Adaptive capacity of commercial real estate firms in New York City to urban flooding

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ABSTRACT

This article examines the adaptive capacities of real estate firms in New York City in light of the increased risks of urban flooding. This exploratory research attempts to shed light on how and why firms of varying risk profiles are strategically adapting to these risks – if at all. Through the lens of a qualitative multi-criteria adaptive capacity framework, the results of six case studies are analyzed to identify what influences are shaping the actions and strategies of firms. The article examines the propositions that: (A) firms with observable strategies have undertaken ex post strategies which are principally driven by 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 influences; 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 urban flooding. While the evidence largely supports the propositions, the results of this research can help shape the development of intelligence and strategic units within firms as they develop a capacity to adapt to ever changing conditions.

Key words | adaptive capacity, climate adaptation, corporate strategies, floods, private sector, real estate

INTRODUCTION

On 29 October 2012, Hurricane Sandy’s (Sandy) storm surge inundated coastal areas of New York City (NYC) causing $19 billion dollars in economic losses and killing 43 people (Mayor’s Office of the City of New York 2013, p. 13). More than 12,000 structures – accounting for more than 70,000 residential units – were flooded and over 900 structures were destroyed (Federal Emergency Management Agency (FEMA) 2013). A preliminary survey conducted as part of the research for this article identified an estimated $950 million dollars of repairs and associated capital improvements in private commercial real (CR) estate alone. A majority of these costs and expenses have been attributable to dry flood proofing and the placement of critical building systems on higher floors.

Sea level rise in NYC has been projected to be as high as 1 m in the next 50 years and almost 2.1 m in the next 100 years (New York City Panel on Climate Change (NPCC) 2013). This additional sea level rise would mean that a $19 billion dollar loss in 2012 could be a $35 billion dollar (present value, PV) loss in 50 years and a $90 billion dollar (PV) loss in 100 years (Mayor’s Office of the City of New York 2013). While hurricanes have been the driver of re-conceptualizing the risks of urban flooding, the risk from both inundation from sea level rise and more regular flash flooding events are increasingly the focus of concern. Preliminary research estimates that the aggregate CR estate losses in just the iconic Lower Manhattan business district alone could exceed $15 billion dollars (PV) if left unmitigated from sea level rise in the years leading to the year 2100.

Given the nature of the investment at risk, there exists an active debate as to the division of responsibility for mitigating and adapting to these risks by and between the public and private sectors. As NYC expands 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 recovery of households and residential real estate, very little is known about the activities and strategies of the CR estate sector which is critical to the broader notions of urban adaptation.

Through a meta-analysis of case studies, this exploratory and qualitative research seeks to evaluate the adaptive capacity of six CR estate firms in NYC. The relevance of this research is that it begins to frame a larger unexplored capacity of the private sector to adapt to the long-term flooding impacts associated with climate change given the increasingly relevant argument that the public sector is fiscally and practically incapable of bearing the burden of mitigating and adapting to these risks in isolation. By extension, a failure of CR firms to timely and robustly adapt could lead to a potential disruption of the economic and social structures which are physically reliant on the assets of the CR sector.

These structural vulnerabilities highlight the intent of this work to advance a larger dialog as to the conceptualization of the nature of vulnerability. In de Graaf et al. (2007), the authors position a vulnerability framework defined by threshold, coping, recovery and adaptive capacities, with adaptation comprising a capacity defined by the intent to manage the future implications of the unknown through a variety of techniques ranging from technological experimentation to strategic management (pp. 167–168). This article focuses on the strategic implications of adaptive capacity within the private sector. Therefore, only after the physical vulnerabilities are contextualized with the aforementioned capacities, including adaptive capacity, can the true nature of urban vulnerability to climate change be understood.

**PROPOSITIONS**

Despite the magnitude and relevance of the vulnerability, scholarship has largely neglected to address questions of if, how, when and why the CR sector is adapting to the risks associated with climate change, notably urban flooding. Adaptation can be thought of as cyclical process of maintaining points of stability in the operations of the status quo through, if necessary, the transformation from the operations of one domain to another. 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 six CR firms operating in NYC. These case studies were undertaken to evaluate three propositions: (A) Real estate firms with observable climate adaptive strategies have undertaken ex post adaptation strategies and interventions which are primarily driven by known and immediate risks to the firms’ financial bottom lines; (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 regulatory, social or 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.

