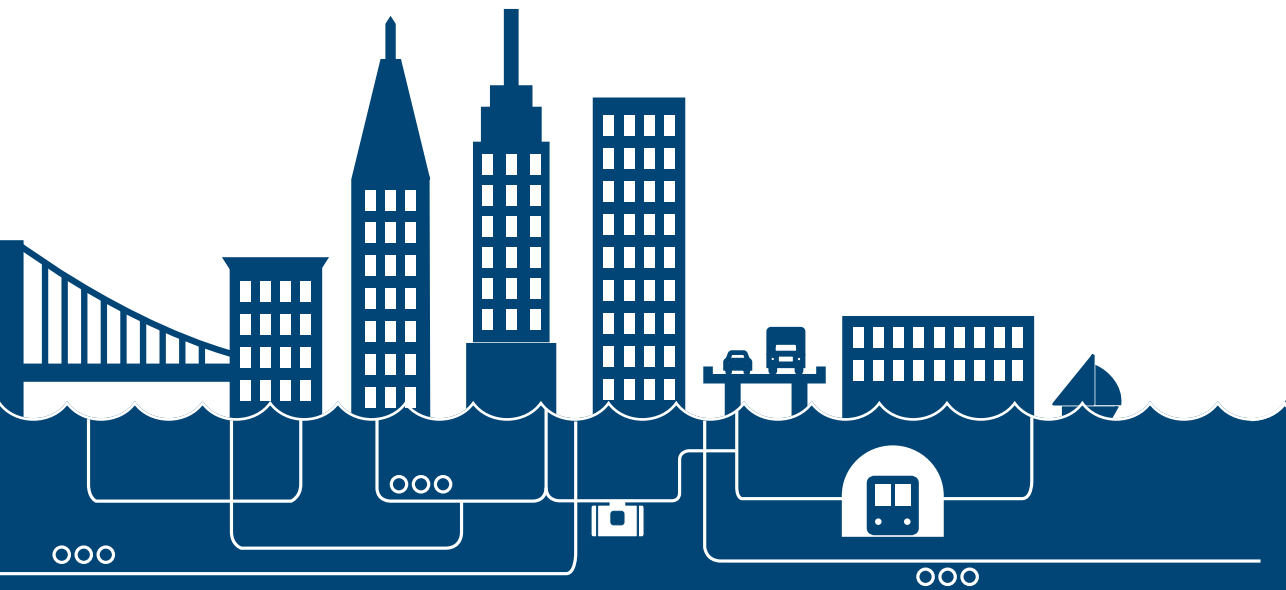


# **Understanding Adaptive Capacity in Real Estate and the Built Environment: Climate Change and Extreme Weather in New York City**



**Jesse Michael Keenan**



The research presented in this dissertation was conducted at Delft University of Technology and Columbia University.

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**Understanding Adaptive Capacity  
in Real Estate and the Built Environment:  
Climate Change and Extreme Weather  
in New York City**

**Jesse Michael Keenan**

Delft University of Technology,  
Faculty of Architecture and the Built Environment,  
Department of Management in the Built Environment,  
Chair of Real Estate Management



# **Understanding Adaptive Capacity in Real Estate and the Built Environment: Climate Change and Extreme Weather in New York City**

PROEFSCHRIFT

ter verkrijging van de graad van doctor  
aan de Technische Universiteit Delft;  
op gezag van de Rector Magnificus prof. ir. K.Ch.A.M. Luyben;  
voorzitter van het College voor Promoties,  
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Jesse Michael KEENAN

Bachelors of Arts, University of Georgia  
Masters of Science, Columbia University  
Master of Law, University of Miami  
Doctorate of Law, Georgia State University

geboren te  
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Dit proefschrift is goedgekeurd door de promotoren:

Promotor: Prof. ir. H. de Jonge  
Prof. dr. L.B. Janssen-Jansen

Copromotor: Dr. ir. T. A. Daamen

Samenstelling promotiecommissie:

---

Prof. ir. H. de Jonge, Technische Universiteit Delft,  
Prof. dr. L.B. Janssen-Jansen, Wageningen Universiteit  
Dr. ir. T. A. Daamen, Technische Universiteit Delft

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Prof. dr. E. van der Krabben, Radboud Universiteit Nijmegen  
Prof. mr. M.F.M.W. van Rijswijk, Universiteit Utrecht  
Dr. W.J.W. Botzen, Vrije Universiteit Amsterdam

Prof. dr. ir. J.W.F. Wamelink, Technische Universiteit Delft, reservelid

Let them be educated, skillful with the pencil, instructed in geometry, know much of history, have followed the philosophies with attention, understand music, have some knowledge of medicine, know the opinions of jurists, and acquainted with the theory of the heavens.

–Vitruvius





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In my lifetime, I have witnessed both extreme events and gradual changes in weather and climate that I can attribute in some measure to climate change. However, my awareness to climate change some twenty-five years ago can be attributed to my father, Michael Chazal Keenan. As a chemist, micro-biologist and ornithologist, he was keenly aware of the emerging scientific literature that suggested that we were entering into an era of climate change. Growing up, we did our part to conserve energy and reduce waste; but, now we know that so much more needs to be done. Beyond instilling an ethical foundation in the environment, he has provided invaluable feedback on the valorization of my research, as well as the motivation to keep going.

Closer to a decade ago, I was hosted by Professor Leonie Janssen-Jansen at the University of Amsterdam. I had read her work and was impressed by her leadership in integrating scholarship in law and planning. In my ambition to more closely study Dutch housing, Leonie graciously hosted me in her office while she was on sabbatical. This extraordinary act of kindness led to a great friendship. I have relied on Leonie as a mentor for providing the guidance and support in holding my work and ambitions to the highest order of scholarship. For this, I am eternally grateful—as are a countless number of students and young academics.

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development of a pedagogy in urban area development. Tom's work will likely provide a lifetime of inspiration. He also has the knack for sending me his very talented students who often rank as some of the most talented students that I have worked with in my career.

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# Summary I

Climate change is currently well underway. With each successive year, scientific evidence provides a more definitive understanding of the nature and pace of climate change, as well as its wide ranging impacts. These impacts are just now being studied in the field of real estate and the built environment—from short-term asset values to long-term geographic viability. A practical challenge for this strand of climate change research is the incremental pace of many environmental aspects of climate change, which are often misaligned with the timing and certainty necessary for conventional economic decision-making. Given the broader array of long-term incremental risks, public and private sectors are expanding their primary focus from climate mitigation to that of risk mitigation, resilience and adaptation. While private sector actors have to some extent embraced concepts of sustainability that promote climate mitigation and have begun to explore resilient interventions that serve to stabilize operations in the face of anticipated extreme weather events, there is very little scholarly understanding as to how these same actors conceptualize their capacity to adapt to climate change over the long-term.

Following the occurrence of Hurricane Sandy and various other recent extreme weather events in New York City (NYC), there is an increasing public awareness of the potential socioeconomic and physical impacts of climate change. Yet there is very little understanding of the nature of the response and/or preparations undertaken by the real estate sector. This dissertation thus explores the current state of the adaptive capacity of select real estate firms in NYC, as well as how one might be able to conceptualize and strategize building design, firm management and professional intelligence so as to promote a robust capacity to adapt. By moving across perspectives from buildings, to real estate firms and finally to professionals, this dissertation provides a set of conceptual linkages that connect physical and social aspects of adaptive capacity. These linkages are reinforced by empirical findings that provide practical application, as well as a foundation for future research in the science of adaptation in the built environment.

In terms of the measurement of adaptive capacity within the built environment, these three perspectives—and the multiple and interdependent systems within each perspective—represent a collective range of actors and objects that define the fundamental categories of the study of real estate management and development. The empirical research contained in this dissertation is focused on private sector firms (or sub-organizations within firms) who develop and/or manage real estate in some capacity and professionals who participate in the allied operations of designing, planning, financing, and managing the built environment in the metropolitan region of New York City (NYC). Buildings are

conceptualized as single units defined in limited physical and social terms that are not otherwise subject to a broader conceptualization as part of an urban aggregation. However, the empirical evaluation of real estate firms and professionals does attempt to understand, in part, broader urban phenomena as they may influence and shape adaptation decisions, strategies and perspectives. Hereinafter, these three perspectives are referenced simply as buildings, real estate firms (variously, firms) and professionals.

## **1. Research Aim and Central Research Question**

The main research aim of this dissertation is to develop an understanding of the adaptive capacity of: (i) buildings, (ii) real estate firms, and (iii) professionals in NYC. The central research question seeks to understand how and to what extent the three aforementioned perspectives and systems have the capacity to manage, accommodate and otherwise adapt to the risks and opportunities associated with extreme weather and climate change. This dissertation seeks to accomplish this aim and address this central question through the development of conceptual frameworks and then explore and refine those frameworks through case studies and other empirical research.

The anticipated contribution of this dissertation is to advance a synthetic understanding in the professional practice of real estate that acknowledges the possibility, if not necessity, to design and manage adaptive buildings and real estate firms. Hence, this dissertation sets forth a set of working definitions and frameworks for adaptive capacity and related concepts that represent potential steps in the translation from theory to practice. By focusing on adaptive capacity, including exploratory empirical evaluations, normative processes and explanatory motivations, this dissertation explores useful ways to measure and evaluate adaptive capacity, and provides options for operationalizing the capacity within the complex systems of buildings and real estate firms. The adaptive capacity of professionals is based on an assumption that their individual capacities are predicated on their knowledge, preferences and biases for developing plans, designs and strategies that prepare for and respond to extreme weather and climate change. Therefore, the focus in this dissertation is not in developing a complex theory of individual professional adaptive capacity but in developing an understanding of the current state of professional knowledge, preferences and biases that, in turn, logically affects their ability to (further) develop robust adaptive capacities in buildings and real estate firms. Together, these three perspectives from buildings, real estate firms and professionals form the basis for further investigation into the concept and nature of adaptive capacity in real estate and the built environment in NYC.

## 2. Research Approach, Frameworks and Results

The content of this dissertation is composed of four chapters that each represent an independent, peer-reviewed and published research article, as well as introductory and conclusion chapters. The organization of this dissertation tracks three perspective: buildings; real estate firms; and, professionals in NYC. Chapter II starts with a literature review and theoretical development of the adaptive capacity of buildings. Building upon scholarship in architecture and architectural technology, this chapter defines adaptive capacity of buildings as a construction of both human managers and artificially intelligent building systems. While largely focused on the perspective of the building, the research also incorporates frameworks from firm adaptive capacity that define the human element of social construction. Building off of a previous generation's architectural research in the morphology of buildings, this research is positioned within prevailing ecological and systems theory—notably the adaptive cycle and a Theory of Panarchy—to provide a basis for conceptualizing how buildings adapt to changing environmental conditions, user demands and even economic fundamentals along a continuum of the adaptive cycle.

Chapter III advances a more detailed development of a conceptual framework for firm adaptive capacity introduced in Chapter II. This framework is built upon a three-part approach that identifies and evaluates: (i) the awareness and intelligence of individuals and organizational elements; (ii) the selection of economic strategies undertaken by the firm; and, (iii) the space of decisions and allocation of resources to support those economic strategies. The framework is then contextualized against a meta-analysis of the case studies of the adaptive capacity of six commercial real estate firms in NYC following Hurricane Sandy. The research attempts to resolve several debates within the scholarship as to whether private sector adaption is a matter of simple financial optimization in the short-term or more complex multi-criteria analysis over the long-term. The findings suggest that it is a combination of both processes, with highly vulnerable firms undertaking a more comprehensive multi-criteria development of their strategies. With this exception, the findings suggest that firms are giving very little consideration to external factors, such as long-term market risk and developments in public policy. The research also contributes to the scholarly debate as to the nature and timing of adaptation in terms of being reactionary (*ex post*) to external stimuli, although this conceptualization is found to be less than complete when adaptive capacity is conceptualized to exist along a continuum that likely predates a historical stimulus, such as an extreme weather event. However, with the exception of the most vulnerable firm, the balance of the firms could be viewed as exclusively undertaking *ex post* adaptation, as defined in conventional terms. Finally, firms that were found to have the most robust adaptive capacities were those firms who were most vulnerable and were most aware of their vulnerabilities. While this finding

is somewhat intuitive, it highlights the critical importance of the aspect of the framework that focuses on internal organizational awareness and intelligence.

Chapter IV explores the theoretical conflicts and synergies between sustainability, resilience and adaptive capacity. While the technical theory suggests that sustainability fundamentally breaks the adaptive cycle to which socioeconomic adaptation is conceptually dependent, this chapter suggests that as a practical matter adaptation and resilience requires some measure of sustained resource allocation. This provides the basis for a conceptual linkage between the aforementioned concepts, which are explored in a case study of the corporate real estate strategies of the firm Goldman Sachs. The findings of the case study support the proposition that sustainable corporate real estate and asset management strategies may advance the adaptive capacity of the firm. The case highlights three historical shocks (i.e., Hurricane Sandy, conversion to a banking corporation and the advent of cloud computing) and the extent to which the adaptive capacity of the firm to respond to these shocks was advanced by practices that were motivated by sustainability. The findings also support an additional proposition that a robust adaptive capacity may promote sustainability by advancing the capacity of the firm to identify and implement sustainable interventions, as well as what elements should be sustained. Therefore, the findings are inconclusive as to the nature of which of these concepts memorialized by their strategies and interventions may be deterministic of the other. In addition, the findings also suggest a positive connection between the physical adaptive capacity of a building and the adaptive capacity of a firm located in that building. The chapter provides a conceptual and empirical basis that suggests not only a deeper understanding of firm adaptive capacity, but also an alternative set of values assigned to sustainability.

Chapter V shifts perspectives from that of the building and the firm to the larger class of professionals operating within the built environment. The adaptive capacity of professionals is based on an assumption that their individual capacities are predicated on their knowledge, preferences and biases for developing plans, designs and strategies that prepare for and respond to extreme weather and climate change. It is assumed that a core function of this collective notion of intelligence and behavior is premised on each individual's ability to understand concepts and meanings that are critical for more complex decision making. This chapter sets out to evaluate the range of meanings and preferences for the critical concepts of adaptation, resilience, risk mitigation and coping of a sample of professionals operating in the built environment who are active in climate change leadership in the NYC metropolitan region. Utilizing a survey method, these critical concepts are evaluated by and between the: (i) concepts and meanings; (ii) concepts and applications; and, (iii) applications and preferences, as applied to various risk based scenarios ranging from sea level rise to heat waves. The findings confirm the hypothesis that resilience was not well understood by respondents. To the contrary, respondents were able to consistently discern both meanings and hypothetical

applications of each of the concepts, except for resilience. The findings also support the hypothesis that resilience was the least preferred conceptual application. To the contrary, respondents consistently and overwhelmingly preferred applications assigned to the concept of adaptation and to a lesser extent, risk mitigation. Overall, the chapter attempts to provide insight into the contextual intelligence and strategic preferences of professionals that serve as the ultimate source of judgement from which both building and firm adaptive capacities are dependent.

### **3. Scientific Relevance**

This dissertation advances the sciences of adaptation, management and real estate by contributing new knowledge to the study of adaptation in the built environment. With the preponderance of the scholarship focused on public sector led adaptation, this research begins to address a critically important aspect of adaptation in the private sector. By developing conceptual meanings for adaptation (and its various related concepts) and adaptive capacity in real estate, this research contributes to an understanding of adaptation that is scalable in its analytical applications and epistemological meanings, as manifested in the material and social constructions of the built environment. Specifically, this dissertation has contributed to a conceptual and empirical understanding of the nature of the adaptive capacities of a variety of firms and professionals in NYC. From operationalizing firm adaptive capacity to developing analytical design and development models for buildings, this dissertation sets the stage for advancing a wide variety of future research inquiries in the advancement of the science of adaptation in the built environment.

