ADAPTIVE CAPACITY OF COMMERCIAL REAL ESTATE FIRMS TO CLIMATE CHANGE IN NYC

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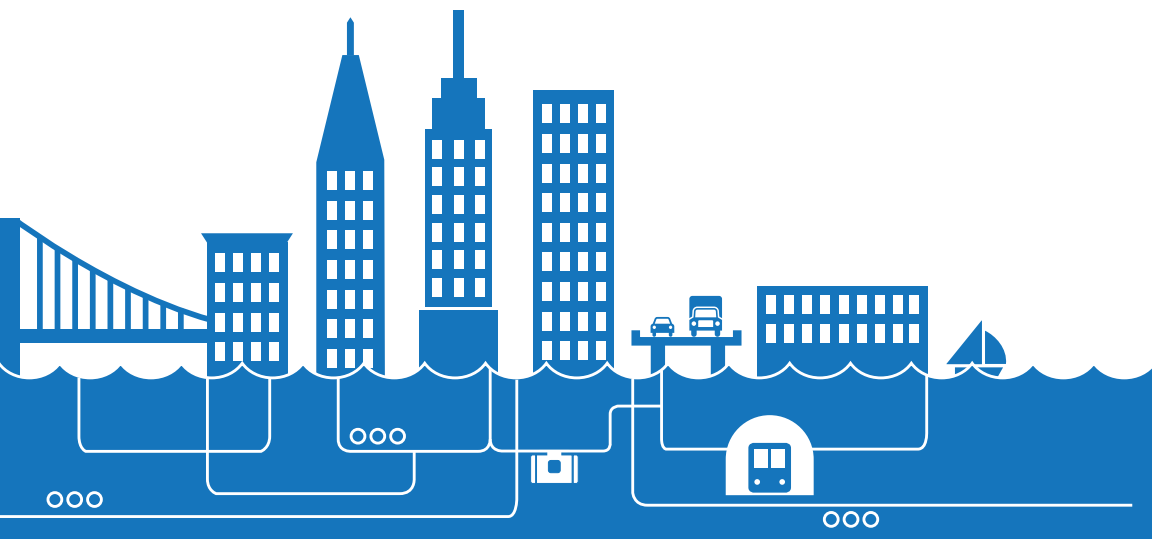

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ABSTRACT

This paper examines the adaptive strategies and capacities of real estate firms in New York City in the face of climate change and the increased probability of per occurrence risk of urban flooding. Built upon an initial technical survey of post-Sandy flood responses, the research attempts to shed light on how and why firms of are strategically approaching the aforementioned risks—if at all. Through the utilization of a multi-criteria adaptive capacity model built upon an interrelation of awareness, strategy and observed decision space(s), the paper is presented as a meta-analysis of six (6) case studies which seek to identify what and how internal and external influences are shaping the actions and strategies of firms. The article attempts to evaluate the propositions that: (A) firms with observable climate adaptive strategies have undertaken an *ex post* strategies which are principally driven by known and immediate risks to the firms' financial bottom line; (B) firm strategies attribute little to no influence in their decisions to external or delayed costs and/or impacts relating to social and environmental impacts which are indirect to the current or anticipated operations of their firms; and, (C) firms with the comparatively most robust adaptive capacities will be those who: (i) are most aware of their vulnerabilities; and, (ii) are themselves comparatively more vulnerable to the immediate risks associated with flooding and climate change. The paper concludes by finding that the results of the cases studies are largely consistent with the propositions.

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I. INTRODUCTION

On October 29, 2012, Hurricane Sandy's (Sandy) storm surge inundated coastal areas of New York City (NYC) causing $19 billion dollars in property damage and killing 43 people.[1] More than 12,000 structures—accounting for more than 70,000 residential units—were flooded and over 900 structures were destroyed.[2] A survey conducted as part of the research for this article identified an estimated $950 million dollars of repairs in private commercial real estate alone. A majority of these costs being attributable to dry flood proofing and the placement of critical building systems on higher floors.[3] Despite the tremendous damage and loss of life, Sandy's strength in the NYC metropolitan area was that of a mere tropical storm and not a hurricane.[4]

While the impact of the storm caught many in the public and in the real estate industry by surprise, the storm fit squarely within expected maximum probable losses modeled by the insurance industry.[5] Had Sandy hit the area as a true hurricane, the potential insured losses in property, casualty and business interruption could have been three to five times greater.[6] Unfortunately, the city and the insurance industry now cite the probability occurrence of a Sandy like storm at one in every seventy years.[7] To compound the risk, sea level rise in NYC has been projected to be as high as 3 feet in the next fifty years and almost 8 feet in the next one hundred years.[8] This additional sea level rise would mean that a $19 billion dollar loss in 2012 could be a $35 billion dollar loss in 50 years and a $90 billion dollar loss in 100 years.[9] While the exact numbers relating to the estimated losses from sea level rise alone have not been made public by NYC, preliminary research estimates that the commercial real estate losses in just the iconic Lower Manhattan business district alone could exceed $15 billion dollars if left unmitigated from sea level rise over the next century.

Without regard to the existence of a causal relationship between climate change and the increased frequency and intensity of storm activity in the NYC region, there is little doubt among city policy makers and the insurance industry that the complex modern urban systems of NYC have not yet been fully tested under the weight of a storm which will

[1]Mayor's Office of the City of New York, *Report of the Special Initiative for Rebuilding and Resiliency* (SIRR)(June 11, 2013) pg. 13.
[2]Federal Emergency Management Agency, *MOTF-Hurricane Sandy Impact Analysis* (June 21, 2013).
[3]Estimated losses are based on building surveys, interviews and costs estimates from filed building permits. Losses do not include the loss of economic productivity on higher floors which are now the site of relocated building systems including electrical distribution boards, communications systems and other critical operations systems.
[4]Eric S. Blake, Todd B. Kimberlain, Robert J. Berg and John P. Cangialo, *Tropical Cyclone Report, Hurricane Sandy (AL182012)*, National Hurricane Center (February 13, 2013) pg. 139.
[5]Interview of Andrew Castaldi, Head of Catastrophic Perils, Swiss RE Americas (October 18, 2013).
[6]Interview of Joseph Gunset, General Counsel, Llyod's America (October 18, 2013).
[7]*See* Footnote 1, at pg. 34. (SIRR).
[8]New York City Panel on Climate Change (NPCC), *Climate Risk Information 2013: Observations, Climate Change Projections, and Maps* (2013).
[9]Dollars are in present value (PV) to 2012 dollars; *see* Footnote 7.
[10]New York City Panel on Climate Change (NPCC), *Climate Change Adaptation in New York City: Building a Risk Management Response*, Annals of the New York Academy of Science, Vol. 1196 (2010).

inevitably strike.[10] Risks also arise from smaller storms and rain events which will be amplified by the expected occurrence of sea level rise. As NYC shifts its public focus from climate mitigation to broader notions of adaptation, the question arises as to the modality and capacity of the private sector to adapt to significant risks stemming from climate change and coastal storms. While much focus after the storm has been on the resiliency of households and residential real estate given the larger aggregate impacts, very little is known about the activities and strategies of the commercial real estate (CRE) sector which is critical to the broader notions of urban resiliency, particularly as it relates to the continuity of economic productivity.

In Smit et al.'s "Anatomy of Adaptation" (2001), the authors cite three critical questions for evaluating the existence of a climate change strategy: (i) adapt to what?; (ii) who or what adapts?; and, (iii) how does adaptation occur? Simply stated, the answer to the first question is the risk of urban flooding either gradually or through storm surge at some unknown point in the future. The answer to the second and third questions are the object of this research.

II. PROPOSITIONS

Despite the magnitude and relevance of the vulnerability, scholarship has largely neglected to address questions of if, how, when and why the CRE sector is adapting to the risks associated with climate change—notably urban flooding. As applied herein, adaptation "involve[s] both building *adaptive capacity* thereby increasing the ability of individuals, groups, or organizations to adapt to changes, and *implementing* adaptation decisions, i.e., transforming that capacity into action." (Adger, et al., 2005). By focusing on adaptive capacity, this article attempts to reframe and answer these questions through the meta-analysis of the individual case study of the adaptive capacity of 6 commercial real estate firms operating in NYC. These case studies were undertaken to test three propositions:

> A. Real estate firms with observable climate adaptive strategies have undertaken an *ex post* adaptation strategies and interventions which are primarily driven by known and immediate risks to the firms' financial bottom line.

B. Real estate firms with observable climate adaptive strategies attribute little to no influence in their decisions to external or delayed costs and/or impacts relating to social and environmental impacts which are indirect to the current or anticipated operations of their firms.

