010).
- Communities require resources that are sufficiently robust, redundant, and rapid to respond with resilience. Resources bases economic, social, information, and community competence (Norris et al, 2008).
- In order for communities to foster connections, they require public space to interact and socialize
- Public spaces require upkeep and renovations to remain safe and attractive to residents.
- Buildings that cannot provide a desirable quality of life will face difficulties attracting new residents.
- Deteriorating conditions will encourage financially secure residents to seek alternative

housing options (MacDonnell et al, 2011).

- Elevators, climate control systems, and building envelopes (windows, exterior walls) require maintenance and replacements as they age. These are expensive, and often pull resources away from other needs.
- New and upgraded systems use less energy, and save money in the long run.
- Overcrowding in units can lead to social and community breakdown (Calhoun, 1962).

Discussion Questions

1. What data is available to describe the socioeconomic character and composition of the building?
2. Can an anonymous survey be distributed to ascertain the economic vitality and diversity of the community? Who will administer this survey? How can anonymity be ensured?
3. What is the state of building repair? Are there systems that require replacement?
    a. How feasible are these repairs or replacements given the current economic conditions of the building community?
4. Does the building have established connections with contracting services? It will be much costlier and difficult to establish connections following a citywide hazard when services are in peak demand.
5. Is there a registry of residents requiring assistance in the building? If not, consider the issues of privacy before attempting to implement one.
    a. Are there informal connections that exist within the building community to access vulnerable residents in the event of an emergency?
6. Who are the well-connected residents in the community? Can their connections be made redundant?
7. Who is in charge of community decision-making? Who will take their place in an absence?
8. What spaces exist in the building that can be used as focal points in the event of crisis? Are there additional spaces that can be converted if necessary? What will it take to convert if

necessary?

9. What are the common languages spoken in the community? Who can offer help with translation in the event of a major crisis? Can these translation resources be made redundant?
10. Does the building have an emergency stockpile of resources? Can community members collaborate for wholesale purchasing of supplies? Refer to the City of Toronto, Get Emergency Ready: Highrise Living document for a checklist of recommended supplies.
11. Access to open spaces decreases the sense of crowding. Are connections to local parks well inviting, safe, and accessible?
12. How can community assets be mapped within and around the building? How will this information be accessed in the event of a power outage?
13. An important element of community resilience is the narrative being told during and after a crisis. If stories and anecdotes of positive past reactions to crises are shared, it will influence further positive responses. What stories of resilience already exist within the community? How are these being shared with the broader community?
    a. What capacity exists for storytelling to occur through public art and engagement?

Flooding

Potential Effects

- Damage to property
- Loss of power
- Loss of plumbing
- Sewage backup
- Mould growth
- Human displacement
- Loss of regional mobility

- Power Surges

Key Considerations

- Climate change is increasing the frequency and severity of storms (Nirupama, Armenarkis, & Montpetit, 2014).
- Flooding will normally come with some warning. It is always better to prepare for more precipitation than is forecast.
- Precipitation has a compounding effect, meaning each successive day of rain will have a greater impact, even if the same volume of rain falls per day.
- Conditions can change rapidly, especially in low-lying areas.
- The use of electrical appliances can pose a serious risk in a flood scenario; short circuits and power surges can be fatal.
- Flooding has long-term implications, as damage may not be immediately apparent.
- Transportation networks can be seriously affected by flooding in any part of the region.

Discussion Questions

1. Are low-income residents located in an area of greater risk? Might they require more support than others in the event of an extreme flood?
2. How well protected are IT systems within the building? How will records and important information be safeguarded in the event of a major flood?
3. Does the building have a crisis response team? If not, one may emerge after a major flooding event.
4. Will a communication system operate in the event of a power failure?
5. Is there a well-established chain of command for coordinating an evacuation?
    a. Are residents likely to trust that this order is in their best interest?
6. Who are there residents that can provide support in the event of an evacuation order?

7. Who will coordinate community-rebuilding efforts? This will require leaders and participants.
8. Are common areas at high-risk of flooding? Are there backup spaces that can be used for community coordination if necessary?