### **4. Practical Relevance**

The practical relevance of this research is manifest in the stated necessity of firms to develop and promote their adaptive capacities and for designers and managers to construct and operate buildings that have the capacity to adapt to changing environmental and socioeconomic conditions. This research has already contributed to setting design and planning standards for the American Institute of Architects, the 4th Regional Plan for the New York metropolitan region and for the U.S. government. In addition, the research has provided the foundation for analyzing and designing a variety of climate sensitive development projects around the world ranging from multi-purpose levees in Lower Manhattan to adaptive commercial buildings in central Tokyo. As climate change accelerates in its manifested and distributed impacts, an increasing diversity of sectors will need to develop robust adaptive capacities for accommodating both the known and unknown. With real estate and the built environment on the front lines of housing commerce and people, it is critical that the private sector develop robust adaptive capacities. A failure to do so could result in cascading impacts that are amplified in their effects so as to challenge the stability of our societies, economies and environments.

## 5. Conclusions

The central research question of this dissertation seeks to understand how and to what extent (i) buildings, (ii) real estate firms, and (iii) professionals in NYC have the capacity to manage, accommodate and otherwise adapt to the risks and opportunities associated with extreme weather and climate change. The conclusions of this dissertation are premised on a framework that positions buildings and real estate along a continuum of the adaptive cycle. This ecological perspective of the building is conceptualized to be composed of both material and social constructions that define the mechanisms of adaptation and the capacity to adapt. The social aspects of this perspective are extended in conceptual terms to real estate firms and professionals.

As an empirical undertaking, this dissertation sets forth the current behavior and capacities of a group of real estate firms operating within the built environment in NYC. The case studies of these firms also provide an initial application of a framework for evaluating firm adaptive capacity. The subject firms were found to qualitatively vary in their adaptive capacities in a manner that shed light on a variety of scholarly debates concerning the timing, nature and mode of firm behavior in adapting to external stimuli, as advanced in both climate change and business scholarship. The case helped refine the firm adaptive capacity framework to focus not just on internal resources but how those resources are internally managed in executing an adaptive economic strategy.

This dissertation also developed a framework that highlights the theoretical and practical synergies and conflicts between aspects of sustainability, resilience and adaptive capacity. Empirical findings based on this framework suggest a positive reciprocal relationship between sustainability and adaptive capacity in practice. This framework and these findings support future research questions that attempt to understand the management of a firm's adaptive capacity, as well as new values assignable to sustainable real estate.

Based on an argument that a professional's adaptive capacity is premised, in part, on their ability to develop consistent descriptive terminology and analytical models, a survey of the concepts adaptation, resilience, coping and mitigation were undertaken to evaluate existing levels of professional intelligence, as well as their associated biases and preferences. The findings support a broader argument that resilience in its current rhetorical usage is thwarting the development of consistent terminology and meanings for the concepts. Otherwise, the survey suggests a robust level of understanding of the core concepts and a consistent preference for the application of the concept of adaptation in the built environment.

A contemporary understanding of the capacities of these firms and professionals is critical for developing models which engage private sector actors based, in part, on their own self-interest, with the theoretical recognition that larger societal

co-benefits may reside in their adaptation of the built environment. To fully engage the private sector, profit-seeking motivations have to be acknowledged and incorporated within analytical and organizational processes. This dissertation provides a critical conceptualization of the adaptive capacity of firms and buildings, as well as emerging understanding of the connections between them.

At the core of the manifestation of these various perspectives is the capacity of a professional to understand critical concepts and analytical models necessary for objective data driven decision making. This dissertation advances an epistemological foundation for core concepts and frameworks for adaptive capacity. These core concepts are not static states, but perceived dynamic processes that must be perceived in the process of building and maintaining an adaptive capacity in the built environment. The research work and results thus attempt to provide the theoretical groundwork for the future development of tools, designs and studies that operationalize the adaptive capacity of buildings, real estate firms and professionals. As a contribution to new knowledge in the sciences of adaptation, management and real estate, this dissertation provides the foundation for understanding of the multi-perspective nature of adaptation in real estate and the built environment.





# **Samenvatting | Het begrijpen van adaptatievermogen van vastgoed en de gebouwde omgeving: klimaatverandering en extreem weer in New York City**

Het klimaat verandert. Wetenschappelijk onderzoek geeft ons ieder jaar beter inzicht in de aard en het tempo van klimaatverandering en de vele gevolgen daarvan. Het bestuderen van deze gevolgen op het terrein van vastgoed en de gebouwde omgeving—van het effect op vastgoedwaarden op korte termijn tot de woonbaarheid van bepaalde geografische gebieden op langere termijn—is daar recentelijk bijgekomen. Een praktische uitdaging waar dit soort klimaatveranderingsstudies mee te maken heeft is dat de incrementele voltrekking van klimaatverandering zich moeizaam verhoudt tot de tijdigheid en voorspelbaarheid die rond conventionele economische besluitvorming vereist zijn. Het brede scala aan incrementele lange-termijnrisico's heeft ervoor gezorgd dat zowel publieke als private sectoren hun primaire focus van klimaatmitigatie hebben verlegd naar de risicomitigatie, veerkracht en adaptatie. Hoewel actoren in de private sector duurzaamheidsconcepten—die klimaatmitigatie promoten—tot op zekere hoogte hebben omarmd, en hoewel zij tevens begonnen zijn om veerkracht-interventies—die zijn gericht op het bestendigen van de bedrijfsvoering wanneer verwachte extreme weersomstandigheden zich voordoen—is er erg weinig academisch inzicht in hoe deze actoren hun lange-termijn adaptatievermogen rond klimaatverandering vormgevenzelf begrijpen.

De orkaan Sandy en verschillende andere extreme weersomstandigheden in New York City (NYC) hebben de afgelopen jaren voor een groeiend publiek bewustzijn van de potentiële sociaaleconomische en fysiek-ruimtelijke effecten van klimaatverandering gezorgd. Ondanks dat is er weinig bekend over de aard van de reactie en/of de voorbereidingen van vastgoedsector op dit terrein. In dit proefschrift wordt daarom de huidige staat van het adaptatievermogen van een selectie vastgoedbedrijven in NYC verkend, evenals hoe men gebouwwontwerp, bedrijfsmanagement en professionele kennis conceptueel en strategisch zou kunnen benaderen met de bedoeling een robuust adaptatievermogen te promoten. Door te schakelen tussen het perspectief van gebouwen, vastgoedbedrijven en professionals wordt in dit proefschrift een set conceptuele verbindingen gemaakt die de fysieke en sociale aspecten van adaptatievermogen met elkaar verenigd. Deze verbindingen worden onderbouwd met empirische bevindingen die op het terrein van adaptatie in de gebouwde omgeving zowel praktische toepassingen als een basis voor vervolgonderzoek bieden.

De drie genoemde perspectieven en de meervoudige en wederzijds afhankelijke systemen daarbinnen, omvatten—met het oog op het meetbaar maken van adaptatievermogen in de gebouwde omgeving—groepen actoren en objecten die behoren tot basiscategorieën binnen vastgoedmanagement en -ontwikkelingsstudies. Zo richt het empirische onderzoek in dit proefschrift zich op private bedrijven (of organisatiedelen van die bedrijven) die in zekere mate vastgoed ontwikkelen en/of managen, en op professionals die participeren in activiteiten rond het ontwerpen, plannen, financieren en managen van de gebouwde omgeving van NYC. Gebouwen worden daarnaast begrepen als losse eenheden die in fysieke of sociale zin op zichzelf staan, en niet als onderdeel van een of ander groter stedelijk geheel. De invloed van de stedelijke omgeving op adaptatiebeslissingen, -strategieën, en -perspectieven wordt echter geenszins ontkend maar meegenomen in de empirische evaluatie van vastgoedbedrijven en professionals. In het hiernavolgende zal simpelweg naar deze drie perspectieven verwezen worden als gebouwen, vastgoedbedrijven (of: bedrijven) en professionals.

## 1. Doel van het onderzoek en hoofdvraag

De algemene doelstelling van dit proefschrift is het ontwikkelen van inzicht in het adaptatievermogen van (i) gebouwen, (ii) vastgoedbedrijven en (iii) professionals in NYC. De centrale onderzoeksvraag is gericht op het begrijpen hoe en in welke mate het vanuit de drie bovengenoemde perspectieven mogelijk is de risico's en kansen die geassocieerd worden met extreem weer en klimaatverandering te managen, te accommoderen, of zich er anderszins op aan te passen. In dit proefschrift worden hiertoe conceptuele raamwerken ontwikkeld die vervolgens verkend en aangescherpt worden op basis van case studies en ander empirisch onderzoek.

Met deze dissertatie wordt naar verwachting een bijdrage geleverd aan de bevordering van een samenhangend begrip van adaptatievermogen binnen de professionele vastgoedpraktijk—een praktijk die de mogelijkheid ofwel de noodzaak tot het ontwerpen en managen van adaptieve gebouwen en vastgoedbedrijven onderkent. Dit proefschrift zet aldus een aantal werkdefinities en raamwerken voor adaptatievermogen en gerelateerde concepten uiteen die in potentie helpen deze vertaling van theorie naar praktijk te maken. Op basis van o.a. empirische evaluaties, normatieve processen en verklarende motivaties wordt verkend hoe adaptatievermogen op een nuttige manier kan worden gemeten en geëvalueerd, en worden mogelijkheden geboden om dit vermogen binnen de complexe systemen van gebouwen en bedrijven te operationaliseren.

Het adaptatievermogen van professionals is gebaseerd op de veronderstelling dat hun individuele vermogen voortkomt uit kennis, voorkeuren en een neiging om plannen, ontwerpen en strategieën te ontwikkelen die inspelen en reageren op extreem weer en klimaatverandering. Het is daarom logisch dat de nadruk in deze

dissertatie niet ligt op het ontwikkelen van een complexe theorie van individueel professioneel adaptatievermogen, maar op het ontwikkelen van inzicht in het huidige professionele kennisniveau als geheel, en in voorkeuren en neigingen daarbinnen die, op hun beurt, logischerwijs het vermogen beïnvloeden om in de praktijk gebouwen en vastgoedbedrijven (meer) robuust adaptief vermogen te laten ontwikkelen. De drie perspectieven van gebouwen, vastgoedbedrijven en professionals bieden dus in samenhang een basis voor verder onderzoek naar het concept en de aard van adaptatievermogen van vastgoed en de gebouwde omgeving van NYC.

## **2. Onderzoeksbenadering, -raamwerken en -resultaten**

Deze dissertatie bestaat uit vier hoofdstukken die ieder een op zichzelf staand, peer-reviewed en gepubliceerd onderzoeksartikel weergeven, welke zijn aangevuld met een inleidend en een concluderend hoofdstuk. De dissertatie is in volgorde van de drie perspectieven georganiseerd: gebouwen; vastgoedbedrijven; en professionals in NYC. Hoofdstuk II begint met een literatuurstudie en theorievorming rond het adaptatievermogen van gebouwen. Voortbouwend op academisch werk in de architectuur en bouwtechnologie, definieert dit hoofdstuk het adaptatievermogen van gebouwen als een construct van zowel menselijke managers als de intelligentie van kunstmatige gebouwssystemen. Terwijl dit hoofdstuk voornamelijk gericht is op het gebouwperspectief, zijn in het onderzoek ook raamwerken van bedrijfsadaptatievermogen meegenomen waarin het menselijke element ervan wordt gedefinieerd. Net als de voorgaande generatie aan architectonisch gebouw-morfologisch onderzoek positioneert dit onderzoekswerk zich niet alleen binnen bestaande ecologische en systeemtheoretische concepten, maar maakt er ook gebruik van—met name de adaptieve cyclus en de Panarchy-theorie. Deze theorie vormt de basis voor een conceptualisering van de wijze waarop gebouwen zich aanpassen aan veranderende milieuomstandigheden, gebruikerseisen en zelfs economische grondslagen, langs een continuüm van de adaptieve cyclus.

In hoofdstuk III wordt een conceptueel raamwerk voor het adaptatievermogen van bedrijven, dat in hoofdstuk II al werd geïntroduceerd, meer gedetailleerd uitgewerkt. Dit conceptueel raamwerk is gebaseerd op een driedelige identificatie en evaluatie van: (i) het bewustzijn en de intelligentie van individuen en elementen van de organisatie; (ii) de selectie van door het bedrijf ondernomen economische strategieën; en (iii) de besluitvorming rond en de toewijzing van middelen voor die economische strategieën. Het raamwerk wordt vervolgens van context voorzien aan de hand van een meta-analyse van case studies van het adaptatievermogen van zes commerciële vastgoedbedrijven in NYC in de periode na orkaan Sandy. Het onderzoek poogt verschillende academische debatten, gericht op de vraag of adaptatie binnen de private sector eenvoudigweg volgt uit een financiële korte-

termijn-optimalisatie of dat er een complexere multi-criteria analyse met oog voor de lange-termijn aan te grondslag ligt, te slechten. De bevindingen wijzen op een combinatie van beide processen, waarbij alleen de zeer kwetsbare bedrijven aan meer omvattende, multi-criteria strategieontwikkeling blijken te doen. Deze uitzondering suggereert dat bedrijven externe factoren, zoals lange-termijn marktrisico's en ontwikkelingen in publiek beleid, nauwelijks op hun netvlies hebben. Het onderzoek draagt ook bij aan het academisch debat rondom de aard en timing van adaptatie als zijnde reactionair (ex post) op externe prikkels. Hoewel deze conceptualisering incompleet wordt bevonden als adaptatievermogen wordt het gezien als een fenomeen dat waarschijnlijk ook aan historische prikkels, zoals extreem weer, voorafgaat. Echter, als we adaptatievermogen in conventionele termen definiëren, zouden we kunnen stellen dat bedrijven—met uitzondering van de meest kwetsbare—over het algemeen uitsluitend aan ex post adaptatie doen. Bedrijven die de meest robuuste adaptatievermogens hadden ontwikkeld waren immers degenen die tevens het meest kwetsbaar zijn en hier ook het meest bewust van bleken. Hoewel deze bevinding wat intuïtief lijkt, bevestigt deze het kritische belang van de aspecten in het raamwerk die wijzen op intern organisatorisch bewustzijn en intelligentie.

Hoofdstuk IV verkent de theoretische conflicten en synergiën tussen de concepten duurzaamheid, veerkracht en adaptatievermogen. Terwijl meer technische theorieën suggereren dat duurzaamheid de adaptieve cyclus waarop socio-economische adaptatie gebaseerd is op fundamentele wijze verbreekt, stelt dit hoofdstuk dat adaptatie en veerkracht vanuit praktisch oogpunt continue van middelen moeten worden voorzien. Dit biedt de basis voor een verband tussen de hier genoemde concepten, welke samen verkend worden in een case studie van de corporate real estate strategieën van Goldman Sachs. De bevindingen van de case studie ondersteunen de propositie dat duurzame corporate real estate en asset management strategieën het adaptatievermogen van het bedrijf zouden kunnen bevorderen. De case laat drie historische schokken zien (orkaan Sandy, de conversie naar een bankbedrijf, en de komst van cloud computing) en de mate waarin het adaptatievermogen van het bedrijf werd bevorderd door praktijken die op basis van duurzaamheidsmotieven werden uitgevoerd. De bevindingen ondersteunen ook een tweede propositie, die stelt dat een robuust adaptatievermogen duurzaamheid bevordert omdat het bedrijf zijn vermogen om duurzame interventies te identificeren vergroot, alsmede het vermogen om te bepalen welke elementen behouden moeten worden versterkt. Hieruit volgt dat het op basis van de bevindingen niet mogelijk is om vast te stellen welke van de onderliggende strategieën en interventies van deze concepten bepalend zijn voor de ander. De bevindingen suggereren echter ook een zeker positief verband tussen het fysieke adaptatievermogen van een gebouw en het adaptatievermogen van een bedrijf dat zich in dat gebouw bevindt. Het hoofdstuk biedt niet alleen een conceptuele en empirische basis voor een dieper inzicht in bedrijfsadaptatievermogen, maar ook voor een alternatieve waardering van het concept duurzaamheid.