C. Real estate firms with the comparatively most robust adaptive capacities will be those who: (i) are most aware of their vulnerabilities; and, (ii) are themselves comparatively more vulnerable to the immediate risks associated with flooding.

However, given the historic reputation of the CRE sector to slowly adopt to new construction, operations and management processes and techniques (Linneman, 1997; Miller et al, 2009), propositions A and B are premised on the theory that the dominant factor in advancing adaptation is the anticipated tendency of firms to seek an equilibrium of costs and revenue in an immediate time horizon (Fankhauser, et al., 1999). What is less well understood is the extent to which this tendency is driven by direct private market influences from insurance companies, institutional investors, lenders, tenants or from any other external influences.

The reasons for this disassociation between internal and external influences could be attributable to the speculative and intangible nature, extent and occurrence of the potential negative effects. The counter argument—to be inversely evaluated through Proposition B—is that a certain awareness of the sensitivities to larger social, environmental and political considerations is critical to maintaining long-term demand for their products. By evaluating the aforementioned propositions, there rests an opportunity to advance an understanding among private and public built environment actors as to not only how but why firms frame and act upon the uncertainty associated with the risks cited herein as a matter of risk-adjusted actions and strategies (Hallegatte, 2009).

The fundamental intent of this research is to question the existence or extent to which CRE firm adaptation is reactive (*ex post*) or proactive. Published scholarship has begun to explore the varying modalities of adaptation of business organizations in a variety of fields, with agriculture (Smit et al., 1996; Rosenzweig, 1997, et. seq.; Smithers, et al., 2001; Yang, et. al, 2007); water management (Arnell 1999, 2006; Subak,

2000; Berkhout, 2004; Horbulyk, 2005); and, energy (Huang, et al., 2005; Bansal, et al., 2008; Kichham, 2008) dominating the literature with over 54 published cases (Nitkin, et al. (2009). With exception to Hertin, et al. (2003) and specific to the CRE sector, only building and construction subsectors have been explored within the built environment (Graves, et al., 2002; Hertin, et al., 2003; Shimoda, 2003; Hasegawa, 2004; Milne, 2004; Liso, 2006; Shipworth, 2007) and much of this work has been focused on managing technology and change in construction and/or design processes.

However, Hertin, et al., highlighted a central debate in the scholarship between one camp that views adaptation of business organizations as a process of economic and financial optimization (Mehndelsohn et al., 1994; Mendelsohn, 2000) and another camp which rejects optimization as impractical and as-such frames adaptation through the lens of external social and political complexities (Schneider et al., 2000; Kandlikar and Risbey, 2000). While Propositions A and B do not literally opine as to a pure application of mathematical optimization acknowledging that management decision of firms are invariably a matter of multi-criteria evaluation, it does draw a closer rhetorical analogy to 'optimization' than those lines of scholarship which focus on a diverse set of external values within a complex multi-criteria analysis. To the contrary, this research attempts to draw some resolution between the two camps by evaluating the existence of financial 'optimization' as a dominant consideration within the context of a continuous multi-criteria framework discussed in Section IV.

III. RESEARCH DESIGN & METHODOLOGY

The research design is based on a qualitative case study of individual CRE firms in NYC. This sector specific case study is more specifically a meta-analysis of 6 individual case studies of CRE firms (Yin, 2003; Ford, et al., 2010). The diversity of the cases highlights an intention to create a generalized

[11]Tom Shachtman, Skyscraper Dreams: The Great Real Estate Dynasties Of New York (iUniverse 2001).

understanding of a single sector with similar market and institutional based rules—although the firms themselves vary by size, activities and relative vulnerability within CRE. The firms are anonymously identified as L1-3, for the large firms, and S1-3, for the small firms, in order to protect the proprietary interests of the firms. Half of the firms are characterized as large in terms of both organizational and capitalization. The other half are comparatively smaller on both accounts and are considered 'family offices.'[11] Together the firms represent an estimated 42 million square feet (SF) in their portfolios with an estimated 75 thousand total housing units. Roughly half of the total space is located within the study area of metropolitan NYC. Specific to the study area, the larger firms each represent nearly 5.9 million SF of commercial space alone. The average portfolio size of the smaller family office firms is just over a half-million square meters.

The firms were selected in part due to their disproportionate market share for the large firms and for their noted history of successful multigenerational enterprise for the smaller family firms. The division and classification between large and small family offices also reflects the general representation of NYC real estate companies. However, the size of the firms is not independently relevant, except that the output variable (i) and the input variable (ii) in Proposition C are more readily measurable within the context of the comparative size of organizational structures relative to the firm's awareness and ability to act on said awareness as defined in the following sections. However, specific to size, no claim is made as to the representative nature of the sample from the cross-section of the industry at-large within the metropolitan area. However, it was deemed important for purposes of comparison and generalizability to

Table 1: Firm Characteristics

Large Firms	Public/Private	Portfolio At-Risk	Portfolio Specialization
L1	Private	High	Residential, Office
L2	Public	Low	Office, Residential
L3	Public	Medium	Office, Retail
Small-Mid Sized Firms			
S1	Private	High	Commerical, Other
S2	Private	Medium	Residential, Office
S3	Private	Low	Residential, Retail

include varying sized firms with varying organizational structures.

The same intent was rationalized for inclusion of a diverse level of vulnerability of subject firms, wherein the intent at the outset was to have at least one pre-determined highly vulnerable firm per size category. This final selection criterion was based on the desire to achieve diversity per category for those portfolios which are at-risk to urban flooding, as determined independently by the researcher. Having some representative diversity as per vulnerable firms is independently relevant to the extent that statement (ii) in Proposition C requires some comparison of vulnerability to confirm or falsify. Finally, some firms were biased in their selection based on the investigator's existing personal and/or professional relationships, as said firms presented an opportunity for greater accessibility.

In terms of the degree to which firm portfolios are at risk from either being flooded or from interruption in business operations from flooding, the research process included an independent evaluation of portfolio risk. The metric also includes those buildings which are not in physical risk of being flood but their operations are dependent on urban services which are themselves susceptible to flooding. A *low* level of risk is between 0-20% of the portfolio; a *moderate* level is between 20-49%; and, a *high* level is 50% or greater is at risk. This is a relative and simplified means to represent the degree of portfolio risk. Risk is either from uninsured casualty losses or from loss of revenue in the interruption of service. Likewise, the calculation does not include risks from debt or equity investments in either other non-controlled real estate or non-real estate assets. However, this simplified metric was a useful and a practical way for managers to reference immediate and known risks over the course of the interviews.

Data collection for each firm was collected with two different methods. First, firms were asked to undertake a systematic and consolidated survey of their post-Sandy activities to identify specific interventions and costs associated with Sandy flooding. The survey was based on based on standard building assessment for flooding utilized by the American Society for Civil Engineers (2010). The survey was amended to cover building systems damage, flood response, drying process, health & safety issues and flood resistant design & technology. The purpose of the survey was: (i) to advance an independent understanding of how large commercial buildings are susceptible to flooding and the extent

to which these vulnerabilities impose direct and indirect costs; and, (ii) to give context to the range of decisions undertaken within each firm and by and between various intra-organizational actors. While the data from the survey does not independently advance the testing of the propositions, the data would later partially validate that the identity and selection of individuals selected for interviews, as well as the data collected from the interviews.

To provide additional context to the data collected in the surveys. Vulnerable properties were mapped in GIS to evaluate relative values and other geophysical risks. For projects currently undergoing planning and development, public local land use filings were reviewed to evaluate consistency with stated actions and intentions. Overall, the independent data collection undertaken herein over the entirety of the project was used to triangulate data collected in subsequent interviews in terms of validation and interpretation of said data (Howe, 2012). The simulation modeling and the survey provided the initial foundation for advancing the preparation of the core method for data collection: semi-structured interviews (Wengraf, 2001).

Semi-structured interviews took place over two phases. The first phase was within the first 3 months of Sandy while most firms were in their middle of the responsive actions. The second phase occurred leading up to the anniversary of Sandy, which allowed actors time to process the new policies, regulations and market activities. Although the exact title may vary, interviews were first conducted with the chief executive and were generally followed by heads of asset management and design & engineering. Subsequent non-sequential interviews were made within risk departments for those firms who had dedicated risk managers, as well as a number of individuals who worked onsite as building managers.