Ice Storms

Potential Effects

- Loss of power
  - Heating
  - Elevators
- Unsafe surfaces
- Falling tree branches
- Fires and carbon monoxide poisoning from informal heating sources
- Damage to property
- Loss of regional mobility

Key Considerations

- Climate change is increasing the frequency and severity of ice storms (Klima & Morgan, 2015).
- The impacts from ice storms can be hard to predict, as effects are very contextual. Ice does not flow like stormwater.
- Ice storms cause widespread power losses that can take weeks to repair (Armenarkis & Nirupama, 2014).
- People have died from carbon monoxide poisoning while using gas powered heating devices during power outages (CBC News, 2013, December 23rd).
- Slips and falls can cause major injuries.
- Power surges can damage electrical systems and devices.
- Improperly trimmed trees pose a major threat to people and electrical systems during and

after an ice storm.

- Regional transportation systems can be interrupted as a result of power loss and fallen debris.
- When power returns, use should be kept to a minimum to avoid overloading the system. Other people need power too.

Discussion Questions

1. Are important systems safeguarded from power surges and losses?
2. In a power loss scenario, residents with mobility issues on upper floors may not be able to use the stairs on a regular basis, how can support be provided to these residents?
    a. How will residents requiring assistance notify others?
3. How long will backup power systems operate? What can be done in this time to maximize the benefit to the community?
4. Where are local warming stations? Are there support systems to provide transportation for residents with mobility issues?
5. How can the dangers of the indoor use of gas-powered devices be communicated?
6. Who will coordinate community-rebuilding efforts? This will require leaders and participants.

Extreme Heat

Potential Effects

- Regional power loss
- Circuit overload (breaker trips)
- Health impacts

Key Considerations

- Extreme heat is a major cause of death from heat stroke.
- The signs and symptoms of dehydration and heat exhaustion are not always evident.
- Heat waves increase demand for electricity, in extreme cases overloading distribution networks.

- Climate control systems will accrue wear and tear; poorly maintained systems may fail.
- Cooling centres can offer respite, but only for those who are able to access them.
- Heat gain can be limited in a variety of ways including from reflective roof surface treatments and tinfoil covers in windows.
- Cooling public spaces will offer respite for anyone without functioning air-conditioning in their unit.

Discussion Questions

1. Are important systems safeguarded from power surges and losses?
2. Are climate control systems fully operational and in a good state of repair? Which components need to be replaced?
3. Are windows and doors properly sealed? Weather stripping will reduce heat gain and associated electrical costs.
4. Where can water be provided? Can this be done in a communal area that encourages social interaction?
5. Are community members aware of the signs of heat exhaustion and stroke? Where can materials be displayed explaining common symptoms?

    Common symptoms of heat-related emergencies include; (Canadian Red Cross, n.d.)

    - Cramps or muscle tightening, usually in the legs and abdomen but they can be in other parts of the body
    - Headache
    - Nausea
    - Dizziness, weakness, and feeling faint
    - Skin that is redder or paler than usual, or moist skin
    - Rapid shallow breathing
    - Irritable, bizarre, or aggressive behaviour

Epidemic and/or Pandemic

Potential Effects

- Health impacts
- Social isolation
- Quarantines
- Regional and local economic impacts
- Absent support staff
- Public anxiety and panic

Key Considerations

- Global travel patterns have accelerated the spread of infectious diseases (Public Health Agency of Canada, 2004a).
- Toronto is at an elevated risk due to its status as a major travel hub.
- Vaccines are demonstrably effective at controlling the transmission of infectious diseases (Andre et al., 2008).
- Epidemics can have major social, psychological, and economic impacts on communities.
- Infectious diseases can develop at any time of the year.
- Epidemics can overwhelm healthcare facilities, delaying other important procedures as resources are reallocated.
- Public health management carries ethical issues with respect to freedom of movement, privacy versus public need to know, triage, and others (Public Health Agency of Canada, 2004b). These may impact members in your community.

Discussion Questions

1. Which members of the community are likely to be most at risk from the health impacts of the infectious disease? Are these members able to be connected to support channels?

2. Are units maintained at negative pressure? This is very important for controlling microbial spread between units.
3. Who will be responsible for disseminating information as it becomes available? For which languages will translation be required?
4. Do community members have access to medical masks and other transmission reducing materials?
5. How frequently are contact surfaces sanitized? Are surfaces covered in antimicrobial where necessary?
6. Where are vaccines distributed? Can all community members access these locations?
7. Is there a plan for decision-making and follow through in the case of widespread contagion?
8. Are community members engaged with medical professions? Can they be incorporated in local decision making and planning to mitigate risk in your context?
9. Where are the areas with the highest foot traffic? Target awareness programs, as well as heightened sanitation efforts to these areas.