Hoofdstuk V schakelt van het perspectief van het gebouw en het bedrijf naar dat van een grotere groep professionals die opereren binnen de gebouwde omgeving. Het adaptatievermogen van professionals is, zoals gezegd, gebaseerd op de veronderstelling dat hun individuele vermogen voortkomt uit kennis, voorkeuren en een neiging om plannen, ontwerpen en strategieën te ontwikkelen die inspelen en reageren op extreem weer en klimaatverandering. Daarnaast wordt ervan uitgegaan dat een kernfunctie van deze collectieve notie van intelligentie en gedrag voortkomt uit ieders vermogen om concepten en betekenissen—welke essentieel zijn voor meer complexe besluitvorming—te begrijpen. Dit hoofdstuk evalueert daarom steekproefsgewijs de variëteit aan betekenissen en voorkeuren rond kritische concepten als adaptatie, veerkracht, risicomitigatie en coping onder professionals die opereren in de gebouwde omgeving en een leidende rol spelen in het klimaatveranderingsbeleid van de metropoolregio van NYC. De genoemde kritische concepten zijn door middel van een enquête geëvalueerd door (i) concepten en betekenissen; (ii) concepten en toepassingen; en (iii) toepassingen en voorkeuren, zoals men deze gebruikt in verschillende risico-gerelateerde scenario's—van zeespiegelstijging tot hittegolven—met elkaar te vergelijken. De bevindingen bevestigen de hypothese dat het concept veerkracht door respondenten niet correct werd begrepen. Respondenten lieten zelfs zien dat zij zowel de betekenis als de hypothetische toepassing van elk concept op consistente wijze konden onderscheiden, behalve die van veerkracht. De bevindingen ondersteunen ook de hypothese dat veerkracht onder de respondenten als toegepast concept de minste voorkeur geniet. Daartegenover staat dat respondenten op consistente en overweldigende wijze hun voorkeur uitspreken voor adaptatie en, in mindere mate, voor risicomitigatie. Het hoofdstuk probeert in het algemeen inzicht te verschaffen in de contextuele intelligentie en strategische voorkeuren van professionals die, uiteindelijk, de bron zijn van beoordelingen waarvan het adaptatievermogen van zowel gebouw als bedrijf afhankelijk is.

### **3. Wetenschappelijke relevantie**

Dit proefschrift brengt de wetenschap rond adaptatie, management en vastgoed verder door nieuwe kennis bij te dragen op het terrein van adaptatie in de gebouwde omgeving. Met een overwicht aan academisch werk gericht op adaptatie geleid door de publieke sector, wordt in deze studie een begin gemaakt met het adresseren van het kritische belang van adaptatie in de private sector. Door concepten te ontwikkelen voor adaptatie (en een variëteit aan gerelateerde concepten) en adaptatievermogen van vastgoed, draagt dit onderzoek bij aan een begrip van adaptatie dat, omdat het zich manifesteert in de materiële én sociale constructen van de gebouwde omgeving, schaalbaar is in zijn analytische toepassingen en epistemologische betekenissen. Deze dissertatie heeft in meer specifieke termen bijgedragen aan een conceptueel en empirisch inzicht in de aard van de adaptatievermogens van verschillende bedrijven

en professionals in NYC. Dit werk maakt daarmee een brede variëteit aan toekomstige onderzoeksprojecten mogelijk—van het operationaliseren van bedrijfsadaptatievermogens tot het ontwikkelen van analytische ontwerp- en ontwikkelmodellen voor gebouwen—die de wetenschap rond adaptatie in de gebouwde omgeving verder doen ontwikkelen

## 4. Praktijkrelevantie

De relevantie van dit onderzoek voor de praktijk manifesteert zich in de verklaarde noodzaak van bedrijven om hun adaptatievermogen te ontwikkelen en te promoten, en van ontwerpers en managers om gebouwen te bouwen en te beheren die het vermogen hebben om zich aan te passen aan veranderende weersomstandigheden en socio-economische condities. Het onderzoek in dit proefschrift heeft al bijgedragen aan het formuleren van ontwerp- en planningskaders voor de American Institute of Architects, de 4th Regional Plan for the New York Metropolitan Region en voor de Amerikaanse overheid. Het onderzoek heeft daarnaast als een basis gefungeerd voor het analyseren en ontwerpen van verschillende klimaat-gevoelige ontwikkelingsprojecten, van multifunctionele walconstructies in Lower Manhattan tot adaptieve commerciële gebouwen in het centrum van Tokyo. Wanneer de directe en indirecte gevolgen van klimaatverandering zich versneld gaan voordoen zullen steeds meer sectoren een robuust adaptatievermogen moeten gaan ontwikkelen dat zowel in het bekende als het onbekende kan voorzien. Omdat woningmarkten en mensen niet kunnen functioneren zonder vastgoed en de gebouwde omgeving is het van kritisch belang dat de private sector robuust adaptatievermogen ontwikkelt. Het uitblijven hiervan kan gevolgen hebben die trapsgewijs sterker worden en daarmee de stabiliteit van onze maatschappijen, economieën en omgevingen in gevaar kunnen brengen..

## 5. Conclusies

De centrale onderzoeksvraag van dit proefschrift is gericht op het begrijpen hoe en in welke mate (i) gebouwen, (ii) vastgoedbedrijven en (iii) professionals in NYC het vermogen hebben om zich aan te passen aan de risico's en kansen die geassocieerd worden met extreem weer en klimaatverandering. De conclusies van deze dissertatie komen voort uit een raamwerk dat gebouwen en vastgoed langs een continuüm van de adaptatiecyclus positioneert. Dit ecologische begrip van het gebouw bestaat zowel uit materiële als sociale constructen waarbinnen de adaptatiemechanismen in en het adaptatievermogen van het gebouw worden gedefinieerd. De sociale dimensie van dit begrip van het gebouw zijn in conceptuele zin doorgetrokken naar vastgoedbedrijven en professionals.

Dit proefschrift geeft een empirische inspanning weer om het huidige gedrag en het vermogen van een groep vastgoedbedrijven binnen de gebouwde

omgeving van NYC uiteen te zetten. De case studies van deze bedrijven laten een eerste toepassing zien van een raamwerk voor het evalueren van bedrijfsadaptatievermogen. De bestudeerde bedrijven bleken kwalitatief van elkaar te verschillen in hun adaptatievermogens, en wel op een manier die inzicht verschaft in verschillende academische vraagstukken rond de timing, aard en modus van adaptatieve bedrijfsgedragingen na externe stimulansen, zoals zowel te vinden is in klimaatveranderingsstudies als de bedrijfskunde. De cases hebben geholpen het raamwerk van bedrijfsadaptatievermogen aan te scherpen en de focus niet alleen te leggen op interne middelen maar ook op hoe deze middelen intern worden ingezet ter uitvoering van een adaptatieve economische strategie.

In dit proefschrift is ook een raamwerk ontwikkeld dat de theoretische en praktische synergiën en conflicten tussen aspecten van duurzaamheid, veerkracht en adaptatievermogen aan het licht brengt. Empirische bevindingen op basis van dit raamwerk suggereren dat er in de praktijk een positieve wederzijdse relatie tussen duurzaamheid en adaptatievermogen bestaat. Het raamwerk en de bevindingen ondersteunen toekomstige onderzoeksvragen die het management van het adaptatievermogen van een bedrijf proberen te doorgronden, alsook nieuwe waarden die aan duurzaam vastgoed kunnen worden toegekend.

Op basis van het argument dat het adaptatievermogen van een professional, ten dele, voorkomt uit de kunde om consistente beschrijvingen en analytische modellen te ontwikkelen, is een enquête over concepten als adaptatie, veerkracht, coping en mitigatie uitgezet om het bestaande niveau van professionele kennis in de praktijk vast te stellen, zowel als de hieraan gerelateerde voorkeuren en neigingen. De bevindingen ondersteunen een bredere stellingname dat het concept veerkracht, in zijn huidige retorische gebruik, de ontwikkeling van consistente terminologie en betekenissen van concepten in de weg zit. Daarnaast suggereren de resultaten een robuust begrip van de overige concepten en een consistente voorkeur voor het gebruik van het concept adaptatie in de gebouwde omgeving.

Een hedendaags begrip van het adaptatievermogen van bedrijven en professionals is essentieel voor het ontwikkelen van modellen die de private sector, deels uit eigenbelang, weten te mobiliseren—met een theoretische onderkenning dat in een private betrokkenheid bij de adaptatie van de gebouwde omgeving grote maatschappelijke baten verscholen kunnen zitten. Om deze betrokkenheid volledig te bewerkstelligen moeten winstzoekende motivaties erkend worden en in analytische en organisatorische processen worden ingebouwd. Dit proefschrift biedt een kritische conceptualisering van het adaptatievermogen van bedrijven en gebouwen, zowel als opkomende inzichten in de verbanden ertussen.

Centraal in de manifestaties van deze verschillende perspectieven staat het vermogen van een professional om kritische concepten en analytische modellen te begrijpen waarmee objectieve, data-gedreven beslissingen kunnen worden genomen. Dit proefschrift biedt een epistemologische basis voor



centrale concepten en raamwerken rond adaptatievermogen. Deze centrale concepten zijn niet statisch, maar worden gezien als dynamische processen die ingebracht moeten worden in het proces van het opbouwen en behouden van adaptatievermogen in de gebouwde omgeving. Het onderzoek en zijn resultaten pogen dus een theoretisch kader te scheppen voor de toekomstige ontwikkeling van instrumenten, ontwerpen en studies die het adaptatievermogen van gebouwen, vastgoedbedrijven en professionals operationeel maken. Als een nieuwe kennisbijdrage aan de wetenschappen rond adaptatie, management en vastgoed biedt dit proefschrift dus een basis voor het begrijpen van de meervoudige aard van adaptatie in vastgoed en de gebouwde omgeving.

# CHAPTER I | Introduction

Climate change is currently well underway (IPCC, 2014). With each successive year, scientific evidence provides a more definitive understanding of the nature and pace of climate change, as well as its wide ranging impacts. These impacts ranging from short-term collateral asset values to long-term geographic viability are just now being studied in the fields of real estate and the built environment (Bunten & Kahn, 2014; Peterson, 2014). A practical challenge for this climate research is the incremental pace of many environmental aspects of climate change which are often misaligned with the timing and certainty necessary for conventional economic decision-making (Wise, et al., 2014; Little & Lin, 2015). Given the broader array of long-term incremental risks, public and private sectors are expanding their primary focus from climate mitigation to that of risk mitigation, resilience and adaptation (Friedman & Narula, 2014). While private sector actors have, by some measures, embraced concepts of sustainability that promote climate mitigation and have begun to explore resilient interventions that serve to stabilize operations in the face of anticipated extreme weather events, there is very little scholarly or professional understanding as to how these same actors conceptualize their role in adapting to climate change over the long-term.

This dissertation seeks to understand how and to what extent buildings, real estate firms and professionals have the capacity to manage, accommodate and otherwise adapt to the risks and opportunities associated with extreme weather and climate change. Following the occurrence of Hurricane Sandy and various other recent extreme weather events, there is an increasing public awareness of the potential socioeconomic and physical impacts of climate change. However, there is very little understanding of the nature of the response and/or preparations undertaken by the real estate sector. By extension, the dissertation thus seeks to explore how the sector might be able to conceptualize and strategize building design, firm management and professional intelligence so as to promote a robust capacity to adapt. This dissertation connects three perspectives: buildings, real estate firms and professionals. This dissertation provides a set of conceptual linkages that connect physical and social aspects of adaptive capacity. These conceptual linkages are reinforced by empirical findings that provide practical professional application, as well as a foundation for future research in the sciences of adaptation and the built environment.

In terms of the measurement of adaptive capacity within the built environment, these three perspectives—and the multiple and interdependent systems within each perspective—represent a collective range of actors and objects that define the fundamental categories of the study of real estate management and development (Graaskamp, 1981). The empirical research contained in this dissertation is focused on private sector firms (or sub-organizations within firms) who develop and/or manage real estate in some capacity and professionals who participate in the allied operations of designing, planning, financing, and

managing the built environment in the metropolitan region of New York City (NYC). Buildings are conceptualized as single units defined in limited terms as material objects (i.e., composition of physical building systems) and social constructions that are not otherwise subject to a broader conceptualization as part of an urban aggregation. However, the empirical evaluation of real estate firms and professionals does attempt to understand, in part, broader urban phenomena as they may influence and shape decisions, strategies and perspectives. Hereinafter, these three perspectives will be referenced simply as buildings, real estate firms (variously, firms) and professionals.

NYC is categorized by a generalizable set of vulnerabilities to extreme weather and climate change and a comparatively robust professional and public dialogue for addressing the interrelationships between climate change and the built environment. Likewise, this focus on the private sector aims for a specific contribution to climate change scholarship which has historically had limited access to real estate firms and propriety data. In applied terms, the private sector may be able to utilize this research to design and manage buildings and real estate firms that have the capacity to register and respond to the effects of various classifications of change, including climate change.

In this introductory chapter, the identification of real world problems and vulnerabilities are juxtaposed to gaps in theoretical and empirical scholarship that reinforces the contribution of this dissertation to the production of new knowledge. This chapter begins with a positioning of the relevance of this research within the context of understood relationships between extreme weather, climate change and the built environment in NYC. Thereafter, practical and scholarly problems in these relationships are translated to a set of research questions that will guide the specific inquires for subsequent chapters. Finally, the overall research approach and design to this dissertation is discussed in order to provide the reader with the parameters of the research that help frame the limitations and strengths of the research questions, theoretical models and empirical findings. A synthetic analysis and reflection of the findings of the collective body of research will form the basis of the Findings and Conclusions Chapter. This final chapter will position the scope of future research that addresses critical questions necessary for advancement of the understanding and inducement of adaptation in the built environment.

# **1. Extreme Weather, Climate Change and the Built Environment**

## **A. Hurricane Sandy and Extreme Weather Impacts**

The occurrence of Hurricane Sandy in 2012 in the NYC metropolitan region provided the circumstantial impetus for this dissertation, as it highlighted an opportunistic

shift in both public and private sector thinking about extreme weather and the impending notions of climate change. Hurricane Sandy reminded the world that coastal storms are among the world's most costly and deadly disasters when they strike urban centers. While disasters might be initiated by extreme weather events, social vulnerabilities that cross boundaries from aspects of environmental justice to social inequity are what define the parameters of a disaster in the public realm (Birch & Wachter, 2006; Hartman & Squires, 2006). As a consequence of this human disaster initiated by a natural disaster, a public dialogue began to emerge as to the role of built environment actors in responding to and preparing for extreme weather, particularly as more extreme weather is anticipated with climate change (Visser, Petersen, & Ligtoet, 2014). However, very little was understood about private sector vulnerabilities and to what extent these vulnerabilities were exacerbated by institutional or organizational constraints—particularly as it relates to the real estate industry, which is often disproportionately, physically vulnerable in urban areas. Even less was understood about the capacity of buildings, real estate firms and professionals to adapt to these risks and vulnerabilities.

From a public perspective, systematic existing physical vulnerabilities in the U.S. built environment are known to be exacerbated by outdated flood mapping, outmoded building codes and ill-conceived land use decisions (Siembieda, 2014). In NYC alone, 51 square miles (17% of the city's land mass) were flooded during Hurricane Sandy (Mayor's Office, 2013, p. 13). This flooding impacted 88,700 buildings, more than 300,000 housing units and nearly 23,400 businesses in NYC (Id.). New Jersey had over 70,000 buildings flooded (FEMA, 2012). While NYC suffered approximately \$19 billion in damages, New Jersey's coastal geography comprising of many highly vulnerable beach and resort communities, resulted in upwards of \$29 billion in damages (U.S. Dep't. of Commerce, 2013). When including Connecticut and Pennsylvania, the regional estimates exceeded \$62 billion in losses. In comparison, the much more powerful (Category 5) and record breaking Hurricane Katrina resulted in approximately \$108 billion (2005 PV) in damages.