Given the historic reputation of the CR sector to slowly adopt 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, regulators or from any other external influences. 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 (Hallegrate 2009).

The fundamental intent of this research is to question the existence or extent to which CR firm adaptation is reactive (ex post) or proactive (ex ante). 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; Mearns et al. 1997; Smithers & Blay-Palmer 2001; Yang et al. 2007), tourism (Elasser & Burki 2002; Gossling & Hall 2006; Hennessy et al. 2008; Hoffman et al. 2009), water management (Hurd et al. 1997; Arnell 1999; Subak 2000; Berkhout et al. 2004; Horbulyk 2005; Arnell & Delaney 2006) and energy (Huang et al. 2008; Bansal & Gao 2008; Fuss et al. 2012) dominating the literature with over 54 published cases (Nitkin et al. 2009). With exception to Hertin et al. (2003) and specific to the CR sector, only building and construction subsectors have been explored within the built environment (Graves & Phillipson 2002; 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. (2003) highlighted a central debate in the scholarship between one camp that views adaptation of business organizations as a process of economic and financial optimization (Mendelsohn et al. 1994; Mendelsohn 2000; Haites 2011) 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 & Risbey 2000). While Propositions (A) and (B) do not literally opine as to a pure application of mathematical optimization, in that it acknowledges that management decisions 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. On 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 herein. While these propositions are somewhat self-evident under the assumption that such firms are rational maximizers under a classical economic order of rational institutional change, their strategic development and execution has largely been unexplored until now.

**ADAPTIVE CAPACITY FRAMEWORK**

The framework 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 three prong set of factors for referencing capacity: awareness, strategy and the spaces of decisions, as more particularly illustrated in Figure 1. The conceptual
connective tissues of this relationship are dependent on the internal constraints of organization and vulnerability, resource capacity and the external institutional constraints of markets and regulators (Fankhauser et al. 1999; Arnell & Delaney 2006). However, this framework is not a model and should not be thought of as being parameterized with discrete inputs and outputs. Therefore, no weighting between the prongs of analysis is utilized and should not be inferred. As will be discussed, this research concludes that the capacity of the subject firms was largely driven by awareness given the relatively equal space of decisions and range of strategic options.

**Awareness**

Awareness can be organized by a sub-framework of beliefs and perceptions, learning capacities and processes for detecting signals of change for both individuals and organizations. As Fankhauser et al. (1999) 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’ (p. 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’ (p. 72).

Given the long useful life 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 NYC: (i) where real estate asset valuation is grossly weighted in favor of building values – as determined by income capitalization – over land values; and (ii) where capitalization rates – which represent the underlying risk premium – are presently at global historic lows. Therefore, if the quality of the building is compromised by unmitigated flooding then rents will inevitably reflect this risk which will be amplified in terms of lower asset value two-fold by a higher cap rate. Conversely, in the event of a delay of capital expenses for purposes of flood mitigation, rents may not have parity with an additional capital investment as it is simply maintaining the same minimal flood free functions of an alternative choice.

Citing Graetz et al. (1997) and Risbey et al. (1999), Kandlikar & Risbey (2000) argue in organizational terms that adaptation is an internally generated response system which is made of: (i) signal detection; (ii) evaluation; (iii) decision and response; and (iv) feedback. The authors argue that ‘[d]ecision-makers with an operational focus on different temporal and spatial scales will tend to define signal[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’ (p. 532). 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 framework utilized herein, Kandlikar and Risbey’s perspective of signal detection is expanded to include both an individual’s belief and his/her capacity to learn. Likewise, signal detection in this framework 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 framework attempts to account for a learning capacity of both individuals and the organization. Hertin et al. (2003) further classify signals as having 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 & Shackley (2007) expand on the notion of direct and indirect experience as a matter of individual belief. 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 1. 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 framework wherein interview questions attempted to distinguish between beliefs and perceptions.