Next Steps

Toronto is fortunate that it is not at risk of a major earthquake or tsunami, and Toronto is far enough from an ocean that hurricanes are a comparatively infrequent event. This stability offered by geographic fortune is easy to take for granted. However, it should not stop high-rise communities from taking measures to prepare for the growing risks Toronto does face. Flooding, ice storms, extreme heat, and epidemics are real threats that each require targeted and adaptable responses.

Hazards are marked by their complexity, which demands an integrated community response to avoid sustained dysfunction (Norris et al, 2008; O'Sullivan et al., 2013) Resilience occurs when a community faces damage and change, but emerges to a level of functioning that is similar or greater than before. It is important to recognize the strength emergent communities demonstrate in the face of disasters. This strength can be harnessed to prepare for subsequent disasters by sharing stories, recognizing resources, and fostering community engagement.

Hazards can strike at any time - will your community be prepared? The goal is not to develop a rigid set of protocols for responding to specific scenarios, but to consider the overlapping systems that must function together to avoid dysfunction in the long term.

Plan to not have a plan; prepare by incorporating redundancy wherever possible, engage the community and recognize their assets, and establish a system for disseminating information in a crisis scenario.

With an engaged and informed community, resilience is possible no matter the economic context.

Hazard	Resilience Objective Action Recommendations (Active) (Passive)			Adaptive Capacity Questions and Considerations			
	Resist	**Absorb**	**Restore**	**Economic Development**	**Social Capital**	**Information and Communication**	**Community Competence**
Flooding *Potential effects:* Damage to property Loss of power Loss of plumbing Sewage backup Mould growth Human displacement Loss of regional mobility Power surges	Pay close attention to storm alerts, be prepared for evacuation during storm events.	Verify safety of ground floor residents Move important electronic systems off ground floor Disconnect IT systems connected to power (if not protected from surges) Secure all openings including windows	Replace damaged systems in order of importance Verify effectiveness of all quick-fixes made during Absorption phase Thorough scan for leaking pipes or walls Check for mould throughout building (on numerous occasions)	What important systems need to be replaced within building? Are resources available for these replacements? Are residents employed in diverse fields? Is any major portion at risk of unemployment? Are low-income residents located in an area of greater risk? Might they require more support than others in the event of an extreme flood? Are residents able or likely to purchase emergency supplies beforehand?	Who are the well connected members in the community? Are there ways to make their connections redundant? Who are there residents that can provide support in the event of an evacuation order? Who will coordinate community rebuilding efforts? This will require leaders and participants.	"*A trusted source of information is the most important resilience asset that an individual or community can have*" - Longstaff, 2005 Are there multiple trusted, proximal senders of information? Will the communication system operate in the event of a power failure? What stories of resilience exist within the community? How can the new narrative incorporate resilience?	Is there a well established chain of command for coordinating an evacuation? Are residents likely to trust that this order is in their best interest? Does the building have a criss response team? If not, one may emerge after a major flooding event. Is there a space to accommodate a community working group within the building? Are there community members available to act as translators?
	Restrict access away from low-lying ares Develop elevated access points Ensure downspouts are maintained and directed away from building Regrade surfaces to drain away from building	Elevate energy powered appliances off ground Water-proof analog records Ensure backup power systems are in place and functional Implement surge protection and battery backup for IT systems	Establish connections before hazard with vendors or contracting organizations for rapid response Map community assets Stockpile resources if possible				
Ice Storms *Potential effects:* Loss of power -Heating -Elevators Unsafe surfaces Falling tree branches Fires and carbon monoxide poisoning from informal heating sources	Provide early warning where possible Discourage travel during and immediately after storm	Salt all pathways Ensure entrances are operable Disconnect IT systems from power (if not protected from surges) Restrict access away from falling branches	Replace damaged systems in order of importance Verify effectiveness of all quick-fixes made during Absorption phase Thorough scan for leaking pipes or walls	What important systems need to be replaced within building? Are resources available for these replacements? Are residents employed in diverse fields? Is any major portion at risk of unemployment? Are low-income residents located in an area of greater risk? Might they require more support than others in the event of a long term power failure? Are residents able or likely to purchase emergency supplies beforehand?	Who are the well connected members in the community? Are there ways to make their connections redundant? Who are there residents that have alternative housing options that may not be affected by the storm? Who will coordinate community rebuilding efforts? This will require leaders and participants.	Are there multiple trusted, proximal senders of information? Will the communication system operate in the event of a power failure? How can the dangers of the indoor use of gas-powered devices be communicated? What stories of resilience exist within the community? How can the new narrative incorporate resilience?	Is there a well established chain of command for coordinating resource delivery to upper floors? Are residents likely to trust that resources will be properly allocated? Does the building have a criss response team? If not, one may emerge after a major ice storm event. Is there a space to accommodate a community working group within the building? Are there community members available to act as translators?
	Ensure backup power systems are in place and functional Establish warming locations for long term power failure scenario Weather strip doors and windows	Implement surge protection and battery backup for IT systems Ensure trees are properly trimmed and dead trees are removed	Establish connections before hazard with vendors or contracting organizations for rapid response Map community assets Stockpile resources if possible				