The second phase of interviews was benefited from data collection from the first phase and from the independent triangulation of external documentation cited herein. Both phases of interviews were ordered in favor of senior actors being interviewed first. The reasoning behind this ordering relates to the modes of awareness and strategy development discussed further herein. The triangulation of two phases of interviews allowed for a dynamic process which ultimately clarified data as much as it verified it. The ongoing nature of the design resulted in an evaluation and representation of the case studies not within a static moment in time but over the c ourse of almost an entire year.

IV. ADAPTIVE CAPACITY

A. ADAPTIVE CAPACITY MODEL

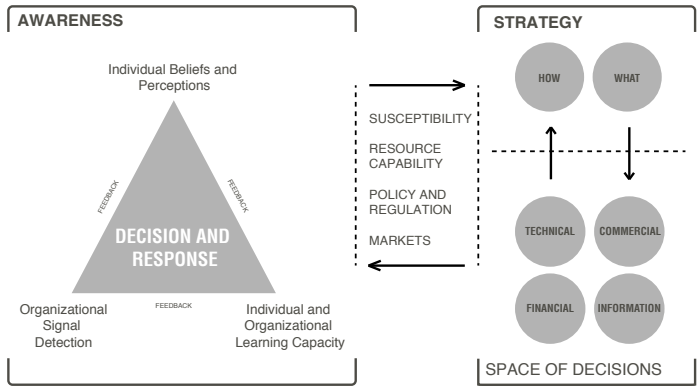
The model applied herein to evaluate adaptive capacity of organizations is based on the work of Hertin, et al. (2003) and Berkhout, et al. (2004) and in that it conceptualizes a dynamic tripartite relationship between said awareness, strategy and the spaces of decisions. The conceptual connective tissues of this relationship are dependent on the internal constraints of vulnerability and resource capacity and the external institutional constraints of markets and regulators, as more particularly illustrated in Diagram 1 (Fankhauser, et al., 1999, Arnell, et al., 2006).

This organizational sensitivity is particularly relevant in the context of awareness which itself is framework defined by the beliefs and perceptions, learning capacities and processes for detecting signals of change for both individuals and organizations. As Fankhauser et al. notes, "it is quite possible that changes in weather extremes, such as crossing certain thresholds will be noticed much earlier than change in mean climate…. Therefore, weather-sensitive investments that are made now and that are meant to remain in function for a couple of decades should take notice of a possible change in climate." (1999 at pg. 71). The authors argue that this impetus of imposing an ability to take notice of change (e.g., signal detection) is important for purposes of managing the flexibility and adaptability of investments. A failure to manage these changes relative to the deployment of capital runs the risk that, "climate change will increase the costs of delay (by reducing performance of existing capital), [and then] the economic lifetime and the technical lifetime of capital will be shortened." (Id. at pg. 72). Given the relative long useful of real estate, small changes in delayed costs, exacerbated by a lack of awareness, could significantly impact building investment economics. This is particularly true in New York City: (i) where real estate asset valuation is grossly weighted in favor of building value over land values; and, (ii) where capitalization rates—which represent the underlying comparatively low risk premium—are at global lows.

B. AWARENESS

Citing Graetz, et al. (1997) and Risbey, et al. (1999), Kandlikar, et al. (2000) argue in organizational terms, adaptation is an internally generated response system which is made of: (i) signal detection; (ii) evaluation; (iii) decision and response; and, (iv) feedback. The author's argue that "[d]

Diagram 1: Framework for Adaptive Capacity of For-Profit Real Estate Organizations



Source: Adapted from Berkhourt (2003); Hertin, et al. (2003); Arnell, et al. (2006); Frankheasuser, et al. (1999)

ecision-makers with an operational focus on different temporal and spatial scales will tend to define singal[s] in terms of processes they can observe at their characteristic scales of attention. Adaptation is dependent on the detection of a recognizable signal—if a signal is not detected, there will be no response." (Id.) Therefore, measuring relative signal detection at the level of decision-makers in terms of their individual observations is critical to understanding the entire adaptive response pattern.

Specific to the model utilized herein, Kandilkar's et al.'s perspective of signal detection is expanded to include both an individual's belief and her capacity to learn. Likewise, signal detection in this model is defined slightly differently to account for an organization's structure and processes which seek and/or record signals and filter signals from noise. To this end, the model attempts to account for a learning capacity of both individuals and the organization. Hertin et al. (2003) further classify signals as direct and indirect impacts—with indirect impacts being those attributable to regulations and/or markets. This distinction is applicable to both individual awareness and organizational signal detection. In modeling the dynamics of belief for adaptation in business organizations, Bleda and Shakley (2007) expand on the notion of direct and indirect experience as a matter of individual belief. With reference to the authors' model, the

measured factors of perceived experience, belief in climate change causality and timing are extrapolated for inclusion in the measuring of individual awareness, as listed in Table 2. The authors' also give recognition to the distinction between perceptions (i.e., superficial experiences based on current information bounded by time and place) and beliefs (i.e., deep convictions based on past information crossing time and place) which are reflected in this model wherein questions/factors attempt to distinguish between beliefs (e.g., political philosophy) and perceptions (e.g., vulnerability).

While understanding beliefs and perceptions are important, these elements change with time and experience and measuring the capacity to learn is critical to understanding overall awareness. Learning capacity is applicable to both individuals and to the organization and is predicated on a number of operationalized measurements. The degree and type of educational background of various interviewees is critical to understanding an overall level of competency in a variety of fields, including those fields which may require a higher than normal technical facility. However, education is not in and of itself a determinant of a learning capacity, but it does speak to a baseline allocation of human capital. Inquiring to the types, if any, of professional membership organizations, external data services and literature one avails to is valuable for understanding the sourcing of external signals. Finally, measuring the extent to which third parties have or do provide external review is useful for understanding a present capacity to reflect on organizational operations and communications which might be sensitive to signal detection but otherwise unacknowledged internally.

Finally, organizational signal detection is measured by the extent to which the organization devotes human and organizational resources to detecting and filtering signals. This prong of the analysis is dependent on both individual beliefs and perceptions and learning capacity. Likewise, the

Table 2: Measured Factors of Awareness

Organizational Signal Detection				
Designated Processes	Designated Personnel	External Relationships	Market Signal Detection Process	Physical Detection Process
Individual Beliefs & Perceptions				
Management Philosophy	Causality of Flooding to Climate Change	Perceived Vulnerability	Timing of Flood Risk	Observations
Learning Capacity				
Education Background	Professional Membership	Literature Reviewed	Training	External Review

latter are informed and advanced by the former in this dynamic relationship. Measuring external relationships for sourcing information and as well as existing and prior modalities for detecting and filtering market based signals is also insightful for understanding the nature and depth of information flows. When conceptualizing each of the three factors as a dynamic process which is constantly in flux, the static measurement in two phases over the course of almost a year, allows potential insight into the capacity to identify and process the meaning and implications of climate change and urban flooding.

C. STRATEGY AND SPACES OF DECISIONS

While it is one thing to observe the existence of a strategy, it has been argued that it is too premature to evaluate the strategy given the slow pace of change relative to the pace of business decisions (Weinhofer and Busch, 2013). This is particularly true given the long useful life of real estate assets. However, this papers seeks to measure robustness of strategy—not whether the strategy meets theoretical evaluatory criteria such as effectiveness, efficiency, equity and legitimacy (Adger et al., 2005). Only at a point in time in the future will researchers be able to evaluate such considerations. Specific to this research, that point in time could very well be the next occurrence of a storm event similar to the scale of Sandy.

Robustness is defined as a "measure of useful flexibility maintained by a decision, [whose] characteristics… make it a suitable criterion for sequential decision-making under conditions of uncertaintity…It reflects the sequential nature of decision-making by placing less emphasis on the on the plan, but

Table 3: Identifying and Classifying Strategies for Urban Flooding and Climate Change

Adaptation Measures	No Regret Strategy	Reversible/Flexible	Safety Margins	Soft Strategy	Reduced Decision Horizon	Positive Synergies with Mitigation & Sustainability
Flood Proofing an Old Building	(+)		(+)			(++)
Infrastructure Improvements	(+)		(+)			(++)
Restrictive Land Acquisitions		(-)				
Low-Cost Flood Barriers	(+)	(-)	(+)			
Share Risk				(++)		
Transfer Risk				(+)		
Corporate Risk Management		(++)		(++)		
Lower Quality Assets					(-)	
Evacuation		(-)			(-)	
(++) = Option yields benefits with or without climate change and flooding.						
(+) = Options yields benefits if urban flooding, but not with inundation from climate change.						
(-) = Option yields loss without occurrence of cliamte change or flooding.						

more on the continuous process of planning." (Rosenhead et al., 1972). To identify and qualitatively classify degrees of robustness, this model builds off of the work of Hallegate (2009) which identifies an economic range of strategies, as more particularly identified in Table 3.