While understanding beliefs and perceptions are important, these elements change with time and experience and, as such, 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 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.

### 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 & Busch 2015). However, this article seeks to measure the 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 following 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 uncertainty…It reflects the sequential nature of decision-making by placing less emphasis on the plan, but more on the continuous process of planning’ (Rosenhead et al. 1972, p. 419). To identify and qualitatively classify degrees of robustness, this framework builds off an organizational framework developed by Hallegatte (2009) which identifies an economic range of strategies, as more particularly identified in **Table 2**.

The final prong of the framework is the space of decisions from which an organization can adapt in technical, commercial, financial and informational terms (Hertin et al. 2005). Those measures in **Table 2** 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

### Table 1 | Measured factors of awareness

<table>
<thead>
<tr>
<th>Organizational signal detection</th>
<th>Individual beliefs and perceptions</th>
<th>Learning capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Designated processes</td>
<td>Designated personnel</td>
<td>Education background</td>
</tr>
<tr>
<td>Designated personnel</td>
<td>Management philosophy</td>
<td>Professional membership</td>
</tr>
<tr>
<td>External relationships</td>
<td>Causality of flooding to climate change</td>
<td>Literature reviewed</td>
</tr>
<tr>
<td>Market signal detection process</td>
<td>Perceived vulnerability</td>
<td>Training</td>
</tr>
<tr>
<td>Physical detection process</td>
<td>Timing of flood risk observations</td>
<td>External review</td>
</tr>
</tbody>
</table>

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argued that a true monetization of measures based on probability and the nature of occurrence is still too speculative, particularly as it relates to the time value of money. However, the idea 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 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 for the novelty of climate change related stimuli.

In returning to the Hallegatte’s strategies (2009), as modified in Table 2, 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 strategic classification is the ‘No-Regret’ strategy wherein actions 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 Hallegatte 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 it 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 (Botzen & van den Bergh 2008). ‘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, Hallegatte (2009) 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 flooding and/or 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 2 are not exhaustive, they do cover a wide range of potential options. It is also

Table 2 Identifying and classifying strategies for urban flooding and climate change

<table>
<thead>
<tr>
<th>Adaptation measures</th>
<th>No regret strategy (++)</th>
<th>Reversible/ flexible (+)</th>
<th>Safety margins (+)</th>
<th>Soft strategy (++)</th>
<th>Reduced decision horizon (+)</th>
<th>Positive synergies with mitigation and sustainability (++)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flood proofing an old building</td>
<td>(+)</td>
<td></td>
<td>(+)</td>
<td></td>
<td></td>
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<tr>
<td>Infrastructure improvements</td>
<td>(+)</td>
<td></td>
<td>(+)</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Restrictive land acquisitions</td>
<td></td>
<td>(-)</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Low-cost flood barriers</td>
<td>(+)</td>
<td>(-)</td>
<td>(+)</td>
<td></td>
<td></td>
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<tr>
<td>Share risk</td>
<td></td>
<td></td>
<td>(+)</td>
<td></td>
<td></td>
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<tr>
<td>Transfer risk</td>
<td></td>
<td></td>
<td></td>
<td>(+)</td>
<td></td>
<td></td>
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<tr>
<td>Corporate risk management</td>
<td></td>
<td></td>
<td></td>
<td>(+)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lower-quality assets</td>
<td></td>
<td></td>
<td></td>
<td>(+)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Evacuation</td>
<td></td>
<td></td>
<td></td>
<td>(-)</td>
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</table>

(+++) = Option yields benefits with or without climate change and flooding.
(+ +) = Option yields benefits if urban flooding, but not with inundation from climate change.
(−) = Option yields loss without occurrence of climate change or flooding.
possible for a measure to fall under different types of strategies with different cost-benefit calculations depending on the intent and capitalization 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 climate mitigation and sustainability in terms of promoting operational efficiency. For instance, flood proofing ground level spaces may result in more effective sealing of windows and doors which could promote efficiencies in heating and cooling the space. Likewise, sharing, transferring and managing risk all are soft strategies that offer the opportunity of yielding benefits in the face of a variety of non-flooding risks. In this sense, it demonstrates that the private organizations ‘mainstream’ their economic logics in the same way the public sector does (Uittenbroek et al. 2013). 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. This potential adaptive intervention has been reported to be taking place by third-party firms (i.e., not a member of the sample evaluated herein) in high risk areas of New Jersey. The reported programs subject to lower-quality construction consist of retail and industrial uses with limited absolute or remaining useful lives of the structures. Each of these strategies, including evacuation, have the potential to measure an overall level of strategic robustness in either individual or groups of strategies.