## **B. Climate Change Vulnerabilities in the Built Environment**

The real estate industry in NYC accounts for \$106 billion in annual economic output, which equals approximately 13% of the Gross City Product (AKRF, 2014). At just over 519,000 jobs, the real estate industry makes up an estimated 11% of the city's employment and contributes \$15.4 billion in annual taxes to the city, or 38% of total municipal tax revenues (Id.). When applying a range of projected sea level rise, in NYC alone, a \$19 billion storm in the 2050s would result in approximately \$90 billion (2013 PV) in damages (Mayor's Office, 2013, p. 34). In addition, Hurricane Sandy is now considered to be a 1 in 70 year event and this probability occurrence is likely to increase with the acceleration of global warming (Id.; Knutson, et al., 2010; Lin et al., 2012). Since these loss estimates were produced, the projected mid-range (25th and 75th percentile) projected sea

level rise is anticipated to be between .27 and .53 meters over the same time period (Horton, et al., 2015). While Sandy was well within the maximum probable losses of the reinsurance industry, with sea level rise, the range of potential losses in the future is highly variable in the eyes of insurance industry. However, based on mid-range climate sensitivity models, it has been estimated that the U.S. faces nearly a \$1 trillion price tag for sea level rise and storm surge leading into the year 2100 (Neumann, et al., 2014). This calculation does not include losses for economic output and intermediate expenditures for mitigation, resilience and adaptation interventions. Mitigation, resilience and adaptation costs—for NYC alone—pursuant to the Special Initiative for Resiliency and Recovery report (SIRR, 2013) were initially estimated to be \$20 billion (2013 PV). However, anonymous interviews conducted by the author with engineers and government officials suggest that current estimates inclusive of debt service expenses and capitalized operations and maintenance expenses could nearly double that figure.

Following Hurricane Sandy, the Federal Emergency Management Agency (FEMA) took steps to update their Flood Rate Insurance Maps (FIRMs) in the New York metropolitan region to reflect a more accurate geographic risk for purposes of pricing flood insurance for the National Flood Insurance Program (NFIP). Based on advisory base floor elevation maps, the number of housing units in NYC in a 100 year flood zone are anticipated to nearly double from 35 thousand to 67 thousand residential units (Mayor's Office, 2013, p. 76). The city comptroller estimates that \$129 billion dollars of real estate is at-risk within the 100-year floodplain based on these revised maps (City of New York, 2014). In New Jersey, 33 thousand more residential structures are anticipated to be included within the 100 year floodplain in New Jersey's updated FIRMs (NJDCA, 2013). The implications of these revised assessment efforts is the potential for significant cost burdens for owners of real estate. Due to the increasing insolvency of the NFIP, homeowners and businesses will eventually over-time pay the actuarial unsubsidized rates that will result in significant economic hardship in the process (Kousky & Kunreuther, 2014). These considerations speak merely to housing and some types of commercial real estate. For a broader range of commercial real estate products, the private insurance market is the only available option for insurance coverage. Likewise, it is not just the actuarial rates in the private market that pose threats to the industry, it is the underlying insurability of the real estate at all. In addition, as will be discussed in Chapter III, business continuity insurance is already driving tenant selection preferences in commercial real estate in a way that is accelerating economic impacts of extreme weather (Korein, 2015). If left unabated, the real and nominal economic impacts in terms of public health, infrastructure and commerce for New York and New Jersey, stemming from extreme weather and climate change, nearly defies calculation and is expected to be the subject of much research in the years to come.

Flooding, storm surge and sea level rise represent just one set of risks to the built environment. Higher temperatures and more frequent sustained heat waves also represent operational risks for real estate, as existing energy infrastructure

is burdened by increased demands for peak load electricity (Wilbanks, et al., 2014). In the name of resilience and sustainability, some real estate actors have begun to develop on-site power generation facilities or to connect their facilities to distributed micro-grids (Davis, Snyder & Mader, 2014). However, these facilities are limited in their durational utility and they do not have the production capacity to power the larger urban environment (i.e., subways, traffic signals, water pumps, etc...) that real estate is dependent on for services and logistics. Other physical risks include land subsidence from sea level rise and unrestrained water consumption (Bakr, 2015), as well as risk from hail and wind from large convection thunderstorms, which are also anticipated to increase in frequency and intensity with climate change (Brown, Pogorzelski & Giammanco, 2015).

It is anticipated that the built environment will face a number of indirect consequences of climate change that are as potentially disruptive as immediate changes in physical and climactic conditions. The first consequence is that inflation in energy and water prices are likely to strain operating budgets and net operating income (Rosenzweig, et al., 2011). Second, materials prices and construction costs are likely to increase, especially for concrete, steel and other energy intensive materials (UNEP, 2009). As markets increasingly reprice risk in debt and equity, especially vulnerable buildings, districts and cities will likely be challenged to align capital cycles with growth cycles in the development and redevelopment necessary to maintain a robust building stock. These implications for supply could very well distort demand functions for real estate that will be challenged by the decisions to invest in physical resilience and adaptation interventions or to retreat and abandon geographies all together—also an application of adaptation. These destabilizing economic dynamics could have significant implications as these consumer decisions scale up to represent larger migration patterns that have the potential to be highly politically, economically, social and environmentally disruptive (Black, et al., 2011). As a general proposition of economics, these trade-offs will result in both risks and opportunities for the real estate sector (Stern, 2006).

## **2. Understanding Adaptation and Adaptive Capacity**

### **A. General Concepts of Adaptation, Resilience and Mitigation**

While the following chapters will go into detail as to the nature of adaptation and adaptive capacity—and to a lesser extent the nature and interrelationships of resilience and risk mitigation—it is useful to begin with a brief survey of these core concepts. Unfortunately, the rhetorical use of these concepts often as “buzz words” has done a great deal to reduce their technical and scientific meanings and applications in the U.S., as will be explored in Chapter V. As will be highlighted in the Findings and Conclusions Chapter, the research in this dissertation relating to

the meanings and applications of these core concepts has already contributed to providing clarification and professional application at a local, regional, and even national level. In this dissertation, understanding the distinctions, synergies and conflicts of these concepts is thus considered critical not just for understanding (the nature of) adaptive capacities but also for professional application in the built environment.

Mitigation is about the prevention of a risk from occurring at all or in some magnitude that imparts some negative impact (Klein, Schipper & Dessai, 2005; Swart & Raes, 2007; Vijaya, et al., 2012). Mitigation is used in two distinct ways. First, risk mitigation implies a certain technical intervention that often prevents the risk from directly impacting a host or object. For instance, flood gates around a building are considered a type of risk mitigation. The second meaning relates to climate mitigation which means actions (or, inactions) undertaken to reduce carbon and other pollutant into the atmosphere in an effort to reduce the risks of the acceleration of global warming. The term mitigation utilized in this dissertation refers to risk mitigation, unless otherwise noted.

Resilience speaks to the elasticity of a host to maintain the full operations of the status quo based on internal designs (Gunderson, 2000; Adger, et al., 2005; Manyena, 2006; Lee, Vargo & Seville, 2013).<sup>1</sup> As such, resilience is about an ability of a host, a piece of infrastructure, a building or even a social group or business to be able to maintain stable operations in the face of external shocks (Hamel & Valikangas, 2003). That ability to continue operations is based on an internal design built into that host or infrastructure to address known risks. For example, while resilience was initially conceptualized within ecological systems theory, one of the first practical applications was in computer science wherein system architecture was internally designed to continue system operations despite the occurrence of evitable errors in operating code (Laprie, 2008). In contrast to mitigation which reduces the occurrence of a risk, resilience fundamentally reduces, but does not usually eliminate, vulnerability. As such, resilience, like adaptation, has no end point. It is an ongoing process of seeking an equilibrium in order to maintain a stable state. As will be discussed in various chapters, resilience's service to the short-term status quo can be problematic in that it may perpetuate inefficiencies and excessive exposure to long-term risks that may lead to maladaptation. However, when extreme weather and disasters strike, promoting recovery and resilience is often a reaction to help stabilize critical populations and economies. As such, resilience has been observed to be an urban policy priority in NYC, as memorialized in the built environment by the building code work of the New York Building Resiliency Task Force and the substantive elements of the SIRR. This

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<sup>1</sup> The usage of resilience and resiliency may vary within this dissertation and in the citations utilized herein. The Merriam-Webster Dictionary (2015) defines the words as entirely synonymous and otherwise interchangeable. The preferred usage is resilience; however, subsequent usage may refer to resiliency as a quality or state of being resilient. As will be discussed, this latter usage is problematic given that resilience is a process and not an outcome.

friction between short-term resilience and long-term adaptation will be explored in depth in Chapter V as it relates to professional intelligence and preferences of the various concepts referenced herein.

## **B. Science of Adaptation**

Specific to climate science, adaptation is defined as the “adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits mutual opportunities” (IPCC, 2007a, p. 869). A more comprehensive definition of 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”[Emphasis Added](Adger, Arnell & Thompkins, 2005, p. 78). It is this conceptual aspect of adaptive capacity that drives the research of this dissertation. As a process, adaptation is about maintaining a flexibility to transform to alternative domains of operations based on internal and external designs (Wiggins, 2009; Folke, et al., 2010; Pelling, O’Brien & Matyas, 2014). It is the transformation function of adaptation that dictates that people will need to change the way they produce and consume in response or in preparation to climate change. Therefore, while resilience maintains the status quo, adaptation requires a shift to do things differently, in different places, and in different ways (Rosenzweig & Solecki, 2014). While resilience is based on internal design imbedded in the host’s operations or performance, it can only respond to known risks from which its internal designs anticipated (Woods & Wreathall, 2008). However, an adaptive host can not only utilize internal designs for known risks but can also utilize external designs to help accommodate unknown risks that might not have been anticipated at an earlier stage of design.

This importance of the conceptual distinction between internal and external design will be explored in Chapter II, specifically as it relates to building design and operation. As a matter of urban adaptation, very little focus has been attended to the physical adaptation of buildings, even though buildings may be understood to be in constant state of adaptation over their life span (Rodgers, 2015). While this dissertation largely focuses on adaptation in social terms, it will also be argued that such adaptations cannot be fully understood within the context of real estate and the built environment without exploring the conceptual adaptation of buildings.

Scientific urban adaptation research is bifurcated into two categories of actors with their own epistemologies: government led (i.e., planned) and individual actor led (i.e., autonomous) adaptation (Eriksen & Brown, 2011). While the objective planning of public actors and the subjective rationality of private actors is a useful distinction, urban adaptation is a more complex process as it represents a composition of multiple actors and interests (Uittenbroek, 2014). To date, most of the scholarship within the realm of urban adaptation has focused on public



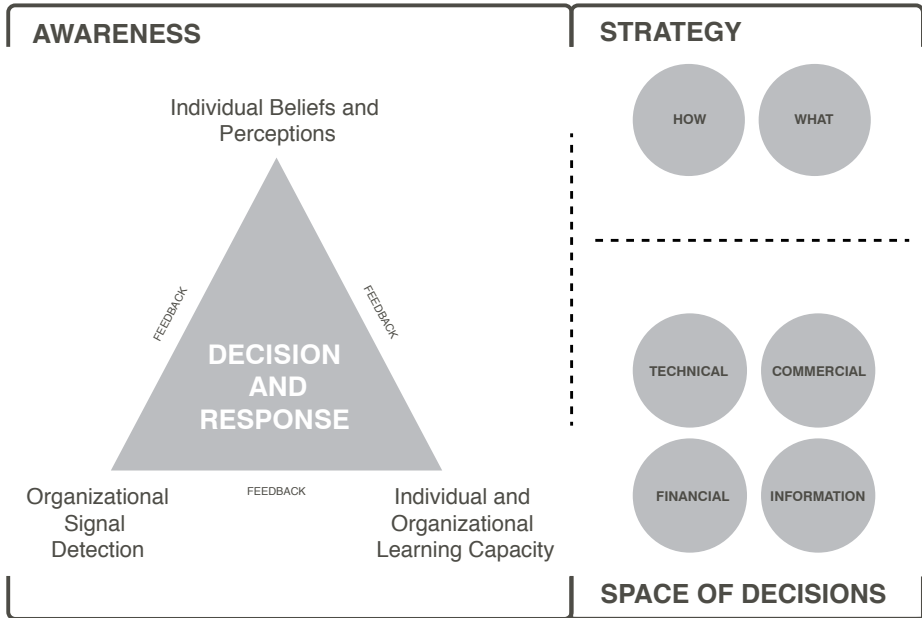
sector governance (Adger, 2001; Paavola, 2008; Uittenbroek, Janssen-Jansen, & Runhaar, 2013) and has operated from two perspectives. First, the research has focused on specific practices and technologies at a local scale that often steer designs and investment decisions in favor of innovative technological approaches or assessments (Corfee-Morlot, et al., 2011; Baker, et al., 2012; Lehmann, et al., 2015). To a lesser extent, this research has also evaluated broader land use decisions at a metropolitan and/or regional scale (Pyke & Andelman, 2007; Duguma, Minang, & van Noordwijk, 2014). The second dominant perspective in the scholarship focuses on opportunities and barriers for institutional design and implementation of climate policies (Adger, Lorenzoni, & O'Brien, 2009; Moser & Ekstrom, 2010; Measham, et al., 2011; Massey, et al., 2014). In particular, much focus has been on 'mainstreaming' climate policies horizontally across a wide variety of policy domains as opposed to a singular top-down climate policy (Kok & De Coninck, 2007; Brouwer, Rayner, & Huiteima, 2013).

To a lesser extent, private sector adaptation scholarship has been largely driven by descriptive case studies of organizations and sectors, as will be internally and externally referenced in Chapters III and IV. Much of this emerging scholarship has focused on adaptation strategies and interventions where the capital stock turnover is on a relatively short cycle, such as in agriculture and alpine tourism (Yang, et al., 2007; Hennessy, et al., 2008; Hoffman, et al., 2009; Nitkin, Foster, & Medalye, 2009). Because of the comparatively short turnover, specific adaptation interventions and their effects are more readily observable in discrete terms. In contrast, the challenge of understanding adaptation of buildings and infrastructure is that each is subject to comparatively long life- and capital-cycles extending over the course of many decades. As such, it is arguably insufficient to focus on any one technology or intended strategy for adaptation in real estate, as conditions could change significantly within the useful life of the asset. Therefore, the more appropriate scope of analysis relates to the adaptive capacity of buildings, real estate firms, and professionals as they prepare for and respond to a variety of known and unknown stimuli.