The final prong of the model is the space of decisions from which an organization can adapt in technical, commercial, financial and informational terms (Hertin et al., 2003). As listed in Table 3, the range of options for urban flooding and the potential from inundation from climate change is relatively limited. Those measures in Table 3 represent the entire space of decisions and options cited by interviewees. As such, strategies (or, non-strategies) of firms will be evaluated in terms of their robustness based on the diversity of strategies and the total number of adaptation measures. It is argued that a true monetization of measures based on probability and nature of occurrence is still too speculative—particularly as it relates to the time value of money. However, the model does account for the possibility that conventional corporate risk management techniques, which would attempt to monetize measures based on probability, is itself a potential measure of adaptation. In particular, it could be argued that such an application is also directly related to the organizational level capacity for signal detection as well. However, there is a counter argument that the risk management department could represent an internal institution which is just as likely to hamper adaptation to the extent that the formal tools of risk management are grounded in historical data which cannot account of the novelty of climate change related stimuli.

In returning to the Hallegate's strategies (2009), as modified in Table 3, it should be noted that each of the strategies is identified as either: (i)

(++) yielding a positive benefit with or without flooding and climate change; (ii) (+) yielding a benefit if flooding but not inundation from climate change; or, (iii) (-) yields a loss without climate change or flooding. Therefore, it is assumed in all three scenarios that urban flooding may not necessarily happen within the useful life of the real estate assets. The first classification of strategy is the 'No-Regret' scenario wherein actions taken have the potential to yield a benefit even if climate change does not happen. 'Reversible Strategies' are those that implement a technology which is flexible and accretive. Therefore, if facts dictate a discontinuance of an intervention, it would have a marginal financial cost. A good example cited by Hallegate is temporary flood protection which has a low capital cost and can be built upon and modified in the future for changing conditions. The 'Safety Margin' strategy is similar to the Reversible Strategy in that is has a low marginal cost, but this strategy is undertaken to reduce vulnerability and not to eliminate it (i.e., create a margin of safety). 'Soft Strategies' are those that utilize financial and institutional resources to manage risk. The clearest example of a soft strategy is the sharing of risks through financial partnerships or the transfer of risks through insurance. 'Strategies that Reduce Decision-making Horizons' are those that reduce the useful life of an

asset or an investment. An example of this strategy may be to build lower-quality buildings in areas which are highly vulnerable to flooding. Finally, Hallegate acknowledges that there may very well be both positive and negative synergies between adaption and mitigation and/or sustainability goals. However, strategies that offer a net positive synergy may very well yield benefits regardless of the occurrence of climate change.

Each of these strategies offers varying level of robustness in terms of potential effect, cost and flexibility. While the adaptation measures identified in Table 3 are not exhaustive, they do cover a wide range of potential options. It is also possible for a measure to fall under different types of strategies with different cost-benefit calculations depending

on the intent of the intervention. Flood proofing new and old buildings and upgrading infrastructure could offer a No-Regret strategy or Margin of Safety strategy depending on the reliability and flexibility of the technical interventions. Yet, all could offer potentially net positive synergies with mitigation and sustainability in terms of promoting operational efficiency. Likewise, sharing, transferring and managing risk all are soft strategies that offer the opportunity of yielding benefits. In this sense, it demonstrates that the private organizations mainstream their economic logics in the same way the public sector does (Uittenbroek, 2012). Although, while one can benefit from sharing a risk by virtue of sharing a variety of risks in a legal partnership, transferring of risks specific to flooding would require the occurrence of flooding to yield a benefit. The final grouping of strategies worth noting are evacuation (e.g., selling assets in flood zones) and building lower quality assets wherein losses—often by virtue of opportunity costs—may be accrued if flooding or climate change does not materialize. Each of these strategies, if identified, have the potential to measure an overall level of strategic robustness in either individual or groups of strategies.

V. RESULTS AND DISCUSSION

A total of 25 individuals were interviewed across the 6 sample firms. The intent of each case study was to determine the overall adaptive capacity of each firm, in addition to its observable and stated strategy. The results for each firm were organized and classified in order to advance comparisons between firms. The model utilized herein does not provide a weighting as to which analytical prong between awareness, strategy and space of decisions advances overall adaptive capacity over and above another firm with a stronger. As such, the model is utilized to provide a qualitative multi-criteria tool for evaluating comparative capacities versus individual capacities. However, it can be argued that the study of individual firm capacities is of limited utility in only discrete terms without being contextualized to similar firms under similar conditions.

A. SURVEY RESULTS

As previously mentioned, the Post-Sandy survey of flooded buildings was completed by each of the 6 case study firms. Where necessary, data collected from interviews either fills in gaps in or otherwise helped explain selected answers in the survey. All of the firms, except Firm B, had buildings flooding

during Sandy. The survey covered building damage, flood response, drying process health & safety issues and flood resistant design & technology. In total, 21 large scale buildings each exceeding 50,000 SF were reported, with the largest building containing over a 1,000,000 SF. The average length of repairs was just over 2 weeks and the average length of closure or interruption in service was approximately 4 weeks. 2 buildings were still closed over a year following Sandy. All 21 buildings were self-reported to be prone to flooding by virtue of their location and 10 report undertaking partial flood mitigation measures—all of which were overwhelmed. The amount of flooding on the first floor various from 9 inches to 4.5 feet.

The timing and mode of the insurance response was considered reasonable and timely across all firms filing claims. However, the timing for both inspection and claims procession varied significantly from 48 hours to 90 days. One large firm and one small firm each reported in the interviews to be at least partially self-insured. Where building inspectors were required, none of the respondents deemed there to be a significant interruption in services. It was reported that the city required professional certification of critical systems for buildings prior to preoccupancy. It was determined in the interviews that "critical systems" standards was perceptively a higher standard than the structural and life-safety soundness determined by the city itself.

In terms of damage, the three most commonly reported damage categories include electrical system, mechanical system and elevators. All damaged electrical systems required either cleaning or replacement of the switching system. 2 buildings who reported electrical damage also cited significant telecommunications system damage. Nearly all of the flooded buildings subsequently elevated their switching systems with roughly half of the buildings cannibalizing rentable space to do so. All buildings who elevated electrical systems provided and/or extended external connections for promoting generator capacity. Those respondents who highlighted damage to elevators also cited, with exception of one firm, that the availability of parts and service was of serious concern. This concern was also reflected for the repair of plumbing systems.

Overall drying ranged from several days to several weeks. All flooded buildings utilized natural ventilation, fans, convection drying and dehumidifiers for drying. Several buildings with more advanced mechanical systems

utilized these system to advance the conventional process. No firms reported damage from uncontrolled evaporation or migrating moisture. All buildings, other than those with solid concrete walls, who were flooded reported minor mold growth which occurred within a week of flooding. The mold was not deemed to be significant health hazard and was abated with protective measures such as gloves, googles and respirators. All mold was deemed to have been removed by the end of the remediation process cited above.

In terms of flood mitigation process and interventions, all flooded buildings had their electrical and mechanical systems shut down prior to flooding. This was either done by the utility company or by the firm. This step was cited in interviews as having mitigated potentially significant damage from arc flashes and electrical fires. Roughly half of the buildings who undertook temporary short-term interventions, which were largely ineffective. Sealing MEP rooms and deployable water barriers were all overwhelmed. Only one respondent sealed windows and report mixed results as to its utility. All respondents have since given consideration to flood resistant gypsum and concrete sealant. Two-thirds of respondents were considering installing temporary flood barricades. Concerns relating to installation include negative aesthetic implications, relatively high costs and operational reliability. No respondents had purchased and installed barricades at the time of the tabulation of the survey results.

B. AWARENESS MODEL RESULTS

Specific to the Awareness prong, the measured perceptions and beliefs of actors, as described in Table 4, provided a number of insightful observed phenomenon. First, the perceived risk to vulnerability of flooding among executives was consistent with the initial classifications of portfolio risk undertaken as part of this research, *see* Table 1. Second, the perception of the executive relating to both vulnerability and flood risk was largely consistent with both the asset and risk managers. This phenomenon is largely unexplained but could reflect either a consistent corporate culture relating to risk or just close working relationship between the actors wherein junior actors ascribe to the perceptions of the executive. However, there is no evidence to fundamentally support this explanation.