**RESEARCH DESIGN AND METHODOLOGY**

The research design is based on a qualitative meta-analysis of six case studies of individual CR firms in NYC (Yin 2003; Dul & Hak 2008; Ford et al. 2010). The diversity of the cases highlights an intention to create an understanding of the CR sector with similar market and institutional based rules – although the firms themselves vary by size and relative vulnerability within CR. 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. It was not known at the start of this research whether a division between large and small firms would ultimately be relevant at all. Half of the firms are characterized as large in terms of both organizational complexity and capitalization. The other half are comparatively smaller on both accounts and are considered ‘family offices’ (Shachtman 2001). However, even the smaller firms are much larger than even the largest firms in most American cities. Together the firms represent an estimated 13 million square meters in their portfolios.

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. However, it was anticipated that the size of the firms would not be independently relevant or salient, 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 statistical representative nature of the sample from the cross-section of the industry at large within the metropolitan area.

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 this research. 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 in order to potentially 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. At risk buildings
are classified as either being directly: (i) at risk from physical flooding based by either: (a) projected sea level rise by the year 2100, as determined by the NPCC; or (b) on a 500 year per occurrence flooding event based on existing national flood insurance program maps; or the buildings are (ii) at risk from flooding which is close enough in proximity so as to negatively impact urban services and utilities. A low level of risk is between 0 and 20% of the portfolio; a moderate level is between 20 and 49%; and a high level is 50% or greater 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 non-controlled real estate assets or non-real estate assets. However, this simplified metric (Table 3) was a useful and a practical way for managers to reference immediate and known risks over the course of the interviews.

Aside from the primary method of undertaking interviews which provided the principal mode of data collection, independent data collection for each firm was collected from three sources. It should be noted that this data has not been published in this article to maintain the confidentiality of the participating firms. 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 standard building assessment for flooding utilized by the American Society for Civil Engineers. The survey was amended to cover building systems damage, flood response, drying process, health and safety issues, and flood resistant design and 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 an evaluation of the propositions, the data would later partially validate that the identity and selection of individuals chosen for interviews was appropriate given the nature of the preliminary questions posed to the firms. Likewise, the survey data, together with independently collected data, helped triangulate data collected from the interviews. For instance, this triangulation was important in confirming the utilization of responsive post-flooding actions and strategies which triangulated between the survey, the interviews and the public records (e.g., building permits).

To provide additional context to the data collected in the surveys, vulnerable properties were mapped with geographic information systems to evaluate static 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 triangulation was formally between data produced by the researcher’s independent analysis, and the data collected from individuals both internal and external to the subject firms. As such, the data collection provided the initial foundation for advancing the preparation of the primary 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 following Sandy, while most firms were in their middle of their initial recovery 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 and engineering. Interviews were conducted over the course of approximately 60 minutes. 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.

<table>
<thead>
<tr>
<th>Firm characteristics</th>
<th>Large firms</th>
<th>Small firms</th>
<th>Portfolio at-risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>L1 High</td>
<td>S1 High</td>
<td></td>
<td></td>
</tr>
<tr>
<td>L2 Low</td>
<td>S2 Low</td>
<td></td>
<td></td>
</tr>
<tr>
<td>L3 Medium</td>
<td>S3 Medium</td>
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The second phase of interviews benefited from data collection from the first phase and from the independent triangulation of external documentation cited 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 course of almost an entire year. Finally, as referenced in the Appendix Tables and Tables 4–6, the results of the interviews were interpreted and classified by the investigator for the convenience of interpreting large amounts of data collected from the interviews (available online at: http://www.iwaponline.com/jwc/006/097.pdf). Likewise, the aforementioned framework was developed prior to the undertaking of the interviews and after the independent data collection as a means to understand and interpret data in each case.