### **C. Adaptive Capacity**

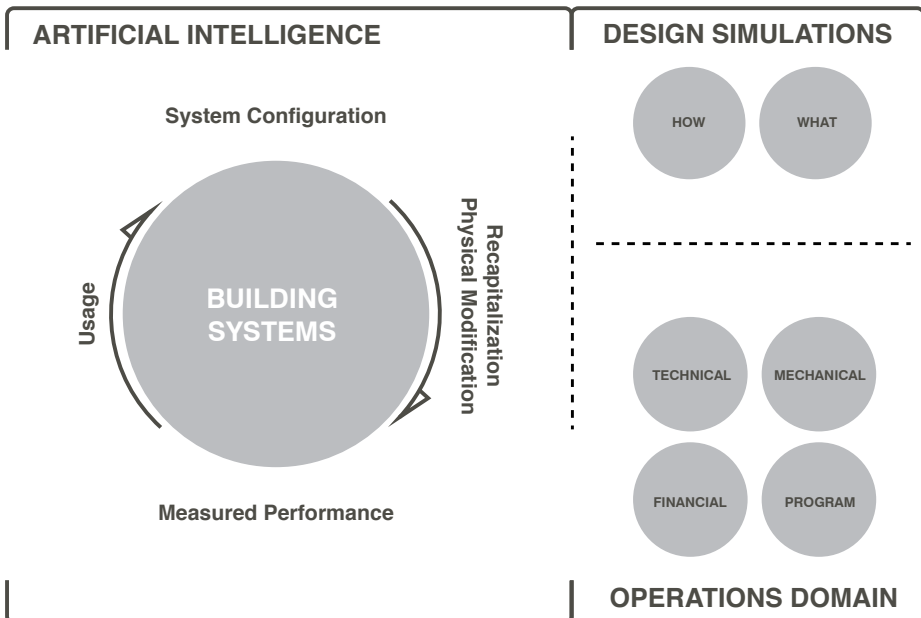
Because of the unknown aspects of extreme weather and climate change, focusing on the capacity to adapt in addition to the actual interventions within an adaptation process has the potential to advance knowledge in both anticipatory (i.e., *ex ante*) and reactive (i.e., *ex post*) adaptation (Fankhauser, Smith, & Tol, 1999). As Fankhauser, et al. highlight, reactive adaptation at one scale is often planned at another scale and vice-versa (Id.). An example of this is a scenario where a real estate developer designs a building to adapt to both current parameters of an extreme weather (e.g., = wind, = flood) and climate change (e.g., = wind, > flood) following the occurrence of an extreme event. That initial extreme event might or might not have been caused by climate change. Therefore, in the future when an extreme event occurs as a consequence of climate change

**FIGURE 1.1:** Framework for Adaptive Capacity of Firms (User / Manager)



Source: Berkhout, et al. (2004); Arnell & Delaney (2006); Fankhauser, Smith & Tol (1999)

**FIGURE 1.2:** Framework for Adaptive Capacity of Buildings (Objects)



(e.g., = wind and > flood), it can be said that this original act in the furtherance of adaptation was both planned and reactionary. Therefore, evaluating the success of adaptation across scales is less dependent on anticipatory or reactive ordering than it is about a capacity to adapt by various social and ecological agents relative to various global and local determinants (Adger, Arnell, & Thompkins, 2005). While scholarship has advanced broader aspects (i.e., determinants) of evaluating and defining socio-ecological adaptive capacity (Yohe & Tol, 2002; Smit & Wandel, 2006), very little scholarship has translated this case specific knowledge to applied measures of adaptive capacity, which are relevant more broadly to private sector real estate from the perspectives of buildings, real estate firms and professionals (Hertin, et al., 2003). As theoretically and empirically explored within these perspectives, broad aspects that unite many of the conceptualizations of adaptive capacity are: (i) intelligence/awareness; (ii) strategy; and, (iii) space of decisions and/or range of resources for executing a stated or emergent strategy. Whether it is the intelligence or awareness of building managers or real estate finance professionals, the designed artificial intelligence of building systems or the identification of real estate management strategies, this dissertation will build upon a variety of investigations that define a working set of parameters for adaptive capacity in real estate and will set the stage for a wide ranging set of inquiries in private sector adaptation.

The failure of a building or a broader real estate sector to adapt to climate change has significant implications for social and economic stability. However, as will be discussed in Chapter IV, the theoretical frameworks and empirical findings of this dissertation may also be applied to private sector adaptation beyond the immediacy of climate change. It is assumed that it is the indirect impacts of climate change in terms of political, social and economic instability that are likely to be just as disruptive as the physical and climactic manifestations. Chapter IV will attempt to bridge business and climate science scholarship to explore how adaptation of real estate firms is related to larger frameworks of socio-ecological adaptation. In short, businesses are always in a state of adaptation to dynamic market conditions. Positioning adaptive capacity as a potential avenue for promoting commercial interests also is likely to serve as a key economic motivator for engaging the private sector within larger societal efforts to adapt to climate change—assuming that some measure of co-benefits exist between public and private realms. As a practical matter, the knowledge developed in this dissertation is thus aimed to be useful for agents in the private sector who are assigned to address a wide variety of changes, from an aging society to declining stocks of natural resources.

The theoretical frameworks developed in this dissertation are aimed to provide a basis for parallel analysis and evaluation of adaptation processes in the built environment that are defined by historical performance and informed estimations of future actions. It is this intermediate perspective of buildings, the real estate firms and professionals where an understanding of intelligence, strategy and resources is critical for understanding motivations and mechanisms of adaptive

and resilient outcomes—even though these outcomes are merely points on a continuum of stable and unstable states within the respective processes. This represents not a bottom-up approach to adaptation but a bottom-up perspective of phenomena that are often viewed in isolation as adaptive or resilient. Therefore, this dissertation represents research in adaptation and not in adaptive objects, organizations or people. As will be discussed in various chapters, these objects have generally always been subject to a process of adaptation whether it was internally acknowledged or otherwise referenced as such. In formal terms, the research presented in this dissertation research represents a link between scholarship in the process adaptation of building systems (Bai & Xin-yuan, 2012; Kumar, Fensel, & Fröhlich, 2013) and the outcome driven perspective of building design (Brand, 1995); and, the process adaptation of private sector organizations (Weinhofer & Busch, 2013; Akgün & Keskin, 2014; Linnenluecke & Griffiths, 2015) and the outcome driven perspective of private sector firm adaptation within markets (Hallen, Johanson, & Seyed-Mohamed, 1991; Lukas, 1999; Andries & Debackere, 2007; Di Valentin, et al., 2012). This distinction is critically important for the consistent replication of the methods applied and the generalizability of knowledge produced.

## **D. Conceptual Distinctions**

The boundaries and interrelationships between the aforementioned concepts have been the subject of a great deal of friction in the translation of theory to practice, as will be theoretically explored in Chapter II and empirically evaluated in Chapter V. However, in order to reinforce the conceptual distinctions so that they might be consistently interpreted across various perspectives and systems, it is helpful to provide an example. A seaside town experiences increasing coastal flooding and storm surge events. The residents' first reaction is to build individual flood gates around their individual buildings—this is an example of a mitigation intervention leading to flood resilience. The problem is that the flood waters hit the barriers and are funneled upland to flood buildings that were previously untouched by flooding. This is an example of resilience that leads to maladaptation. In response, the town builds a flood wall around the town and takes steps to design their buildings differently so that they may be periodically flooded if the floods breach the flood wall. In this case, the flood-wall is a type of mitigation leading to flood resilience that is complimentary to an adaptation of building designs. However, with sea level rise, the flood wall (in its highest and best manifestation) continues to be breached and the town is more regularly inundated. It is at this juncture that the town elects to move a few miles inland. This is perhaps the most classic example of the crossing of a resilience threshold and the ultimate act of adaptation in such a scenario—retreat. This set of scenarios can be viewed along a continuum of stable and unstable states stemming from external shocks, as will be explored in Chapter IV. To this end, it has been theorized that resilience has a threshold and beyond that threshold, one either adapts or fails (Werners, et al., 2013). In this example, the town elected to adapt and not fail. As will be discussed, these

concepts of adaptation, resilience and mitigation do have precise meanings, but their applications are subject to a series of conflicts and synergies that are subjectively dependent on actor orientation, timing, resources and the like.

While mitigation interventions and resilience processes are fairly straightforward in technological and social terms, relative to presently understood risks, adaptation and its transformational aspects are much less understood in its mechanisms and motivations. As such, this dissertation focuses on adaptation and adaptive capacity as it crosses perspectives from the building, to the real estate firm and finally to professionals. While mitigation interventions and resilience processes speak to known risks and vulnerabilities, their operations are discernable within the parameters of the climate as we know it today. However, adaptation's operations across known and unknown risks speaks to a greater challenge consistent with the unknowns associated with climate change. As will be discussed in various chapters, it is widely recognized that it may be maladaptive or even unsustainable to perpetuate the resilience of the built environment as we know it today. As such, the highest order of conceptual priorities is to explore and understand adaptation because the only other option beyond the resilience threshold is failure.

### **3. Research Development and Design**

#### **A. Problem Formulation**

The research focus of this dissertation was formulated through direct professional and academic experiences of the author with real estate development following extreme weather in urban areas across the U.S., including in NYC, Miami and the U.S. Gulf Coast. These experiences suggested that more regular occurrences of extreme weather with the advent of climate change would significantly challenge physical, economic and social elements of the built environment. With a historical track record of stagnate productivity and limited innovation, an initial working proposition was that the U.S. real estate industry lacked the conceptual frameworks and applied mechanisms and designs necessary for effective planned or reactive adaptation. Aside from the conveniences of logistics and access, the NYC metropolitan region was selected as the *situs* for this research as it is considered to be both one of the most sophisticated and most physically vulnerable real estate markets in the world. In this dissertation, firm sophistication is defined by available resources (i.e., financial and human capital), acknowledged leadership among peers, and large volumes of building assets in terms of square meters and market value that otherwise require high levels of management competency. Market sophistication is defined in terms of the underlying transactional efficiency, transactional volume and the high levels of complexity concerning the design, planning, management and transaction of buildings. Vulnerability is defined in terms of the underlying risk to buildings and infrastructure from extreme weather events and from the direct impacts and consequences of climate change, including sea level rise and warming temperatures. As will be discussed in subsequent chapters,

some elements of sophistication and vulnerability are arguably partially deterministic of a building's, a firm's or a professional's adaptive capacity. Finally, in terms of public and private policy, NYC is also considered to be one of the more progressive in terms of climate change mitigation and resilience.

Therefore, it was assumed that if empirical evaluation were to investigate aspects of adaptation and adaptive capacity, NYC would likely have adequately observable phenomena that would provide the empirical basis sufficient to address the main research aim of this dissertation and to produce potentially generalizable results. One may argue that the unique qualities of NYC, in terms market and firm sophistication, as well as vulnerability, limit the generalizability of the results. However, the counter argument is that buildings, real estate firms and professionals operating in NYC are not that fundamentally different, in terms of sophistication and vulnerability, from equally or similarly sophisticated and vulnerable real estate markets elsewhere in the world, such as Hong Kong, London and Tokyo. This is particularly true given the globalization of real estate capital and the increasing standardization of real estate markets and practices (Gotham, 2006; Sassen, 2011).

## **B. Research Aim and Questions**

The main research aim of this dissertation is to develop an understanding of the adaptive capacity of: (i) buildings, (ii) real estate firms, and (iii) professionals in NYC. The central research question seeks to understand how and to what extent the three aforementioned perspectives and systems have the capacity to manage, accommodate and otherwise adapt to the risks and opportunities associated with extreme weather and climate change. This dissertation seeks to accomplish this aim and address this central question through the development of conceptual frameworks and then explore and refine those frameworks through case studies and other empirical research. Figures 1.3 and 1.4 identify the order of the development of these frameworks, as well as the research focus and perspective for each of the subject chapters. Thereafter, as highlighted in Figures 1.5 and 1.6, the intent is to begin to explore how adaptive capacity interacts across the various perspectives and systems so as to provide an epistemological basis for adaptive capacity that is scalable in its operations and offers evaluation criteria across material, social and geographic realities. In Figures 1.5 and 1.6, hatching represents moments in each of the respective chapters where the research focus, methods, questions and/or conclusions have resolved to be understood across more than one perspective.

The anticipated contribution of this dissertation is to advance a synthetic understanding in the professional practice of real estate that acknowledges the possibility, if not necessity, to design and manage adaptive buildings and real estate firms. Hence, this dissertation sets forth a set of working definitions and frameworks for adaptive capacity and related concepts that represent potential steps in the translation from theory to practice in the science of adaptation. By focusing on adaptive capacity, including exploratory empirical evaluations, normative processes and explanatory

motivations, this dissertation explores useful ways to measure and evaluate adaptive capacity, and provides options for operationalizing the capacity within the complex systems of buildings and real estate firms. As will be discussed, the adaptive capacity of professionals is based on an assumption that their individual capacities are predicated on their knowledge, preferences and biases for developing plans, designs and strategies that prepare for and respond to extreme weather and climate change. Therefore, the focus in this dissertation is not in developing a complex theory of individual professional adaptive capacity but in developing an understanding of the current state of professional knowledge, preferences and biases that, in turn, logically affects their ability to (further) develop robust adaptive capacities in buildings and real estate firms.

This research sets forth lessons and values that may extend beyond NYC real estate to other private and public sectors, such as water management, agriculture, transportation, tourism and the like. In addition, the modes of professional intelligence for analyzing adaptation and its related concepts speak to a variety of allied professionals operating within the built environment, including design and planning. As will be discussed, this level of professional intelligence speaks to a larger adaptive capacity of the various institutions of the built environment. However, the empirical scope of the research contained in this dissertation is largely on the private sector.

In furtherance of the research aim and central question of this dissertation, the research seeks to address the following theoretical and empirical questions. Figure 1.6 highlights where each of the research questions are addressed in the respective chapters, as well as the underlying methods associated with addressing these questions.

**R1: How can the adaptive capacity of a building be conceptualized within the parameters of the adaptive cycle and prevailing ecological systems theory**

The aim of this question is to conceptualize how architects and building managers can design and operate buildings and building systems that have the intelligence to register and adapt to change. This question also implicitly questions the range of parameters from which a building may adapt in terms of physical, environmental and economic conditions, as positioned within urban and human ecologies. This question also seeks to harmonize the concepts of building life cycling with the concept of that adaptive cycle that is critical to the aforementioned ecological theories. In addition, the question seeks to conceptually explore the mechanisms of building adaptation and the requisite resources necessary to support those adaptations. Because the physical design is intricately connected to operations and management, this question is mutually dependent in part with questions R2 and R3. This first question will be explored in Chapter II. This chapter introduces and contextualizes a framework for firm adaptive capacity that will be developed in more detail and empirically explored in Chapter III. While Chapter III develops the model more in-depth, Chapter II provides a broader theoretical foundation that connects the three perspectives that are central to the research aim of this dissertation.

**R2: How can the adaptive capacity of a real estate firm in NYC be conceptualized and empirically evaluated?**

The aim of this question is to provide a conceptual basis for developing a framework that can be used to measure and to evaluate adaptive capacity of a firm that develops and manages real estate. The predicate condition is the identification of the essential elements of adaptive capacity. The merits and focus of these elements are refined throughout subsequent chapters of the dissertation. This second question will be raised in Chapter II, addressed through a theoretical framework that will be applied in Chapter III, and will be explored further in Chapter IV.

**R3: How can the adaptive capacity of a real estate firm in NYC be normatively developed?**

The aim of this question is to raise a series of qualitative propositions for evaluating firm processes in NYC that might promote the diffusion of organizational innovation and human intelligence that might be understood as instrumental for the development of a robust adaptive capacity. This question will be introduced and partially explored in Chapter IV.

**R4: How do the concepts of sustainability, resilience and adaptive capacity relate to each other in theory and NYC real estate practice?**

This question stems from a desire to understand how the capacities, techniques and the popular consciousness of sustainability can be translated or even harnessed to relate to the processes of adaptation and the promotion of adaptive capacity. As a more mature applied paradigm in real estate, sustainability offers some potential lessons in how to translate theory to practice that a framework for adaptive capacity could benefit from. In addition, this question sets the context for an attempt to harmonize elements of adaptation scholarship in applied climate science, ecology and business academies. Ultimately, this question seeks to identify and understand potential values that justify the development and promotion of an adaptive capacity in buildings and in real estate firms. These potential values could represent critical first steps in measuring and benchmarking adaptive capacity. The question recognizes the potential for both conflicts and synergies in the parallel implementation and/or emergence of sustainability, resilience and adaptive capacity in NYC real estate practice. In addition, this question is also particularly relevant in light of the global push to align adaptation and climate mitigation strategies, as well as the stated necessity for the private sector to accommodate climate change. This fourth research question will be addressed in detail in Chapter IV.

**R5: What is the state of the adaptive capacity and current behavior of real estate firms in NYC?**



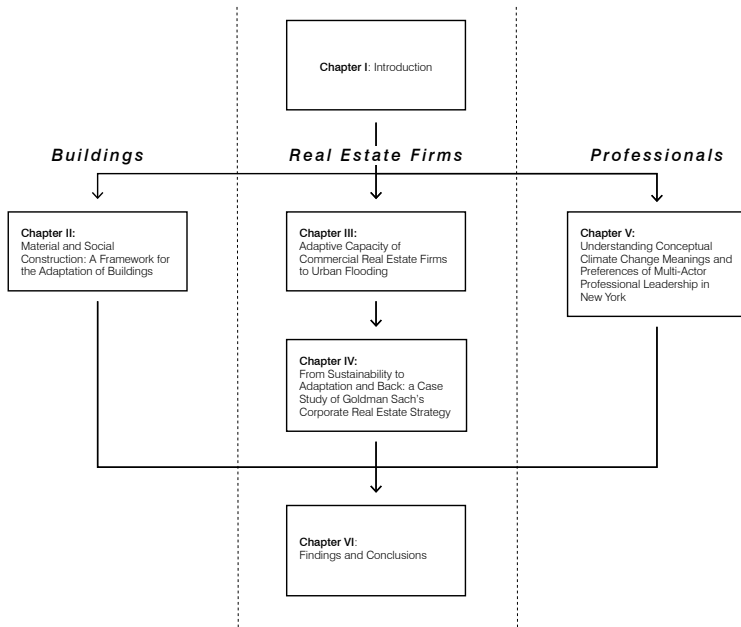
This questions stems from a core empirical aim of this dissertation to uncover the existing state of awareness, behavior, range of resources and options, and strategy of real estate firms. As previously referenced, there is very little empirical research on adaptation and real estate (Hertin, et al., 2003; Roders, 2015). Understanding the current state of real estate practice in NYC is critical for contextualizing more developed adaptation research from other sectors, as well as demonstrating the underlying ripeness of this dissertation. Moreover, this question helps to further contextualize questions R1, R2 and R3. This fifth research question will be explored through a meta-analysis of multiple cases in Chapter III, as well as through an individual case in Chapter IV.