Smaller firms were across the board perceptively more vulnerability to both climate change and flooding. This could reflect the internally assessed limitations of the size and resources of the firm or the relative lack of geographical diversity

Table 4: Summary Results of Individual Beliefs & Perceptions

Firm-Actor	Management Philosophy	Causality of Flooding to Climate Change	Perceived Vulnerability to Climate Change	Perceived Vulnerability to Flooding	Timing of Flooding Risk	Observations
L1-Executive	Progressive	Plausible	Low	Moderate	Short-term	Flooding
L1-Asset Management	Progressive	Likely	Moderate	Moderate	Short-term	Flooding, Power Loss, Operations Interruption
L1-Risk-Management	Conservative	Plausible	Low	Moderate	Short-term	Flooding
L1-Design & Engineering	Progressive	Plausible	High	High	Short-term	Flooding
L1- On-site	Conservative	Unlikely	Low	Low	Long-term	Flooding, Power Loss, Operations Interruption
L2-Executive	Progressive	Plausible	Low	Low	N/A	Operations Interuption, Flooding
L2-Asset Management	Conservative	Plausible	Low	Low	Long-term	Operations Interruption
L2-Risk-Management	Conservative	Plausible	Low	Low	Long-term	N/A
L2-Design & Engineering	Progressive	Likely	Moderate	Moderate	Long-term	Operations Interruption
L2- On-site	Conservative	Unlikely	Low	Low	N/A	Flooding, Power Loss, Operations Interruption
L3-Executive	Progressive	Likely	Low	Moderate	Long-term	Minor Flooding
L3-Asset Management	Progressive	Likely	Low	Low	Long-term	Minor Flooding
L3-Risk-Management	Progressive	Plausible	Low	Low	N/A	N/A
L3-Design & Engineering	Progressive	Likely	Low	Low	Long-term	Minor Flooding
L3- On-site	Progressive	Plausible	Low	Low	Long-term	Minor Flooding, Operations Interrupted
S1-Executive	Conservative	Likely	High	High	Long-term	Severe Flooding, Power Loss, Operations Interrupted
S1-Asset Management	Conservative	Likely	High	High	Short-term	Severe Flooding, Power Loss, Operations Interrupted
S1-Risk-Management	Conservative	Plausible	Moderate	High	Long-term	Severe Flooding, Power Loss, Operations Interrupted
S1-Design & Engineering	N/A	N/A	N/A	N/A	N/A	Severe Flooding, Power Loss, Operations Interrupted
S1- On-site	Conservative	Likely	High	High	Short-term	Severe Flooding, Power Loss, Operations Interrupted
S2-Executive	Progressive	Likely	Moderate	Moderate	Long-term	Flooding
S2-Asset Management	Conservative	Plausible	Moderate	Moderate	Long-term	Flooding, Power Loss, Operations Interruption
S2-Risk-Management	N/A	N/A	N/A	N/A	N/A	N/A
S2-Design & Engineering	N/A	N/A	N/A	N/A	N/A	N/A
S2- On-site	Conservative	Likely	High	High	Long-term	Flooding, Power Loss, Operations Interruption
S3-Executive	Conservative	Plausible	Low	Moderate	Long-term	Operations Interruption
S3-Asset Management	Conservative	Unlikely	Low	Low	Long-term	Operations Interruption
S3-Risk-Management	N/A	N/A	N/A	N/A	N/A	N/A
S3-Design & Engineering	N/A	N/A	N/A	N/A	N/A	N/A
S3- On-site	Conservative	Plausible	Low	Low	Low	Minor Flooding

in their portfolios. Firm S1, which had the highest independent measure of risk, showed remarkable consistency across actors for perceived level of risk and almost uniform stated observations. Firm L1 which also had a predetermined high relative level of portfolio risk showed a great deal of perceptive vulnerability to the occurrence and timing of the flood risk. The distinction between Firm L1 and Firm S1 as to the timing of the risk is worth noting, as the smaller firm viewed the risk as long-term risk which reflected a larger structural risk to the operations of the firm. As to the confirmation of Proposition A, only actors within Firm L2, including the executives, registered any operational awareness to climate change and/or flooding prior to the occurrence of Hurricane Sandy—hence an argument in favor of *ex post* adaptation.

Specific to individual and organizational learning capacity described in Table 5, the larger firms demonstrated a much greater capacity to learn and reflect on internal and externally sourced information. This does not necessarily mean that larger firms can manage acquired information more effectively or efficiently—to the contrary smaller firms may be more agile in terms acting on information. However, a capacity to learn is an important metric for being able to internalize external information that will inevitable change

over the progressive state of climate change.

Larger firms were also more likely to conduct external reviews of either their business operations or their buildings, although the two firms with the greatest measure of predetermined and internally perceived risk did not undertake any external reviews with any degree of regularity.. The two most vulnerable firms also had the greatest level of participation in adaptation related professional memberships both individually and as an organization. Likewise, actors in the most vulnerable firms were more likely to review adaptation related literature. Overall, large firms and those firms with the greatest level of vulnerability possessed the greatest capacity to learn.

This is consistent with a confirmation of Proposition C to the extent that a greater Awareness is indicative of a greater robustness in terms of adaptive capacity.

In terms of the organizational signal detection referenced in Table 6, there again is a great demonstrated disparity between large and small firms in terms of resource allocation. All of the large firms and only the most vulnerable small firm had processes in place to capture and process signals relating to changes in environmental and market risk. These processes include designated formal or informal working groups made up of personnel from a variety of departments.

Again, in partial confirmation of Proposition C, only the large firms and the most vulnerable small firm were active in both governmental and professional

Table 5: Individual and Organizational Learning Capacity

Firm-Actor	Education Background	Professional Membership	Literature Reviewed	Continuing Education &Training	External Review
L1-CEO	Non-Technical	Yes, Industry	Yes, Industry	No	No
L1-Asset Management	Technical	Yes, Adaptation Related	Yes, Adaptation Related	Yes	No
L1-Risk-Management	Non-Technical	Yes, Industry	Yes, Industry	Yes	No
L1-Design & Engineering	Technical	Yes, Adaptation Related	Yes, Adaptation Related	Yes	No
L1- On-site	Technical	No	No	Yes	No
L1- Organization	N/A	Yes, Adaptation Related	N/A	Yes	No
L2-CEO	Non-Technical	Yes, Industry	Yes, Industry	No	Yes, Business Operations
L2-Asset Management	Technical	Yes, Industry	Yes, Industry	Yes	No
L2-Risk-Management	Non-Technical	Yes, Industry	Yes, Industry	Yes	Yes, Business Operations
L2-Design & Engineering	Technical	Yes, Adaptation Related	Yes, Adaptation Related	Yes	No
L2- On-site	Technical	No	No	No	No
L2-Organization	N/A	Yes, Industry	N/A	Yes	Yes, Business Operations
L3-CEO	Non-Technical	Yes, Industry	Yes, Industry	No	Yes, Business Operations
L3-Asset Management	Technical	Yes, Industry	Yes, Industry	Yes	Yes, Building Operations
L3-Risk-Management	Non-Technical	Yes, Industry	Yes, Industry	Yes	No
L3-Design & Engineering	Technical	Yes, Adaptation Related	Yes, Adaptation Related	Yes	Yes, Building Operations
L3- On-site	Technical	No	No	No	No
L3-Organization	N/A	Yes, Industry	N/A	Yes	Yes, Building & Operations
S1-CEO	Technical	Yes, Adaptation Related	Yes, Adaptation Related	No	No
S1-Asset Management	Non-Technical	Yes, Adaptation Related	Yes, Adaptation Related	No	No
S1-Risk-Management	Non-Technical	No	No	No	No
S1-Design & Engineering	N/A	N/A	N/A	N/A	N/A
S1- On-site	Non-Technical	No	No	No	No
S1-Organization	N/A	Yes, Adaptation Related	N/A	No	No
S2-CEO	Non-Technical	Yes, Industry	Yes, Adaptation Related	No	No
S2-Asset Management	Non-Technical	Yes, Adaptation Related	Yes, Adaptation Related	No	No
S2-Risk-Management	N/A	N/A	N/A	N/A	N/A
S2-Design & Engineering	N/A	N/A	N/A	N/A	N.A
S2- On-site	Non-Technical	No	No	No	No
S2- Organization	N/A	Yes, Industry	N/A	No	No

Table 6: Summary Results of Organizational Signal Detection

Firm	Designated Processes	Designated Personnel	External Relationships	Market Signal Detection Process
L1	Yes	No	Active Government & Professional	Active Market Analytics
L2	Yes	Yes	Active Government & Professional	Occassional Market Analytics
L3	Yes	No	Active Government & Professional	Active Market Analytics
S1	Yes	No	Active Government & Professional	Occassional Market Analytics
S2	No	No	Semi-Active Professional	Occassional Market Analytics
S3	No	No	Semi-Active Professional	Occassional Market Analytics

Table 7: Summary Factors for Awareness

Firm	Relevance of Beliefs & Perceptions	Learning Capacity	Capacity of Organizational Signal Detection
L1	Moderate	High	High
L2	High	High	Moderate
L3	Low	High	High
S1	High	Moderate	High
S2	Moderate	Low	Low
S3	Low	Low	Low

external relationship management. The balance of the small firms participated indirectly in professional associations and industry groups, but only in a limited capacity. External relationships should be distinguished from the professional industry factor cited in the learning capacity analysis to the extent that external relationships denote an active role in issue and policy development, as opposed to the passive role of the former. In terms of active external sourcing of information, only two large firms had active market intelligence units. While market intelligence is not the same as intelligence with regard to risk, it could be argued that the same processes for advancing market intelligence could be replicated and modified to accommodate long-term signal processing specific to larger environmental risks.