Table 7: Analysis framework for Flooding and Ice Storms.

Extreme Heat *Potential Effects:* Regional blackouts Circuit overload (break-er trips) Health impacts	Disseminate information on cooling centres when extreme heat warning in effect	Provide water in public spaces Ensure vulnerable residents are connected to support channels Light common areas in the event of power failure Encourage residents to close windows and blinds, tinfoil can be used if necessary	Verify all systems are fully operational following power failure	What important systems need to be replaced within building? Are resources available for these replacements? Can the community allocate resources to preventative measures such as weather stripping and surface treatments? Are residents employed in diverse fields? Is any major portion at risk of unemployment? Are low-income residents located in an area of greater risk? Might they require more support than others in the event of a long term power failure? Are residents able or likely to purchase emergency supplies beforehand?	Who are the well connected members in the community? Are there ways to make their connections redundant? Are residents able access cooling centres? Are there support systems within the community to assist if necessary?	Are there multiple trusted, proximal senders of information? Will the communication system operate in the event of a power failure? Are there community members available to act as translators?	Can groups or organizations within the building be tasked with distributing resources in the event of a power failure? Are there community members available to act as translators?
	Develop shading in exterior public areas Explore reflective surface treatments for roof elements to reduce heat gain Weather strip doors and windows	Implement surge protection and battery backup for IT systems Ensure backup power systems are in place and functional	Establish connections before hazard with vendors or contracting organizations for rapid response Map community assets Stockpile resources if possible				
Epidemic or Pandemic *Potential Effects* Health impacts Social isolation Regional and local economic impacts Absent support staff	In the event of quarantine, follow orders from healthcare professionals Advocate on behalf of vulnerable community members	Provide hand sanitizer in building entrances and at front desk, sanitize surfaces Encourage the use of medical masks Ensure vulnerable residents are connected to support channels Cancel or postpone social events until public health risk is averted	Assess community health by carrying out unit inspections. In the event of a death ensure support networks are notified and involved	Does the community have the capital to maintain or replace ventilations systems? Are residents employed in diverse fields? Is any major portion at risk of unemployment? Are low-income residents located in an area of greater risk? Areas of high traffic are at greater risk. Are residents able or likely to purchase emergency supplies beforehand? Can the community afford emergency medical supplies, or are there programs available to cover the costs?	Who are the well connected members in the community? Are there ways to make their connections redundant? Who will coordinate community rebuilding efforts? This will require leaders and participants.	In what capacity are health professionals already engaged with the community? Can these connections be leveraged to disseminate information? What stories of resilience exist within the community? How can the new narrative incorporate resilience? If a system of records of vulnerable residents exists, ensure it is protected.	Is there a well established chain of command for coordinating resource delivery to upper floors? Are residents likely to trust that resources will be properly allocated? Is there a space to accommodate a community health group within the building? Are there community members available to act as translators?
	Ensure negative pressure is maintained within units Encourage vaccination among residents Hold annual flu clinics and vaccinate on-site Implement antimicrobial surfaces in elevators and door handles	Ensure decision making and maintenance can be continued in the case of widespread illness	Establish connections before hazard with vendors or contracting organizations for rapid response Map community health assets Stockpile resources if possible				

Table 8: Analysis framework for Extreme Heat and Epidemic/Pandemic.