### RESULTS AND DISCUSSION

A total of 25 individuals were interviewed across the six subject 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 framework 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 each respective component. Although, the results suggest that awareness has the greatest impact on capacity, as the other two prongs are relatively equal across the sample firms. As such, the framework is utilized to provide a qualitative multi-criteria means for evaluating comparative firm capacities versus individual firm capacities. 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.

#### Awareness results

Specific to the Awareness prong, the measured perceptions and beliefs of individual actors provided a number of insightful observed phenomenon (see Appendix Table 1, http://www.iwaponline.com/jwc/006/097.pdf). First, the perceived risk to vulnerability of flooding among executives was largely consistent with the initial classifications of portfolio risk undertaken as part of this research (see Table 3). Second, the perception of the executive relating to both vulnerability and flood risk was largely consistent with both the asset
and risk managers. Smaller firms were, across the board, perceptively more vulnerable to both climate change and flooding. Interviewees cited their assessed limited resources of the firm and, in one case, the relative lack of geographical diversity in their portfolio. Firm S1, which had the highest independent measure of risk, showed remarkable consistency across actors for a perceived level of risk. 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 a long-term risk which reflected a larger structural risk to the operations of the firm. In favor of an argument supporting Proposition (A), only actors within Firm L2, including the executives, registered any operational awareness to a flooding risk prior to the occurrence of Sandy – hence an argument in favor of ex post adaptation.

Specific to individual and organizational learning capacities, the larger firms demonstrated a much greater capacity to learn and to reflect on internal and externally sourced information (see Appendix Table 2, http://www.iwaponline.com/jwc/006/097.pdf). Large firms were observed to allocate more resources to allowing interested employees to participate in educating themselves about flooding and climate change risks, through the participation in resiliency task forces and other external professional engagements, for example. 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 arguably possessed the greatest capacity to learn. This is consistent with an argument in favor 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, there is a demonstrated disparity between large and small firms in terms of resource allocation (Table 4). 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 in the aforementioned firms included designated formal or informal working groups made up of personnel from a variety of departments. The working groups were exclusively dedicated to specific projects and no working group was dedicated to a portfolio level analysis. The two most vulnerable firms formally incorporated risk managers and engineers into their working groups. It was independently verified that several changes to ongoing projects were undertaken to accommodate a revised understanding of risk, including elevation and grade changes and the incorporation of autonomous power generation systems.

Overall awareness was found to be the highest in the two most vulnerable firms. Small firms possessed a relatively low level of awareness which was attributable in the interviews to a lack of resources being allocated to learning and signal detection. In addition, a greater capacity for internal intelligence was far more significant in driving strategic development than external intelligence. There was no evidence that greater capacity for external intelligence gathering had any impact on the decisions which were being undertaken in the advancement of ex post strategy development. This disconnect reinforces 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 (Table 5).

Structured interview questions inquired as to the awareness of individuals regarding 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 in buildings which may be perceived to be at risk. Interviewees uniformly cited no to little influence, with the exception of business continuity insurance premiums dictating some tenant selection choices. 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 relatively long length of commercial tenancies. Therefore,
as more leases roll over, there is a chance that consumer preference may become more transparent.

**Strategy and space of decisions results**

The two final remaining prongs of the adaptive capacity framework utilized herein relate explicitly to strategy and the space of decisions and/or options available for adapting to risk from urban flooding and climate change. Appendix Table 3 (at http://www.iwaponline.com/jwc/006/097.pdf) contains the entirety of the options for adaptation collected from the interviews. 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 some logics may have been developed beyond the scope of the interviewees. 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 acknowledged and approved for implementation but may not yet have been fully implemented.