Overall awareness was found to be the highest in larger firms with the two most vulnerable firms having the highest level of awareness. Small firms possessed a relatively low level of awareness which is largely attributable to a lack of resources being allocated to learning and signal detection. However, this analysis assumes an equal weighting between the three categories. One could argue that firms may be more agile by virtue of a more rigid and vertical decision and management processes which might weight beliefs and perceptions of executives higher

than the other two categories. This might be particularly true in smaller firms which are family offices and who have a lower level of awareness but a quicker ability to act. An additional weakness is that signals may be lagging signals and that occurrence of coastal storms in particular may and do occur without any prior warning. However, if one views the risks of climate change and coast flooding as being more incremental in nature, then these observations might bear some validity on the overall awareness and corresponding adaptive capacity of any given firm. Finally, there was very little evidence that greater capacity for awareness had any impact on the decisions which were being undertaken in the advancement of *ex post* strategy development. This disconnect reinforces that the argument for Proposition B in that external intelligence—even if it was being cognitively or organizationally internalized—had little effect on adaptation decisions and strategies. However, this doesn't necessarily exclude the value of the capacity as information changes and the space of decisions expands with the pace of technological and financial advancement.

C. STRATEGY AND SPACE OF DECISIONS MODEL RESULTS

The two final remaining prongs of the adaptive capacity model utilized herein relate explicitly to strategy and the space of decisions and/or options available for adapting to climate change and flooding. In Tables 8 through 13, the entirety of the options for adaptation collected from the interviews is identified in each table, whether selected or not. These options do not represent the totality of options available for adapting CRE firms to the risks associated with climate change and flooding, but only those identified over the course of the case studies. Likewise, the extent to which each option has the potential to yield benefits or losses is not entirely known as it relates to the internal logics of the organization. As such, there may be un-interviewed actors involved in the selection of these strategies who may have an entirely different or more

nuanced reasons for imposing such a strategy from those actors who were subject to interviews. Finally, while the tables reflect a selection of a particular set of strategies by the firms, this static representation does not fully account for the various stages of implementation and deliberation of such strategies. For purpose of selection here, the strategy need only be under advanced consideration for implementation.

As previously discussed, strategies are analyzed by their degree of robustness which is evaluated by the depth and diversity of strategies as a matter of relative flexibility. As graphically referenced in Tables 8 and 13, the two most vulnerable firms have both the most diverse strategies with the most depth, which partially confirms Proposition C. In furtherance of the proposition, Firm S1 and L1, which are the absolutely most vulnerable firms in terms of perceived and actual risk, have the most depth in terms of selected strategies. Depth is qualitatively determined based the diversity of strategies and on the relative impact of those strategies on ongoing and future operations across the portfolio. For instance, modifying acquisitions strategy to exclude properties in high to moderate risk flood zones arguably may impact a much larger component

Table 8: Firm L1 Strategies

Adaptation Measures	No Regret Strategy	Reversible/Flexible	Safety Margins	Soft Strategy	Reduced Decision Horizon	Positive Synergies with Mitigation & Sustainability
Flood Proofing a New Building	(+)		(+)			(++)
Flood Proofing an Old Building	(+)		(+)			(++)
Infrastructure Improvements	(+)		(+)			(++)
Restrictive Land Acquisitions		(-)				
Low-Cost Flood Barriers	(+)	(-)	(+)			
Share Risk				(++)		
Transfer Risk				(+)		
Corporate Risk Management		(++)		(++)		
Lower Quality Assets					(-)	
Evacuation		(-)			(-)	
(++) = Option yields benefits with or without climate change and flooding.						
(+) = Options yields benefits if urban flooding, but not with inundation from climate change.						
(-) = Option yields loss without occurrence of cliamte change or flooding.						

Selected Strategy

Table 9: Firm L2 Strategies

Adaptation Measures	No Regret Strategy	Reversible/Flexible	Safety Margins	Soft Strategy	Reduced Decision Horizon	Positive Synergies with Mitigation & Sustainability
Flood Proofing a New Building	(+)		(+)			(++)
Flood Proofing an Old Building	(+)		(+)			(++)
Infrastructure Improvements	(+)		(+)			(++)
Restrictive Land Acquisitions		(-)				
Low-Cost Flood Barriers	(+)	(-)	(+)			
Share Risk				(++)		
Transfer Risk				(+)		
Corporate Risk Management		(++)		(++)		
Lower Quality Assets					(-)	
Evacuation		(-)			(-)	
(++) = Option yields benefits with or without climate change and flooding.						
(+) = Options yields benefits if urban flooding, but not with inundation from climate change.						
(-) = Option yields loss without occurrence of cliamte change or flooding.						

Selected Strategy

of the portfolio than would retrofitting existing buildings to be flood proof.

A nuance to the results relates to properties in Lower Manhattan wherein interviewees highlighted the idea exploring district level financing capacity to promote two levels of security. The first level would an integrated flood protection system (IFPS) and the second level would be building level flood proofing. This is an unusual departure in short-term thinking given that the IFPS is critical given the projected increase in sea level rise. One perspective may argue that this observed perspective supports the counter argument to Proposition B which is that societal and environmental concerns are not driving strategy development. However, because of the physical constraints and relative vulnerability in Lower Manhattan, retreat and do-nothing strategies have extraordinarily high costs which are part of a terminal calculus that leaves little other options—a phenomenon which supports Proposition A. This harsh reality highlights a larger implication and perspective on climate change strategy and real estate. Because real estate requires land as a part of its various modes of production and land—not just the building—is susceptible to absolute loss, one should conceptually consider

Table 10: Firm L3 Strategies

Adaptation Measures	No Regret Strategy	Reversible/Flexible	Safety Margins	Soft Strategy	Reduced Decision Horizon	Positive Synergies with Mitigation & Sustainability
Flood Proofing a New Building	(+)		(+)			(++)
Flood Proofing an Old Building	(+)		(+)			(++)
Infrastructure Improvements	(+)		(+)			(++)
Restrictive Land Acquisitions		(-)				
Low-Cost Flood Barriers	(+)	(-)	(+)			
Share Risk				(++)		
Transfer Risk				(+)		
Corporate Risk Management		(++)		(++)		
Lower Quality Assets					(-)	
Evacuation		(-)			(-)	
(++) = Option yields benefits with or without climate change and flooding.						
(+) = Options yields benefits if urban flooding, but not with inundation from climate change.						
(-) = Option yields loss without occurrence of cliamte change or flooding.						

Selected Strategy

Table 11: Firm S1 Strategies

Adaptation Measures	No Regret Strategy	Reversible/Flexible	Safety Margins	Soft Strategy	Reduced Decision Horizon	Positive Synergies with Mitigation & Sustainability
Flood Proofing a New Building	(+)		(+)			(++)
Flood Proofing an Old Building	(+)		(+)			(++)
Infrastructure Improvements	(+)		(+)			(++)
Restrictive Land Acquisitions		(-)				
Low-Cost Flood Barriers	(+)	(-)	(+)			
Share Risk				(++)		
Transfer Risk				(+)		
Corporate Risk Management		(++)		(++)		
Lower Quality Assets					(-)	
Evacuation		(-)			(-)	
(++) = Option yields benefits with or without climate change and flooding.						
(+) = Options yields benefits if urban flooding, but not with inundation from climate change.						
(-) = Option yields loss without occurrence of cliamte change or flooding.						

Selected Strategy

the distinction between property and real estate.