Discussion Guide Use in Rental and Condominium Communities

The discussion guide is designed for condominium boards of directors to use in conjunction with their respective communities. Rental high-rise communities can also use this guide, but decisions require the support of landlords, which is not democratic. Residents can still use the guide for community-led initiatives for building social connectivity informally, and this was considered in the development of the materials. For a condominium community, the process of implementing resilience-based changes can be democratic. Ideally, a condominium board would review the guide at a meeting and pinpoint protective measures that can be carried out quickly and easily, such as IT system protections. They may choose to assign new tasks to property management firms. If this this is the case, the change should be explained in a way that builds buy-in on the overall goal of resilience. The guide should also provide an overview of some preparative measures to absorb the hazard to some degree. Upon completing a review of the guide, a community meeting can be organized where preferred questions can be tabled for public discussion. The goal is to get people talking about shocks and preparedness, fostering a dialog over what has been done, what must be done, and what can be done. The organizers will collect comments, concerns, and feedback, and next steps will be derived based on feedback at a following board meeting. If there are large-scale changes proposed, a vote may need to be held at an annual general owners meeting. If this is the case, voting can be informed by explaining the potential savings of the measure: economic, environmental and social as they apply. Decisions are always contextual, and should be considered against the condominium declaration to determine points of tension for the specific building. Reaching quorum can be challenging for some communities, so notices in high-traffic public spaces should be posted if the proposed changed will require a high proportion of owning members to vote. Voting by proxy should be encouraged. All decisions made in the pursuit of resilience will be most impactful if they spur community awareness, engagement, and buy-in. Participation should be transformative at all stages, so whether guide is used solely as a reference for individuals, or is fully carried through a community consultation series spurring significant changes, something positive is gleaned.

Conclusion

With an engaged and informed community, resilience is possible no matter the economic context. The economic challenges facing high-rise communities are explored to better understand the 'durability' of poverty (MacDonnell et al., 2011) and how it relates to sustainability and resilience. High-rise communities may face a challenge in developing community connections as a result of deteriorating or absent public spaces (Lawson, 2010; MacDonnell, 2011), but there are always opportunities for developing social infrastructure through dialogue and narrative if people are at the table (O'Sullivan et al., 2013). The purpose of this paper is to formulate a discussion guide which will help high-rise condominium boards and rental agencies assess and consider their community's capacity for resilience in four hazard scenarios in Toronto; flooding, ice storms, extreme heat, and epidemics. Each hazard has specific considerations for management and response, but there are common themes between all four. The common themes have been synthesized in the 'General Considerations' section of the discussion guide, which are followed by each hazard scenario's key considerations and discussion questions. The intent of the design is to provide a level of education to the reader to help them frame the potential effects of a hazard within their community. Disaster planning, like sustainable development, requires adaptable community based responses paired with top-down policy and resource management (Robinson & Dale, 2012). Support communities emerge in times of crisis, but the effectiveness of these communities depends on resource preparedness. Economic resources are important, but they are not the only factor. Social capital, community competence, and information and communication are the other factors that any community can exercise regardless of their economic situation (Norris et al., 2008).

"A trusted source of information is the most important resilience asset that an individual or community can have" - (Longstaff, 2005, emphasis in original, p 62)

Future Research

It would be interesting to see more targeted research in Toronto's high-rise communities. *Vertical Poverty* (MacDonnell et al., 2011) was such an important piece in understanding the status of high-rise living in Toronto, and much time has changed since it was first published. Since its release, there has been a massive boom in high-rise development, yet the stock of purpose-built rental has grown very little. The cost of living has increased substantially, especially in housing. Recognizing the contextual social expectations for housing, how much will the high-rise communities have changed in light of new pressures and economic trends? I would be very interested to see a follow-up study on this matter.

I also believe that a Ryerson studio project could utilize the research and discussion guide developed through this project as a basis for holding a resiliency based community meeting in a high-rise building, and follow up with responses to feedback with this community as part of the deliverables component. There are many opportunities for exploring this important issue and student projects can produce excellent case studies in new and emerging fields. Resilience is a newer concept relatively speaking, what does it really look like in Toronto high-rises? The major limitation of this paper is the lack of community voices to support the recommendations, which means there is an opportunity to find those voices and build them into community champions.

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