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 referenced in Appendix Table 3 (at http://www.iwaponline.com/jwc/006/097.pdf), the two most vulnerable firms have the most robust strategies, which is in support of Proposition (C). Depth is qualitatively determined based on the diversity of strategies and on the relative impact of those strategies on ongoing and future operations across the portfolio. For example, modifying acquisition strategies to exclude properties in high to moderate risk flood zones arguably may impact a much larger component of the portfolio than would retrofitting existing buildings to be flood proof if the firm is executing a larger growth strategy of ground-up development, as was the case in Firms L1, L2, and S1. Only S1 availed itself of all of the identified strategic elements and was the only firm to consider evacuation. Specifically, S1 planned to dispose of property which it determined to be highly vulnerable to flooding over the long-term. This strategy is arguably counter to Proposition (A) in that it could be interpreted to be an *ex ante* strategy prior to the occurrence of the risk, in this case future devastating floods and/or sea level rise.

An additional nuance to the results relates to properties in Lower Manhattan wherein interviewees from Firm L1 and S3 highlighted the idea of advancing district level financing to promote two levels of security. The first level would be an integrated flood protection system (IFPS) and the second level would be building-scaled flood proofing. This is an unusual departure in short-term thinking given that the IFPS has been argued to be critical given the projected probabilistic increase in sea level rise. One may argue that this strategy supports the counter argument to Proposition (B) which is that external societal and environmental concerns are not driving strategic 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 few other options – a phenomenon which supports Proposition (A).

In Lower Manhattan, retreat and do-nothing strategies have extraordinarily high costs which are part of a terminal calculus that leaves few other options – a phenomenon which supports Proposition (A). This 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 additionally susceptible to total loss through inundation, one should conceptually consider the distinction between property and real estate. This was precisely and explicitly the logic of Firms L1 and S3, they were concerned with the ability of the land to support future buildings.

An additional grouping of measures, beyond building flood proofing, which are part of a common economic calculus and strategy are the measures relating to site evacuation and the production of lower-quality buildings. As cited by firm S1, 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, as cited by S1’s development team. 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. On the contrary, evidence collected in the interviews suggests that most vulnerable firms, with the exception of S1, rather invest more in technology and develop higher quality buildings, even if that includes the chance that the useful life of the building would extend into the time period where it could 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 firms are thinking over the
long-term and not just in terms of immediate financial
‘optimization’. However, one could argue that this
reinforces the argument in favor of Proposition (A) to the
extent that present value calculations will price in the
future value of long-term interventions – specifically when
continually underwritten by appraisers and lenders over
the course of periodic financing cycles (i.e., an argument
against Proposition (B)).

The next group of strategies relate to transferring and
spreading of risk through insurance, partnerships and the
application of corporate risk management processes.
While households and small business may avail themselves
to federally subsidized flood insurance, there are no such
policies available to the CR sector – a critique commonly
cited by interviewees. All firms registered a comprehensive
perspective on the transfer of risks through formal insurance
products, with only the two most vulnerable firms partially
self-insuring. In partial support of Proposition (C), nearly
all of the firms referenced the spreading of climate and
flood risk to partners, but only the most vulnerable firms
(i.e., S1 and L1) cited it as 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 (i.e., L2 and S1), all
of the firms who selected these measures cited that they
would have independently undertaken flood proofing
regardless of the imposition of the regulations. To this end,
asset managers within all of the firms observed that most
of the regulations served as enabling the process of flood
proofing and not requiring it. As cited by L1 and L2, the
only mandatory requirements related to those buildings
which contained critical systems such as data centers, oper-
ations centers, hospitals and other institutional uses. This
regulatory bias in favor of enabling and not enforcing
action is consistent with Proposition (B) which implicitly
propositioned, in part, that public policy considerations
have played a limited role in influencing the development
of strategy. When referenced with the production of the
special initiative for rebuilding and resiliency (SIRR;
Mayor’s Office of the City of New York 2013) report and
associated public 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 pre-
viously cited properties located in Lower Manhattan.
These observations support Proposition (B) to the extent
that external political and regulatory influences have
played a minor role in firms’ decisions to undertake flood-
related interventions (Table 6).