An additional grouping of measures, beyond building flood proofing, which are part of a common rational, economic calculus and strategy are the measures relating to site evacuation and the production of lower quality buildings. Both strategies are predicated on absorbing upfront losses in lieu of greater and more significant long-term losses. However, lower building quality is really not applicable but for industrial and some types of commercial and/or retail uses. Given the relative productivity of urban land and highly stringent building codes, there exists little variation or incentive to build lower quality products in anticipation of repeated flooding over the useful life of the asset. To the contrary, evidence collected in the interviews suggests that highly vulnerable firms rather invest more and create an even high quality building, even if that includes the chance that the extended life of the building would extend into the time period where it would be inundated by sea level rise. This phenomenon highlights a tension in the cohesiveness of the propositions in that it partially supports proposition C to the extent that highly vulnerable firms have more robust capacities; but it is counter to Proposition A in that they

Table 12: Firm S2 Strategies

Adaptation Measures	No Regret Strategy	Reversible/Flexible	Safety Margins	Soft Strategy	Reduced Decision Horizon	Positive Synergies with Mitigation & Sustainability
Flood Proofing a New Building	(+)		(+)			(++)
Flood Proofing an Old Building	(+)		(+)			(++)
Infrastructure Improvements	(+)		(+)			(++)
Restrictive Land Acquisitions		(-)				
Low-Cost Flood Barriers	(+)	(-)	(+)			
Share Risk				(++)		
Transfer Risk				(+)		
Corporate Risk Management		(++)		(++)		
Lower Quality Assets					(-)	
Evacuation		(-)			(-)	
(++) = Option yields benefits with or without climate change and flooding.						
(+) = Options yields benefits if urban flooding, but not with inundation from climate change.						
(-) = Option yields loss without occurrence of cliamte change or flooding.						

Selected Strategy

Table 13: Firm S3 Strategies

Adaptation Measures	No Regret Strategy	Reversible/Flexible	Safety Margins	Soft Strategy	Reduced Decision Horizon	Positive Synergies with Mitigation & Sustainability
Flood Proofing a New Building	(+)		(+)			(++)
Flood Proofing an Old Building	(+)		(+)			(++)
Infrastructure Improvements	(+)		(+)			(++)
Restrictive Land Acquisitions		(-)				
Low-Cost Flood Barriers	(+)	(-)	(+)			
Share Risk				(++)		
Transfer Risk				(+)		
Corporate Risk Management		(++)		(++)		
Lower Quality Assets					(-)	
Evacuation		(-)			(-)	
(++) = Option yields benefits with or without climate change and flooding.						
(+) = Options yields benefits if urban flooding, but not with inundation from climate change.						
(-) = Option yields loss without occurrence of cliamte change or flooding.						

Selected Strategy

are thinking over the long-term and not just in terms of immediate financial 'optimization.' However, one could argue that this reinforces the confirmation of Proposition A to the extent that present value will price in the future value of long-term interventions—specifically when continually underwritten over the course of periodic financing cycles.

The next group of strategies relate to transferring and spreading of risk through insurance, partnerships and the application of corporate risk management processes. All firms registered a comprehensive perspective on the transfer of irks through formal insurance products. In partial confirmation of Proposition C, nearly all of the firms referenced the spreading of climate and flood risk to partners, but only the most vulnerable firm cited it is a leading factor for considering partnerships in the future.

The most commonly applied strategy related to flood proofing of buildings. While some of the decisions were based on new government regulations, all of the owners who selected these measures cited that they would have independently undertaken flood proofing regardless of the imposition of the regulations. To this end, most of the regulations served as enabling the process of flood proofing and not requiring it. The limited exceptions for mandatory requirements being for those buildings which contained critical systems such as data centers, operations centers, hospitals and other institutional uses. This regulatory bias in favor of enabling and not enforcing action is consistent with the Proposition B which proposed, in part, that public policy considerations play limited role in influencing the development of strategy as a matter of promoting adaptive capacity. When referenced with the production of SIRR report and associated strategy for NYC, almost all interviewees, except those from Firm S1, stated that the public strategy had little bearing on their operations and/or anticipated costs going forward. The one caveat relates to those properties located in Lower Manhattan. The observations support the confirmation of Proposition B to the extent that external political and regulatory influences played a minor role in firms' decisions to undertake flood related interventions.

D. SUMMARY DISCUSSION

In returning to Proposition A, it can be argued that the results have confirmed that strategies have been developed *ex post*, as all of the firms had given little to no consideration to immediate or long-term implications of flooding prior to Sandy. Thereafter, not a single firm

studied had a wait and see or do nothing strategy. In support of the assertion as to the dominance of financial 'optimization' and with exception to the buildings in Lower Manhattan who might benefit from public district level organization and financing, all other rational and economic logic were primarily oriented and minimize costs. While the timeline towards the incentive to maximize returns for such equilibrium seeking varied, only those most at risk framed the process as a long-term proposition. As it relates to Proposition B, social, environmental and public policy considerations had a marginal stated impact on the various decisions made or identified to be made. The process of seeking continual economic 'optimization' was observed through the recounted deliberations in those organizations which developed processes for addressing and managing the flooding and climate change.

Specific to Proposition B, the institutional influence relating to the power of markets and consumer preferences which had little to no impact on the strategic decisions cited. Structured interview questions inquired as to the state of marketing, post-occupancy surveys, reported market conditions, contract terms and a variety of other considerations which may directly or indirectly reflect consumer preferences. This low level of recorded influence could be due to the relative short amount of time (12 months) over which interviews were collected. Market influences, other than business interruption insurance, may manifest themselves over a longer period of time given the relative long length of commercial tenancies. Therefore, as more leases roll-over, there is a chance that consumer preference may become more transparent.

With exception to those owners with buildings in Lower Manhattan who were giving consideration to a districted scaled public-private IFPS, interviewees were explicit in their acknowledgment that external social and environmental considerations were either not within their domain of consideration or were otherwise

Table 14: Summary Factors for Adaptive Capacity Model

Firm	Awareness	Robust Strategies	Space of Decisions/Options	Overall Capacity
L1	High	High	Low	High
L2	High	Low	Low	Moderate
L3	Moderate	Low	Low	Moderate
S1	High	High	Low	High
S2	Low	Low	Low	Low
S3	Low	Low	Low	Low

minor considerations. Interviewees acknowledged the importance of these considerations in terms of the long-term implications of maintaining market share but they uniformly opined that such considerations were squarely within the responsibility of the public sector, which indirectly reinforces singular financial perspective of Proposition A. Interviewees from firms L1 and all of the small firms argued in one form or the other that it was a matter of limited resources in the face of already burdensome tax liabilities.

Finally, Proposition C was partially confirmed to the extent that firms L1 and S1—who had the most risk exposure and were most aware of their risk—were ultimately evaluated to have the most robust adaptive capacity. In terms of observed strategies, both of these firms exhibited the most depth in terms of diversity and impact of their strategies. Because firms L1 and S1 have relatively similar financial resources to adapt—as a percentage of capitalization relative to their portfolio—and because the existing technology, market demand and political will for mitigating flood and climate risk is relatively constant, the scope of decisions and options is limited and equally applicable across the sample. Overall, compared to other sectors, the space of decisions/options is relatively low in quality and diversity in CRE. This may not be true if the sample were larger and included small scale commercial owners and operators with comparatively fewer resources to limit their options. In the future, this prong of the model may provide more meaning and relevance as an independent measure, but for now the space of decisions is adjudicated to be the same across the model. This was reflected in the lack of novelty across the interviewees when prompted by alternative strategies and/or measures

As Table 14 represents, the ultimate utility of the model was to give equal weighting to the capacity to be aware and the degree of robustness for strategy development and implementation. In the future, additional econometric and quantitative research could be undertaken to retroactively evaluate adaption strategies to identify empirical

justification for internal weighting of factors. One could argue that awareness plays a disproportionate role in the evaluation of capacity based on notions of leadership and the need to identify a risk before one could adapt to it. In this sense, awareness connotes the greatest degree of flexibility. However, there exists no empirical evidence to support the assertion that adaptive capacity should be disproportionately evaluated in favor of measures awareness over the depth of strategies and the spaces of decisions.

VI. CONCLUSION

Evidence collected over this course of the research tend to support the first two propositions in that adaption strategies were *ex post* and driven by a definitive economic calculus made largely irrespective of larger social, environmental and political considerations. While the long-term thinking of the Lower Manhattan owners deviated from these propositions, there is a compelling argument that their motivations could be both short-term and principally financial in their orientation. Finally, the results of this research partially confirm that the most self-aware and vulnerable firms have developed the most robust adaptive capacities as a matter of the implicit flexibility of greater awareness and the depth of strategies. The two most vulnerable firms were deemed to have adaptive capacities which were discernibly advanced compared to the other firms.