**R6: What is the facility of professionals in NYC to understand and apply core climate change concepts in the built environment and what are their preferences for the application of these concepts?**

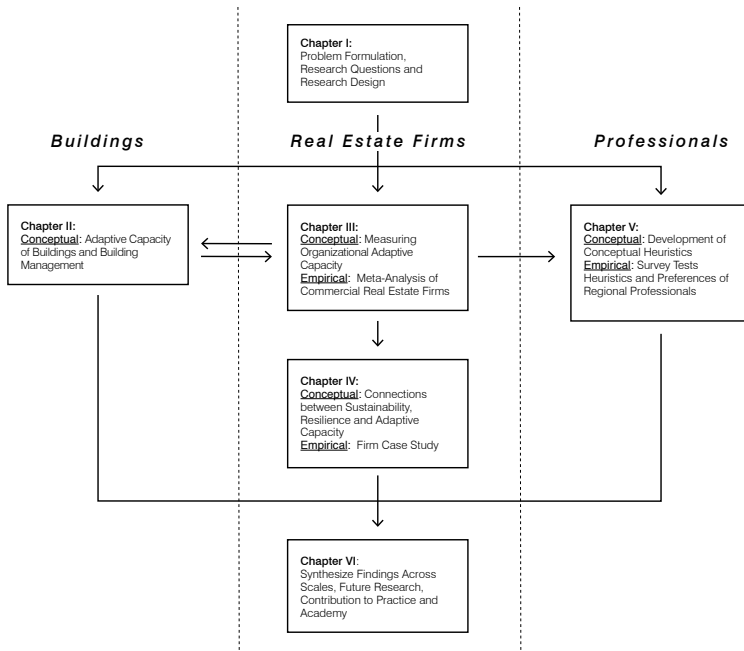
The development of adaptive capacity in real estate by professionals is based on an assumption that their individual capacities are predicated on their knowledge, preferences and biases for developing plans, designs and strategies that prepare for and respond to extreme weather and climate change. It is assumed that a core function of this collective notion of intelligence and behavior is premised on each individual's ability to understand concepts and meanings that are critical for more complex decision making. Therefore, the focus in this dissertation is in developing an empirical understanding of the current state of professional knowledge, preferences and biases that may have impact on their ability to develop robust adaptive capacities in buildings and real estate firms.

Experience both prior to and after the commencement of this dissertation with climate change planning and post-disaster real estate development suggested a very uneven distribution of working knowledge of critical concepts for responding to and preparing for climate change and extreme weather. However, as previously referenced, progressive climate policy and an active public discourse in NYC suggest a potentially higher level of contextual professional intelligence. The answers to this consolidated question are critical for evaluating how concepts of adaptation and adaptive capacity are translated and communicated across perspectives and systems to various actors with varying levels of interest, motivation and education. Likewise, a demonstrated lack of conceptual distinction undermines the development of potential analytical tools that are predicated on uniform metrics and modes of analysis that would otherwise advance the adaptive capacity of a building, firm and/or professional practice. This sixth and final question will be explored quantitatively among professionals who are taking leadership roles in the ongoing discourse and practice in NYC in Chapter V.

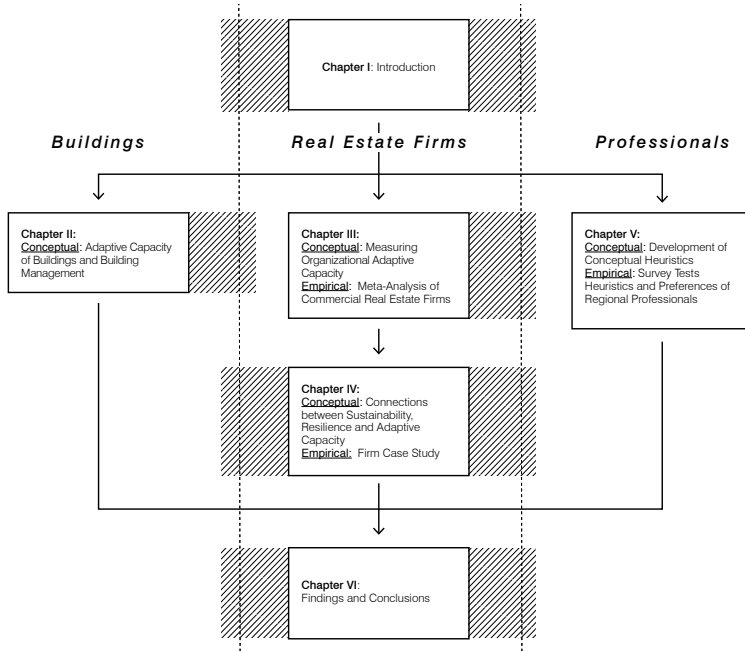
**FIGURE 1.3:** Chapter Organization



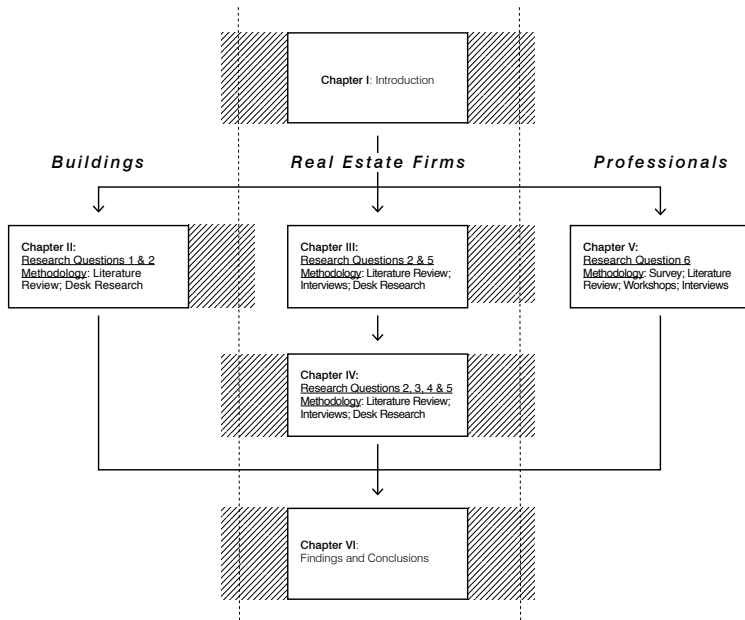
**FIGURE 1.4:** Research Focus



**FIGURE 1.5:** Research Overlap Across Perspectives



**FIGURE 1.6:** Research Questions Across Perspectives



## C. Outline of Dissertation

As previously referenced in Figure 1.3, the content of this dissertation is composed of four chapters that each represent an independently researched, peer-reviewed and published article. As represented in the foregoing figures, the organization of this dissertation tracks three perspectives: (i) buildings; (ii) real estate firms; and, (iii) professionals in NYC. As tracked in Figure 1.4, the research will begin in Chapter II with a literature review and theoretical development of the adaptive capacity of buildings. This chapter defines adaptive capacity of buildings as a construction of both human managers and artificially intelligent building systems. While largely focused on the perspective of the building, the research also incorporates concepts of firm adaptive capacity that define the human element of social construction. Building off of a previous generation's architectural research in the morphology of buildings (Brand, 1995; Roaf, Crichton & Nicol, 2005), this research is positioned within prevailing systems and adaptation theory to provide a basis for conceptualizing how buildings adapt to changing conditions of the environment, user demands and even economic fundamentals along a broad continuum of the adaptive cycle. Chapter II will address questions R1 and R2.

Chapter III will advance a more detailed development of a conceptual framework for firm adaptive capacity, primarily as developed through a literature review. The framework is then contextualized against a meta-analysis of the case studies of the adaptive capacity of six commercial real estate firms in NYC following Hurricane Sandy. The research attempts to resolve several debates within the scholarship as to the processes of private sector adaptation and to what extent adaptation is exclusively self-serving, reactionary or *ex post*. As such, the research examines the propositions that: (i) firms with observable strategies have undertaken *ex post* strategies which are principally driven by the firms' financial bottom line; (ii) 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, (iii) firms with the comparatively most robust adaptive capacities will be those who: (a) are most aware of their vulnerabilities; and, (b) are themselves comparatively more vulnerable to the immediate risks associated with urban flooding. Chapter III will address question R2 and R5.

Chapter IV will explore the conflicts and synergies between sustainability, resilience and adaptation both in theory and in practice. While other literatures suggest that sustainability fundamentally breaks the adaptive cycle to which adaptation is conceptually dependent, this chapter suggests that adaptation and resilience requires some measure of sustained resource allocation. The argument provides the basis for a link between the concepts, which is then explored in a case study of the

corporate real estate strategies of Goldman Sachs. The case attempts to demonstrate how corporate real estate and asset management strategies, driven in part by sustainability logics, also advance the adaptive capacity of the firm. Pursuant to this conceptual framework, the core proposition is that there are positive relationships that do exist, whether recognized or not by the firm. A secondary proposition seeks to evaluate whether the capacity of the firm to adapt and be resilient to changing conditions has been positively advanced by the firm's sustainable corporate real estate strategies. Chapter IV will directly address question R4 and secondarily addresses question R2 and R5.

Chapter V will shift perspectives from that of the building or firm to the larger allied professional classes operating within the built environment. This article sets out to evaluate the range of meanings and preferences for the concepts of adaptation, resilience, mitigation and coping of a representative sample of largely private sector professionals active in climate change leadership in the NYC metropolitan region. This chapter will position a normative set of interpreted and simplified meanings for each of the aforementioned concepts based on a review of existing literature. Utilizing a survey, these normative meanings are evaluated by and between the: (i) concepts and meanings; (ii) concepts and applications; and, (iii) applications and preferences, as applied to various risk based scenarios ranging from sea level rise to heat waves. Based on observations of two leading climate change panels in the NYC metropolitan region, resilience was observed to be inconsistently and incorrectly utilized in its rhetorical form as the leading meta-concept in place of adaptation. The survey tests the hypotheses that the respondents: (i) are unable to consistently match the concept of resilience with the normative meanings or applications; and, (ii) will not consistently show a preference for resilience applications or outcomes ahead of other concepts. Overall, the chapter will attempt to provide insight into the contextual intelligence and strategic preferences of professionals consistent with the inquiry identified in question R6.

The dissertation will conclude with a Findings and Conclusions chapter that provides a survey of the findings of the chapters, including the strength and weaknesses of the findings, methods and broader research design. The chapter will also attempt to provide a synthetic discussion of how various findings may be understood to cross by and between the various perspectives and units of analysis. This final chapter will provide some context for the scientific and practical relevance for motivating and stimulating future research.

<b>Table 1.1: Publication Status of Chapters/Articles</b>		
<b>Chapter / Paper</b>	<b>Abstract Published / Presented at Conference</b>	<b>Published in Journal</b>
<b>Chapter II:</b> Material and Social Construction: A Framework for the Adaptation of Buildings	2015 European Climate Adaptation Conference, Copenhagen	Enquiry: Journal of Architectural Research
<b>Chapter III:</b> Adaptive Capacity of Commercial Real Estate Firms in NYC to Urban Flooding	2014 Deltas in Times of Climate Change II, Rotterdam	Journal of Water and Climate Change
<b>Chapter IV:</b> From Sustainability to Adaptation and Back: a Case Study of Goldman Sach's Corporate Real Estate Strategy		Building Research & Information
<b>Chapter V:</b> Understanding Conceptual Climate Change Meanings and Preferences of Multi-Actor Professional Leadership in New York	2015 European Climate Adaptation Conference, Copenhagen	Journal of Environmental Policy & Planning

## **D. Research Design and Methodology**

The research design of this dissertation is based on an exploratory undertaking within four independently published research projects, whose individual preliminary or final questions and/or results, form some basis for each successive or parallel inquiry (Creswell, 2013). The research primarily utilizes a multiple case study design in tandem with the development of theoretical and conceptual frameworks that guide the interpretation and organization of data collected from the cases (Noor, 2008; Yin, 2013). This design is reinforced with both normative and other forms of descriptive research. In total, seven firms were selected for case study evaluation. As per Chapter III, six commercial real estate firms were selected following the occurrence of Hurricane Sandy and data collection was undertaken in an exploratory manner prior to the complete development of the conceptual framework (Stebbins, 2001). However, framework development was largely complete by the end of the case studies, which offered the researcher the opportunity to refine specific inquiries and data requests and collection strategies. These six firms were evaluated over the course of a year and the results were utilized to perform a meta-analysis that offered the opportunity to interpret data that defied comprehensive meaning and analysis in isolation (Hunter, Schmidt, & Jackson, 1982; Rosenthal, 1991). As will be discussed, the results were most meaningful when contextualized against the benchmarks provided by other subject firms, as no such benchmarks existed in the literature. The case study of Goldman Sachs also commenced with an exploratory intent, but was concluded after two and one-half years with the benefit of a more developed conceptual framework that allowed for more focused and refined data collection, as well as comprehensive findings.

Despite the initial exploratory disposition with each of the cases, particular attention was placed on identifying actions, inactions, management processes, and strategies as it may have related to both the direct and indirect impacts of extreme weather and climate change (Eriksson & Kovalainen, 2008). A significant limitation to this focus on climate change is that the wide range of potential impacts and vulnerabilities from extreme weather and climate change is beyond the knowledge of the researcher and the research subjects. Likewise, as previously referenced, many aspects of extreme weather have little to no empirical connection to global climate change at the present (Muis, et al., 2015). However, for each firm, risk analysis and evaluation were performed for each firm for known or probabilistic risks, such as urban flooding, storm surge, sea level rise, heat waves and power brownouts. These studies were by no means comprehensive, but, instead, they provided a starting point for understanding the relative disposition of each firm by and between the respective firms' portfolios. Because these case studies were focused on firms, a great deal of sensitivity was acknowledged within the data collection methods for organizational structure, agency, authority and proprietary data (Eisenhardt, 1989).

With the exception of Goldman Sachs, the six other case study real estate firms were reviewed and published anonymously. This anonymous publishing requirement was guaranteed by the researcher in order to gain complete access to firms who have tremendous market and reputational sensitivities to an evaluation of their operations and portfolios (Yin, 2013). While case selection will be discussed in each of the respective chapters, it should be recognized that access to firms was more or less a function of existing professional relationships and practical considerations. Although relationships generally existed in some form prior to the commencement of the research, there existed no conflicts of interest or perceived conflicts of interest. The principle selection criterion was based on the anticipated and committed level of access and transparency for undertaking the research (Dul & Hak, 2007).

This dissertation attempts to balance theoretical and empirical research in order to provide a useful perspective of the adaptation processes and the adaptive capacity of buildings, real estate firms, and professionals in NYC. Therefore, in addition to the cases, one chapter will be devoted to a descriptive and normative conceptual development and another chapter will be devoted to an empirical assessment based on hypotheses developed in part through action research (Stringer, 2013). The order of the chapters does not reflect the chronological order that the research was conducted and published. Empirical research in Chapters III and IV was undertaken concurrently with theoretical development of Chapter II which would later have a reciprocal influence on the frameworks developed in the former. In this sense, there was dynamic relationship between empirical and theoretical research wherein early stage empirical research advanced a refinement of theoretical perspectives, arguments and applications. Finally, research in Chapter V was undertaken in part to provide an empirical validation of the core concepts developed in prior research. Because of the non-sequential

and non-linear nature of the research, there existed many feedback loops between theory and data that regularly provided a refinement and calibration of the research. Likewise, feedback was incorporated from external reviewers and other colleagues prior to submission and during the blind peer review process that provided invaluable feedback that often advanced the quality of chapters with dependent concepts and arguments.