CONCLUSIONS

The results of this research suggest a measure of complexity to
the often misperceived short-term financial biases of corpor-
ate governance. Likewise, this research has demonstrated
a range and depth of strategies within CR firms which
suggest an increasingly engaged sector – albeit such
engagement is being driven by its own vulnerabilities. The
results have supported Proposition (A) that strategies
have been developed ex post, as all of the firms had given
little consideration to the implications of flooding prior
to Sandy. Thereafter, not a single firm studied had a wait
and see or do nothing strategy, even among the least
vulnerable firms. However, with exception to the firms
with buildings in Lower Manhattan who might benefit from
a publicly provisioned IFPS and the single firm which
advanced strategic evacuation, all other reasoning and econ-
omic logics were primarily oriented toward maximizing
returns and minimizing costs on a project-by-project basis.
While the exact timeline for such equilibrium seeking
varied, only those most at-risk framed their strategies over
the long term.

Social, environmental and public policy considerations
had a marginal stated impact on the various strategies eval-
uated, as was consistent with Proposition (B). The
interviews suggested that the external influences relating to
the anticipated re-pricing of risk by the markets and chang-
ing consumer preferences had little to no impact on their
firms’ current strategies. Although, many interviewees did
acknowledge that the imputed internalization of risk on
valuation and rents driven by external phenomena (e.g.,
increased business continuity risks, insurance premiums,
etc.) was likely inevitable. Interviewees were explicit in
their acknowledgment that external social, environmental
and political considerations were either not within their domain of consideration or were otherwise minor considerations. Disaster recovery and resiliency plans and programs were all cited as largely inconsequential to their current and past actions and strategies. Interviewees acknowledged the importance of these considerations in terms of the long-term implications as it relates to matters of policy of maintaining the stability of markets but they uniformly opined that such interventions were squarely within the responsibility of the public sector. 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 supported 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 capacities. In terms of observed strategies, both of these firms exhibited the most depth in terms of diversity and anticipated impact of their strategies. Overall, compared to other sectors, the space of decisions/options is relatively limited in CR when compared with other sectors, such as agriculture. However, in the future, this prong of the framework may provide more meaning and relevance as an independent measure; but, for now, the space of decisions was observed to be virtually the same across all firms, although only the most vulnerable firms availed themselves at least in part to all of the available strategies.

In the future, additional econometric and management research could be undertaken to retroactively evaluate adaptation strategies to identify empirical justification for internal weighting of the framework factors. The results herein suggest that awareness plays a disproportionate role in the evaluation of capacity. However, future empirical research could help evaluate not only the validity of this tentative conclusion but could explain the organizational processes which may advance or impair modes of awareness in the translation of strategic behavior. Likewise, future and ongoing research could evaluate the utility of financial methodologies behind various multi-objective strategic investments so as to understand if the division between various strategic classifications (e.g., no-regret, reversible/flexible, etc.) is meaningful given various historical occurrences and non-occurrences of flooding and inundation events. Finally, future research could evaluate the extent to which hard strategies relating to technological or engineered physical interventions were superior in a cost–benefit analysis to soft strategies relating to risk transfer, evacuation, alternative acquisitions, and so on. The outcomes of this research could lead to the normative development of protocols and methods for optimizing CR portfolios and organizational structures in the advancement of realized adaptation. Finally, future research could address some critical unanswered questions regarding the limited capacity of individual action by private firms and the extent to which collective interventions may be necessary in the advancement of adaptation across a variety of private and public sector actors operating in the built environment.

The results of this research could be applied by firms to proactively develop intelligence processes and strategic units which many advance the robustness of their adaptive capacities. While the framework utilized herein has proven to be less than complete, specifically as it relates to the future development of a model which could provide comparative weighting between awareness and the optionality of strategic action, it has the potential to evaluate sector-wide adaptive capacities in the future, as resource allocations for developable land and for the implementation of risk mitigating public infrastructure becomes more varied if not scarce. Likewise, the results demonstrate that the assumptions and theories concerning financial equilibrium seeking tendencies of private firms are not as unidimensional as once positioned in light of a complex set of logics which are dependent, in part, on the nature of their own vulnerabilities that are defined, in part, by their own adaptive capacities. For now, this research offers the perspective of a range of firms whose existing portfolios are critical to the economic operations of NYC. As such, the stakes for adaptation are not merely the economic viability of the subject business organizations but the continuity of urban systems which have global implications.

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