While the model utilized herein has proven to be less than complete, specifically as it relates to a comparative weighting of relevance between awareness and strategy, it has the potential to evaluate sector wide adaptive capacities in the future as resource allocation of land becomes more varied if not scare. Research in the future could address some critical unanswered questions regarding the public, private, institutional and organizational orientations which advance adaptation and the degree to which resources will be allocated toward adapting the entirety of sectors operating in the built environment. For now, this research offers the perspective of a range of firms whose managed built environment is the home to hundreds of thousands of residents and workers. The stakes of adaptation are not the mere economic life of business organizations but the continuity of urban systems which have global implications.

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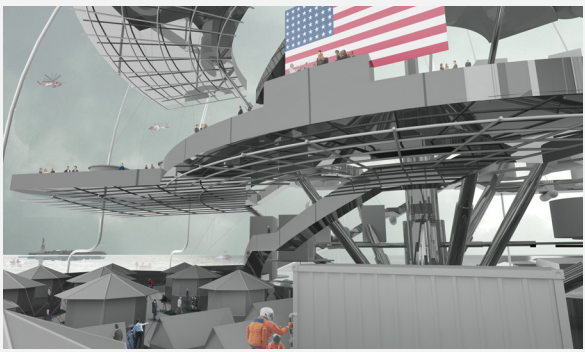
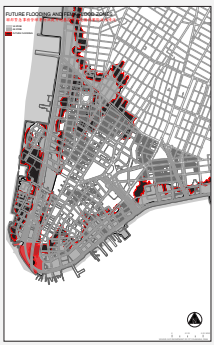
ARCHIGRAM ON THE MARGINS

As this paper highlights, awareness and communications is key to the development of a robust adaptive capacity. As part of the 2013 Hong Kong Biennale, the Center for Urban Real Estate (CURE.) exhibited a body of work which highlighted the unique risk of Lower Manhattan to climate change. Through a fictional narrative based on the interpretation of Peter Cook's Blowout Village (1966), the exhibition highlighted the relevance of temporary architecture in the face of climate change and natural disasters. Cook's work was repurposed as a post-disaster structure for the housing of critical urban institutions. The work was transformed into an emergency relief product with variable program options ranging from a temporary hospital to a senior housing facility. In the exhibition, the product was sited in Lower Manhattan where it would ostensibly serve as the Emergency Financial Command and Control Center for the NYSE and NASDAQ. By maintaining a fictional continuity of operations for the financial services sector, the product redefined the expansive notions of urban resilience and adaptation that go beyond mere physical flood protection. Representation of the product also highlighted the financial implications of a radical form of architecture which is simultaneously feasible and impractical. With a defined sense of insularity to the urban environment, the product underscored the limitations of the contemporary range of responsive ecological design solutions which have historically given little consideration to the continuity of urban systems. As represented in the excerpts below, the exhibition highlighted the critical need for public awareness of a larger urban vulnerability to climate change which has the potential to be mitigated through innovative design and development.

A VULNERABLE CITY

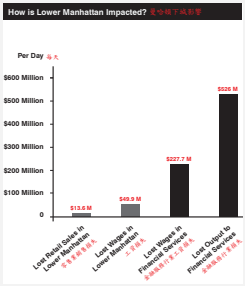
2013 BI-CITY BIENNALE OF URBANISM \ ARCHITECTURE HONG KONG
2013 港深城市\建築雙城雙年展



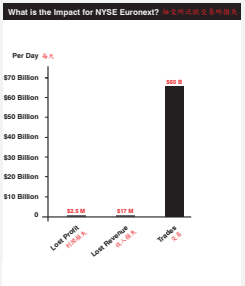


A VULNERABLE INDUSTRY

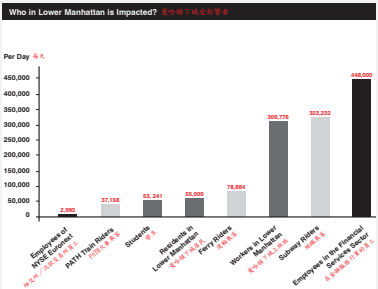
How is Lower Manhattan Impacted?



What is the Impact for NYSE Euronext?



Who in Lower Manhattan is Impacted?



CURE. The Center for Urban Real Estate GSAPP Columbia University

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Jesse M. Keenan is the Research Director for the Center for Urban Real Estate (CURE.) and Adjunct Professor of Real Estate Development at the Graduate School of Architecture, Planning and Preservation at Columbia University. Keenan has previously advised on matters concerning real estate and housing for agencies of the U.S. Government, including Fannie Mae and the Federal Deposit Insurance Corporation, Fortune 500 Companies, not-for-profit community enterprises and international development NGOs. Keenan has previously held various teaching, research and visiting appointments at the University of Miami School of Law, Harvard University's Graduate School of Design and Joint Center for Housing Studies, the University of Amsterdam and The Bauhaus Academy in Dessau, Germany. Keenan previously served as is a member of the U.S. Department of Homeland Security's Regional Disaster Sheltering and Housing Recovery Planning Team and as a member of Mayor Bloomberg's NYC Task Force for Building Resiliency. Keenan currently leads CURE.'s joint project with various agencies of the Netherlands for advancing climate adaptive development research and serves on the Climate Change Working Group for the 4th Regional Plan for the tri-state New York metropolitan area under the auspices of the Regional Plan Association. In a professional capacity, Keenan advised the Rebuild By Design competition on matters relating to financing and insurance and is presently working on the design and development of NYC's Seaport City.

Keenan's work bridging the art and science of the built environment includes exhibitions at the Museum of Modern Art, Hong Kong Biennale and the Southern California Institute of Architecture. Keenan has completed regional planning research in Brazil in collaboration with UN-Habitat; housing research in NYC for the Carnegie Corporation of New York; urban technology research sponsored by Google, CISCO and Airbnb; and, urban systems research in NYC for the Audi Urban Future Initiative. Keenan has had works published by the Wharton Real Estate Review, the Cornell Real Estate Review, Journal of Affordable Housing & Community Development Law, Harvard University, the American Bar Association, GSAPP Books, MoMA.org, John Wiley & Sons and has been cited as a housing and real estate authority by national and international media, including on-air on PBS's History Detectives, Bloomberg TV and CNBC. Keenan serves on the Advisory Board of the Mori Foundation's Global City Power Index and was previously selected in 2012 as a 'Thought Leader' by the Journal of International Affairs. Keenan formerly served as a policy advisor for numerous policy-makers, including the Honorable Bill Richardson. Keenan formerly served as Managing Editor to one of Silicon Valley's first online housing and mortgage data service providers. Presently, Keenan serves as Of Counsel to the law firm Hinshaw & Culbertson, LLP. Keenan is a Fellow of the Forum + Institute for Urban Design and was previously a Pension Real Estate Association (PREA) Scholar.

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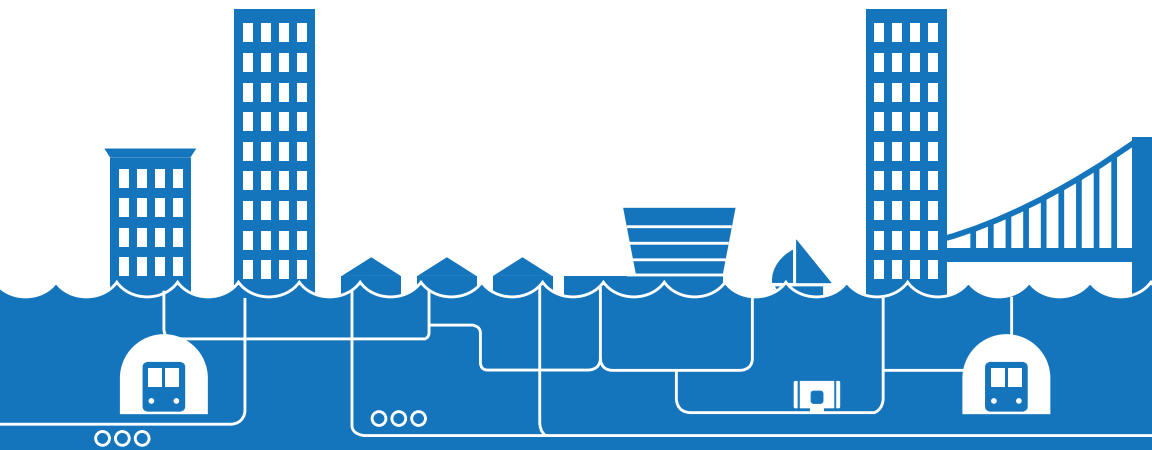

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