While the dissertation largely focuses on qualitative case studies, collectively, a mix of methods was utilized for identifying, collecting and evaluating data. The primary data collection method was semi-structured interviews (Gubrium & Holstein, 2002) with 92 individuals and unstructured interviews with 52 others over the course of just over three years (2012-2015). As a general practice, interviews were recorded on audio devices and transcribed by the researcher (McLellan, MacQueen, & Neidig, 2003). However, while a vast majority of interviews were on-the-record, some interviewees were provided anonymity off-the-record—particularly those interviewees who were at the time public officials. This provided an additional methodological challenge in terms of verifying and validating data collected during such interviews (Guenther, 2009). Not all of the data collected from interviewees were included in the research. Many of the unstructured interviews simply provided context, helped identify alternative data sources or validated existing data. As will be discussed in the respective chapters, to the extent possible, data from interviews was triangulated with data collected from other interviews, from document reviews and content analysis, and, in some cases, from direct observations (Golafshani, 2003). Three-dimensional geographic information systems software and data sets were frequently interfaced with two-dimensional building and real estate data to evaluate the assets and portfolios of subject firms and to verify and/or triangulated data collected from interviews with regard to current or historical practices (Denzin, 2012). For example, the research in Chapter III was advanced by an unpublished survey and mapping of technical responses and repairs to buildings that were flooded by Hurricane Sandy. This information was used to formulate interview questions and to verify, together with public records, specific actions and costs associated with stated strategies and responses.

The survey method was utilized in Chapter V to identify the capacity of professionals to adapt as it related to an examination of their ability to discern core climate change concepts (i.e., adaptation, resilience, coping and mitigation) and their preferences for applications of these concepts (Fowler, 2013). Based on a comprehensive literature review, this method provided a quantification that partially validated the meanings assigned to the respective concepts in prior chapters. The survey tested hypotheses developed in part by direct participation in workshops. While the author contributed to the deliberations of the workshops, these interactions and contributions were not directly related to the formulation and testing of the hypotheses (Kamberelis & Dimitriadis, 2013). The author was careful not to bias the potential sample pool, which the author anticipated sampling at some juncture in the future.



Even in the event of an inadvertent steering or biasing, these interactions were conducted with a very small number of respondents relative to the size of the total sample pool evaluated in Chapter V.

With an epistemological and ontological foundation in critical realism, the author has acknowledged the limitations of his own observations that are dependent on his own understanding of reality. However, these observations may otherwise be accurate representations of an external world that is either patently objective or otherwise subject to some measure of intersubjectivity (Bhaskar, 2013). Therefore, the subjectivities of data and methods (e.g., qualitative) associated with built environment science and social science may very well be accurate representations of actual phenomena also understood in more structured terms under the auspices of the scientific method defined by generalizable and falsifiable truths (Næss & Jensen, 2002; Lawson, 2013; Næss, 2015). For example, the scientific quantitative methods in Chapter V partially confirmed the validity of the interpreted and constructed meanings developed qualitatively in Chapters II and III. Nowhere is the necessity for a cohesive field of knowledge more pressing than in the downscaling of physical climate science to the management and design of buildings (Beauvais, Ghosh, & Dickson, 2015). This philosophy provides the basis for the applied climate science of adaptation within the context of both a physically and socially constructed built environment.

## **E. Scientific Relevance**

This dissertation is aimed to provide a meaningful contribution to the scientific scholarship as the science for adaptation transitions to the science of adaptation (Swart, Biesbroek & Capela Lourenço, 2014). With the preponderance of the scholarship focused on governance and the public sector, this research begins to address a critically important aspect of adaptation in the private sector (Agrawala, et al., 2011) and in the built environment (Roaf, Crichton & Nicol, 2005; Gething, 2010; Hunt & Watkiss, 2011; Georgescu, et al., 2015). There is almost no empirical or theoretical understanding of how real estate actors and buildings—as represented in the three subject perspectives—in NYC or elsewhere are undertaking actions or inactions that may be contextualized or interpreted as part of the process of adaptation—or, maladaptation (Hertin, et al., 2003; Bunten & Kahn, 2014; Hofman, et al., 2015; Putra, Zhang, & Andrews, 2015). Beyond actor orientation, this research also attempts to provide an understanding of adaptation and adaptive capacity that is scalable in its analytical applications and epistemological meanings in its various material and social manifestations (Adger, Arnell, & Thompkins, 2005). As will be discussed, the concepts of adaptation and resilience are often subjectively defined at a singular point in time relative to an intended beneficiary which confuses the conceptualization of process over outcomes. By focusing on a capacity to adapt, this tendency for empirical evaluation of an object or singular state is re-shifted to an appropriate unit of measurement and analysis. By applying this frame of reference to conceptual

and empirical research, within the context of the built environment, the foregoing research represents a potential contribution to the sciences of adaptation and the built environment.

## **F. Practical Relevance**

The practical relevance of this research is manifest in the stated necessity of real estate firms to develop and operationalize their adaptive capacities and for designers and managers to construct and operate buildings that have the capacity to adapt to changing environmental and socioeconomic conditions. Of course, the latter is highly dependent on the former. In terms of environmental risk only, the scope of vulnerability is well beyond that of any aggregation of public resources or authority. In order to engage the private sector, frameworks and analytical models are necessary for the development of tools that define and understand adaptation and adaptive capacity. Likewise, these tools are necessary to demonstrate not only how to manage at-risk capital, but also how value may be created in order to satisfy profit-seeking motivations. By example, Chapter IV will demonstrate how the adaptation of a building and its managed operations created value that advanced business operations at Goldman Sachs. Firms around the world are already seeking to incorporate and operationalize adaptive capacities, generally within the context of supply chains (Westervelt, 2015). However, as climate change accelerates in its manifested and distributed impacts, a variety of operations within an increasing diversity of sectors will need to develop robust adaptive capacities for accommodating both the known and unknown. With real estate and the built environment on the front lines of housing, commerce and people, it is necessary that it maintains a leadership position in the advancement of adaptive capacity. A failure to do so will likely result in a cascading of impacts that are amplified in their effects so as to challenge the stability of our societies, economies and environments.

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## CHAPTER II | Material and Social Construction: A Framework for the Adaptation of Buildings

This chapter is a formulation of a framework for understanding the nature of change, particularly climate change, as it applies to the scale of a building. Through an exploration of various scientific and social scientific literature, the chapter positions the concept of adaptation as the appropriate mode for understanding and managing change. Through the classification of a duality of material and social construction in the ontological composition of a building, various lines of thought relating to adaptive capacity and adaptive cycling within systems theory are appropriated within an integrated framework of adaptation. Specifically, it is theorized that as buildings as objects are developing greater capacities for integrated operations and management through artificial intelligence, they will possess an *ex ante* capacity to autonomously adapt in dynamic relation to and with the *ex post* adaptation of owners and operators. It is argued that this top-down and bottom-up confluence of multi-scalar dynamic change along an adaptive cycle is consistent with the prevailing theory of Panarchy applied in social-ecological systems theory. The chapter concludes with perspectives on the limitations of systems theory in architecture, future directions for research and an alternative positioning of professional practices.

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The advent of climate change has accelerated the development of scientific and social scientific research into understanding the dynamic nature of change by and between complex systems and institutions. In a parallel state of paralytic development, architectural design research on the implications of climate change has largely been subservient in its relevance and application to the economic behaviors of the responsive modes of real estate production (Hertin et al., 2003; Stern, 2007). In a limited capacity to-date, architectural design has been a proxy engagement for the incorporation of mono-technical solutions which serve to mitigate the occurrence of climate change justified through operational economic efficiencies (Etzion, et al., 1997; Givoni, 1998; Steemers, 2003; Van der Linden et al., 2006; Schuetze, 2011; Brown & Dixon, 2014). Yet, in the face of climate change, the construction of architecture's aesthetic and semiotic power has the ability to preserve and advance forms of culture which escape economic unitization. As such, the conventional mitigation framework—often co-referenced as sustainability—is increasingly reaching a threshold of comprehensiveness, influence and development as the occurrence of climate change is now unstoppable by human action (IPCC, 2014).

This chapter proposes a normative framework from which future theoretical and empirical research can advance the practice of designing and managing adaptive buildings. This framework is intentionally limited to the scale of the building and its users and not to the urban form, which has a different range of calculi and associated sets of methods and ontologies (Vachon, et al., 2013). This limitation at scale does not exclude from analysis the natural and urban ecological forces which shape the use and performance of a building. Instead, it merely acknowledges that the systems behind such forces have separate and unique capacities and cycles to accommodate change, even if such capacities and cycles are reciprocally dependent in some measure to the design and operations of a building.

Inherent in this exercise is an acknowledgement that the problem-solution set cannot be entirely optimized or engineered given the socio-ecological complexity of the challenges which are yet to be known (Bulkeley & Betsill, 2013; Mazmanian, Jurewitz & Nelson, 2013; Ovink, 2014). As such, adaptation at the scale referenced herein is a set of dynamic multi-scalar systematic processes which are referenced to a variety of stimuli that are not exclusively physical, ecological or climactic in their proximate degrees of influence. By extension, this adaptation framework is developed not as an exercise for explaining change but as a means to understanding and exploring the balancing of design intentions and management strategies which may be both anticipatory and reactive. From accommodating an aging society in Tokyo multi-family buildings to flood proofing commercial office buildings in New York City, a comprehensive framework for adaptive building design and management which bridges various scales, typologies and stimuli has yet to be explored.

The first step in the development of this nascent framework is the positioning of the concept of adaptation by and between a diverse sets of competing and interrelated

concepts which have specific distinctions relating to actor orientation, time horizon, and system dynamics. Through the classification of a duality of material and social construction in the ontological composition of a building, various lines of thought relating to adaptive capacity and adaptive cycling within systems theory are appropriated within an integrated framework of adaptation. Specifically, it is theorized that as buildings as objects are developing greater capacities for integrated operations through machine learning and the artificial intelligence of building systems, they will possess a capacity to autonomously adapt in dynamic relation to and with the adaptive capacity of managers and users. While building managers and users tend to adapt to stimuli after the occurrence of the stimuli (i.e., *ex post*), the artificial intelligence of adaptive building systems allows for the buildings as objects to possess a capacity based on both internal and external designs which can accommodate change at the time of or prior to the occurrence of various stimuli (i.e., *ex ante*). It is argued that this confluence of multi-scalar dynamic change which has the capacity to result in the realized adaptation of a building is consistent with the prevailing theory of Panarchy applied in social-ecological systems theory. The chapter concludes with perspectives on the limitations of systems theory in architecture, future directions for research and an alternative positioning of professional practices.

## 1. Methodology

This exploratory and qualitative research is primarily based on a comprehensive literature review of both the science of adaptation and the science for adaptation within a variety of science and social science domains (Swart, Biesbroek & Lourenço, 2014). To fill in the gaps between these external domains of theory and practice and that of architecture, select interviews were initially undertaken with practicing architects, landscape architects, urban designers and associated academics who teach adaptation and resilience based studios. The fifteen (n=15) interviews were semi-structured with a duration of approximately one hour and were conducted with faculty primarily teaching in the New York metropolitan area. Inquiries were made about the interviewee's experience in sustainable, resilient and adaptive designs and whether there was any operable knowledge in defining and distinguishing between these concepts, as well as whether any distinctions were ripe, necessary or relevant. The outcome of the research was consistent with the initial assumptions which motivated the production of this research. First, there was no consistency in the application of any of the concepts of mitigation, coping, resiliency and adaptation. However, all fifteen interviewees were able to correctly define mitigation as applied to either climate mitigation or hazard mitigation, but only five interviewees found common meaning between the two applications. When inquiry was drawn as to how these concepts applied in decisions within their professional practices, seven interviewees acknowledged that the primary impetus after Hurricane Sandy was rebuilding the status quo and that resiliency was largely a rhetorical device which cannot be meaningfully separated from risk mitigation. Thereafter, there was no definitional consistency, even for those who additionally practiced in environmentally sensitive geographies following the occurrence of Hurricane Sandy.



As such, the collection and interpretations of the data after Hurricane Sandy may be subject to certain convenience and availability biases (Nicholls, 1999; Sunstein, 2006). This is to say that the risks of flooding may impose a narrow frame of reference in terms of timing and response which biases a larger world view on climate change or any other social, environmental or economic stimuli. The categorical results of the interviews are not presented in this chapter; but, the disparate nature of the results: (i) reinforced the timeliness of the necessity to draw order by and between the concepts presented herein; and, (ii) contextualized the necessity to give a hierarchy of motivations (i.e., real preference for mitigation) by and between the concepts of response. As a consequence of this multi-method research design, it should be qualified that the truth of the existence of any framework as a higher ordering acknowledgment of actual phenomena by agents of artificial or natural intelligence can only be evaluated through the eyes of history and therefore escapes empirical confirmation and falsification short of critical theoretical validation. However, with the proliferation of the adaptive technologies described herein, there exists an opportunity in the future to empirically evaluate the framework of this chapter as applied in professional practice.

## 2. Understanding Concepts of Change

There exists today a great deal of variation in the meanings and heuristics assigned to a variety of concepts which address the nature of a response to change (Moser & Ekstron, 2010; Preston, Mustelin & Maloney, 2013). The distinction and definitional or conceptual consistency between the terms adaptation, mitigation, resiliency and coping is a practical hurdle to framework development in a variety of applied domains. This chapter attempts to assign order to these various concepts with the intent of positioning adaptation as the most appropriate concept with reference to the design and management of buildings. More specifically, it is acknowledged that the adaptation of buildings represents a duality of material (i.e., object) and social construction (i.e., managers/users) which creates a transient ontology from which science and social science applications of the foregoing concepts may be referenced.

Specific to climate science, adaptation is defined as the “adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits mutual opportunities” (Intergovernmental Panel on Climate Change (IPCC) 2007a, p. 869). A more comprehensive definition of 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.” [Emphasis Added] (Adger, Arnell & Tompkins 2005, p. 78). As discussed in the following section, the notion of capacity within the adaptation framework is critical to contextualizing the duality of building as an object and as a social construction.

As Uittenbroek, Janssen-Jansen, and Runhaar highlight, adaptation specific to climate change can be further categorized as a matter of governance versus process (i.e., specific measures) (2013). This is to say that adaptation may be an outcome of an active and willful intention, as well as a passive set of processes disconnected from deliberate manipulation. While resilience can be thought of as a preservation of the entire operations of the status quo of a host (i.e., a host may be an individual, a building, a community, an organization, etc...), adaptation is a gradual process of maintaining periodic points of resilience which ultimately results in a future state of being which is superior to its predicated state in its ability to flexibly respond and continue to be resilient to known and unknown external stimuli through, if necessary, a transformation of domains of operations. As such, resilient hosts revert to the status quo with a minimal change in their internal operations based on existing internal designs, while adaptation results in a superior post-stimuli state based on both internal and external designs. In this sense, adaptation can be defined as having the potential for transformability of the host to an entirely different state of operations (i.e., program, use, intensity of use, services, etc...). The implications for this are not without costs, as transformation may not always be a smooth transition. Likewise, a host may become resilient to a specific stimuli, but it does adapt if it cannot become resilient to slightly, dramatically or totally different sets of stimuli. Therefore, resilience and adaptation are closely related in that resilience is an internal process of adaptation along with mitigation and coping but each concept differs in their future states of being and their long-term implications in response to a diversity of stimuli (Nelson et al., 2007; Nelson, 2011). In comparison, the following concepts each have their own criteria for occurrence, frequency, novelty and timing of stimuli (e.g., risks and opportunities) and their associated modes of response.

Mitigation holds perhaps the clearest conceptual distinction in that it speaks to the prevention of the occurrence of the external stimuli of change. Mitigation is often used interchangeably to mean hazard mitigation or climate mitigation (i.e., preventing hazards or climate change from happening at all or otherwise reducing the vulnerability to the risk). However, climate mitigation is increasingly losing relevancy as an exclusive matter of focus in that there is little doubt as to the probabilistic long-term occurrence of climate change. It should also be acknowledged that many acts of adaptation are also acts of mitigation and they may not easily be separated. For instance, adding a flood barrier in a building may prevent the risk of flash flooding but may also promote adaptation to sea level rise if storm surge is more frequently putting the building at risk. However, mitigation and adaptation may also work against each other with the classic example being that increased urban densities promote climate mitigation but make adaptation more difficult (McEvoy, Lindley & Handley, 2006).

In contrast, coping is a short-term responsive mechanism for the preservation of the minimum operations of a host. Coping is very often utilized in a post-disaster context with the notion of rebuilding and recovery. This should be contrasted with resilience which seeks to maintain all of the operations of the host in the face of present stimuli based on internal designs. Coping has no internal design to

respond to the same stimuli in order to maintain its full operations and therefore is relegated to the process of maintaining minimal operations. Coping is a concept originally borrowed from the field of psychology which evaluated individuals' ability to manage non-routine occurrences that are otherwise novel to the experience of the individual (Lazarus & Folkman, 1984, p. 131). While the provision of emergency shelter and post-disaster psychological and financial counseling are laudable actions to once in a lifetime disasters, coping can very often be grounded in an emotional response with its own rationality that often conflicts with the long-term logics of adaptation. For instance, rebuilding a home which has been repeatedly flooded may serve to advance the coping of the residents but it does not serve to promote either resilience or adaptation. While an on-site flood barrier for these same homes may promote mitigation and resilience, it is unlikely to be an act of adaptation.

Again, in this scenario, an act of mitigation may or may not be an act of adaptation. Klein et al., make three major distinctions between mitigation and adaptation. First, as a function of time and scale, adaptation has long-term impacts distributed across a larger scale (i.e., global warming), with mitigation generally having impact over a shorter time horizon on a more localized scale (Klein, et al., 2005, p. 4). Second, citing the IPCC (2001a), they note that because of the two different scales and time horizons the costs and benefits to be "determined, compared and aggregated" differ (Id.). Finally, the sectorial distinction between actors and interests is highlighted as a matter of administration and policy creation. The authors acknowledge the IPCC's ambition to optimally mix mitigation and adaptation strategies, but they note that variable interests (Lempert & Schlesinger, 2000), actors (IPCC, 1996) and methods (i.e., cost-benefit analysis, cost-effective analysis, tolerable windows approach, game theory and multi-criteria analysis) (IPCC, 2001b) makes optimization an almost impossible task with very little academic or professional consensus.

In comparison to coping, which is oriented towards a single and unique stimuli, resiliency as a responsive concept represents a systemized reaction to singular or ongoing stimuli whether known, unknown or otherwise anticipated based on internal designs. In predicate biological terms, the scholarship of resiliency can be traced to the field of ecology which attempted to move beyond static understanding of the equilibrium of ecological systems in favor of transient systems which explain evolutionary processes that result in either change or extinction (Holling, 1973). As applied in an economic context, resilience has been defined as, "the ability to dynamically reinvent business models and strategies as circumstances change. Strategic resilience is not about responding to onetime crises or rebounding from a setback. It's about continually anticipating and adjusting to [change]" (Hamel & Valikangas, 2003, p. 52). In its broadest sense, resilience can be defined as, "a multidimensional, sociotechnical phenomenon that addresses how people, as individuals or groups, manage uncertainty" (Lee, Vargo & Seville, 2013, p. 29). However, it could be argued that the uncertainty could be further refined to mean a state of unawareness of either the timing or

depth of some occurrence that is within the realm of possibility or probability. For example, resilience to a catastrophic meteorite strike is a matter of luck and not managed process. Of course, the randomness assigned to “luck” could virtually apply to all outcomes; but, the process of managed resilience can at least have a measurable reduction in risk to reduce the negative implications of random events either happening at all or otherwise negatively impacting a specific host. To this end, many scholars have questioned the extent to which resilience can be distinguished from adaptation in their parallel efforts to maintain operational functions by virtue of a managed or developed flexibility (Id., p. 30).

The most useful performance traits of measuring resilience and adaptation—as borrowed from systems and computational theory—are robustness and reliability (Laprie, 2008). Citing Anderson, Laprie defines robustness as a systems “ability to deliver service in conditions which are beyond its normal domain of operation” (Anderson, 1988). From the perspective of computational theory, there are at least some conceptual distinctions between adaptation and resilience. First, resilience is often framed in a host’s degree of robustness in its response as a matter of internal design, whereas adaptation may result in occurrence failure (or, some degree of failure) but may change for the next subsequent occurrence through the import of external designs (Vogus and Sutcliffe, 2007; Woods & Wreathall, 2008). This is often described as the transformability function of adaptation. Second, resilience is additionally defined by its time horizon and depth of impact. As noted by Wiggins,

Resilience and adaptation are not identical. No system can be 100 percent resilient to all changes; there will be a threshold where it breaks down. Beyond that threshold, adaptation is the only option. For example, climate change is projected to cause sea-level risk that will submerge some communities. Those communities would have no option but radical transformation—the scale of change would be beyond the resilience threshold where they could maintain their fundamental structures and functions. Also, adaptation has to be concerned with changes over 20, 50 or 100 years, not just the short term (2009, p. 79).

For as much literature as is cited herein, there is an equal or greater number of scholarly works which conflate the language of coping, resiliency and adaptation. This raises the pragmatic question as to whether the tautological distinction is indeterminate of the modes of analysis and/or evaluation of system or host responsiveness. This research focuses on adaptation as it represents the appropriate localized scale of buildings which are anticipated to face continued novel and anticipated stimuli occurring as a consequence of climate change. While these concepts are interrelated within a meta-application of adaptation, a conscience categorical distinction between adaptation, resilience, mitigation and coping is useful when evaluating specific responsive actions at various scales by various hosts within the built environment. For instance, interviews have suggested

that community planning groups and politicians are primarily concerned with coping (i.e., rebuilding) and resilience, while many engineers orient their practices to adaptation over the long useful life of infrastructure and other improvements. As a rhetorical proposition, this makes sense in that communities and politicians are incentivized to preserve the status quo of their representative constituencies. Likewise, the costs of transformation under adaptation are in contradiction to the tendencies of public policy to promote stability. However, it can be argued that all constructions of urbanity are in a constant and dynamic state of change. To this end, the rhetorical use of resilience to promote the interests and operations of the status quo may perpetuate structural inequalities which reinforce existing power regimes which are often less than truly progressive in their inefficient allocation of resources and are likely serving maladaptive ends over the long-term.

By contrast, the progressive implication of a superior state of flexibility imparted by adaptation is the highest order of outcome among the concepts. While conflicts may arise by and between the concepts, in a perfect scenario the manifestation of a capacity to cope, to mitigate and to be resilient can work in parallel sequence to the advancement of adaptation. Again, adaptation is about periodic points of resiliency which are maintained by a capacity to transform across domains in order to perpetuate resiliency when the resiliency threshold is crossed. However, adaptation is not an ideology defined by the rhetoric of resilience but a process which is open to willful engagement. Preserving the status quo in a building through resilience or mitigation alone may not be desirable over the long-term, as the modification of behavior based on external influences (i.e., external designs) whether environmental, social or economic may require radical transformation through the recapitalization and use of a building. If buildings are exclusively designed to be resilient by an existing internal logic then the chance of failure (i.e., reduction in resilience threshold) is increased as the pace and diversity of change is accelerated with climate change. Therefore, while the transformation associated with adaptation from one regime to another will impart costs, those costs are assumed to be less than the cost of complete failure beyond the resiliency threshold. Although, if one were to think about the broader adaptation of cities, then the failure of a building which has reached its resiliency threshold may be a desirable outcome in that capital may be more efficiently allocated elsewhere.

### **3. Developing a Framework for Buildings: Objects and People**

The scalability of adaptation measures has been a critical barrier to the generalizable outcomes of the applied systematic study of adaptation (Cash & Moser, 2000; Adger, Arnell & Tompkins, 2005; Ostrom, 2010). Within the built environment, crossing scales very often amplifies complexities and highlights the tensions between a diversity of actors and interests. For example, if an individual owner elects to build an integrated flood protection system (IFPS) at the scale of his building to protect the building from flooding, this is an act of mitigation and

resilience as it prevents the building from flooding and maintains the operations of the status quo. Overtime, this may or may not lead to adaption. For instance, if a number of individual owners build IFPS for their individual buildings then it might lead to situation of maladaptation wherein flood waters are redirected to properties which might not have otherwise been flooded. So, what is resilience at one scale might be maladaptation at another.

To date, the study of adaptation has almost exclusively been oriented at the scales of organisms and ecosystems (Schluter, 2009; Mawdsley, O'Malley & Ojima, 2009; Losos, 2010); local cultures (O'Riordan & Jordan, 1999; Adger et al., 2009); business organizations (Nitkin, Foster & Medalye, 2009; Linnenluecke, Griffiths & Winn, 2013); institutions (Naess, et al., 2005; Agrawal, 2010); local governments (Wilson, 2006; Measham et al., 2011); and, national and international governments and organizations (Luterbacher & Spriz, 2001; Aldy & Stavins, 2007; Giddens, 2009; Rübhelke, 2011). The scale of buildings has been unexplored as an object of adaptive action and planning.<sup>1</sup> One explanation for this oversight is perhaps an assumption that an examination of local public policies (e.g., building code, land use and environmental regulations) serves as an appropriate scale of inquiry because the policies result in the actualization of buildings which represent the value sets latent in the policies. However, as a practical matter, this is generally not the case even in the most sophisticated jurisdictions as there are economic and social variables associated with building design which escape the comprehensiveness of local public policy that is generally concerned with life and safety considerations which are set as minimum standards (i.e., flooding, systems continuity, ingress/egress, etc...)(Barton, 2014).

Beyond the decisions and influences which impact the nature of the intent to design and manage a building, the building itself represents a hybrid composition for objectification because of the duality of its material form and the social construction of its design, use, management and interpreted meaning or symbolism. In its material manifestation, buildings represent a very clear delineation of a formal system with parameterized inputs and outputs, with building systems comprising an independent field of study. At the same time, its social utility defined by program is boundless not as a system with defined parameters but as a social construct, or even an institution, which is ever evolving and constrained only by its own historic path dependencies (North, 1990; Thelen, 1999). While some institutions within the built environment may be composed of systems of organizations, others may not. The endless variability in the nature of shelter suggests that the institutions of tenancy and tenure—and the management thereof—may be institutions which are not necessarily comprised of clearly defined systems.

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<sup>1</sup> Post-Publication Note: This observation speaks to the comprehensive *ex ante* adaptation envisioned in this chapter and not to the several generations of research in modular design, flexible space planning and structural design, adaptive redevelopment, historic preservation or *ex post* adaptive design.

As previously noted, adaptation is not just a meta-trajectory of resilience and mitigation measures which preserve the operations of the status quo that overtime transforms (or, has the capacity to transform) to a superior progressive state which maintains the ability to be resilient to known stimuli. It is also about a capacity within that superior state to be flexible in addressing (un)known or (un)anticipated stimuli. Therefore, the question is whether one applies theories of adaptation which are grounded: (i) in science oriented towards buildings as technological systems; or, (ii) in social science oriented towards designers, owners, operators and users? Alternatively, is there a certain hybridity which creates a hierarchy or panarchy of processes for evaluating resilience and adaptation? Are these inquiries ontologically grounded in the fiction of the building as an objective anthropogenic bystander (or, objective owner) or are they grounded in the realities of subjective multi-generational users, managers and owners? The answers to this fundamental problematique is seemingly clear cut. Buildings themselves do not innately adapt without the intent and action of man. Therefore, adaptation of buildings is a behavior which should be evaluated in the domain of social sciences.

However, this perspective may not be so clear cut in light of the technological innovations in software and hardware design which have empowered an artificial intelligence in building systems to measure, register and adapt to environmental and user generated stimuli (Hayes-Roth, 1995; Byun & Park, 2011; Bai & Xin-yuan, 2012; Kumar, Fensel, & Fröhlich, 2013). As previously noted, adaptation is both a process and a deliberate willful imposition on a process set in motion by a combination of internal and external designs. Therefore, a building as an object may be taught to adapt—or, conversely, it may learn to adapt (Brand, 1995). As internal operations of a software design are updated and reconfigured based on external designs, the likelihood of adaptation increases with the increase in pre-designed simulations which accommodate an increasingly diverse range of stimuli. There may eventually even be a future wherein some vast majority of stimuli (e.g., floods, heat waves, biological terrorism, etc...) are simulated within a reconfiguration of the software based on technologically expanding operational domains (i.e., mechanical, financial, etc...). Therefore, while the degree of willfulness vis-à-vis the intent of the software engineer may vary in time and space, the building as an object may possess a certain requisite artificial intelligence necessary for *ex ante* adaptation, in addition to *ex post* adaptation. *Ex ante* and *ex post* being defined as a design for response internalized during/ before or after the occurrence of a stimuli, respectively. In this case, *ex post* adaptation for buildings is the point of reconfiguration or updating of the software following occurrences which are outside of the domains of the building's software. Admittedly, at present, there are functions of buildings which elude measurement and system automation. However, it is possible to envision a future in which every facet of operations, maintenance and capitalization are tactically and strategically evaluated and executed by an integrated computational platform subject to human judgment. With

automated valuation models and the MERS system, an integrated artificially intelligent building may even have the capacity to mortgage itself one day.<sup>2</sup>

The other end of the spectrum is the social construction of buildings which are composed of people, organizations and institutions which manage and use the material form. Adaptation can further be refined to be the object of not just climate change in its physical manifestation but also the variability and uncertainty inherent in the concept itself (Smith, et al., 2000, p. 227; Hallegatte, 2009). Uncertainty being an innately human characteristic. The origin of the process of adaptation can either be “autonomous” (i.e., automatic, spontaneous, passive or natural) or “planned” (i.e., deliberate, strategic or active)(Smith, et al., 2000, p. 239). In the only published paper on the adaptive capacity of real estate developers, Hertin, et al., cite three variations of the theoretical application of adaptation measures by individuals and/or organizations (2003). First, there is the ‘Dumb Farmer’ hypothesis which says that there is no adaptation undertaken at all. Second, there is the hypothetical “*ex post*” (or, efficient) adaptation strategy which “occurs only after the costs of not adapting have become apparent” (Id., p. 279). Finally, there is the “Clairvoyant Farmer” hypothesis, or “*ex ante*” adaptation, which dictates that the host will undertake near perfect measures to expected future change. The authors argue that these divisions do not necessarily reflect how businesses—notably building developers and owners—actually operate.

It could be argued that businesses that fall into the Dumb Farmer category would eventually go out of business, as they have to position themselves within markets which are in a constant state of adaptation. This assumes that markets at least partially internalize and transfer the cost of climate change. Likewise, it seems unlikely that any business—or, building owner/manager—would have the requisite intelligence and resources to anticipate the existence or occurrence of a wide range of potential stimuli and undertake *ex ante* adaptation in perfect concert. However, an artificially intelligent building system with a capacity to iteratively respond to thousands of stimuli might have the capacity to undertake *ex ante* adaptation—or, something very close to it. This *ex ante* adaptation would theoretically be considered autonomous by virtue of its automatic response and not subject to human strategy and deliberation imbedded in the exercise of a plan in the conventional sense. However, this distinction is not entirely so clear cut in that strategic human intervention would arguably be designed within the software. In this sense, the distinction is about execution and not intent.

However, reality is much more complex. Even as a building system autonomously adapts *ex ante*, some measures would require human judgment which may be less than informed and whose outcome may be less than logical. Likewise, those actions may be subject to a historical plan of adaptation or resilience which is less analytically sophisticated than the building’s software. This is at least one

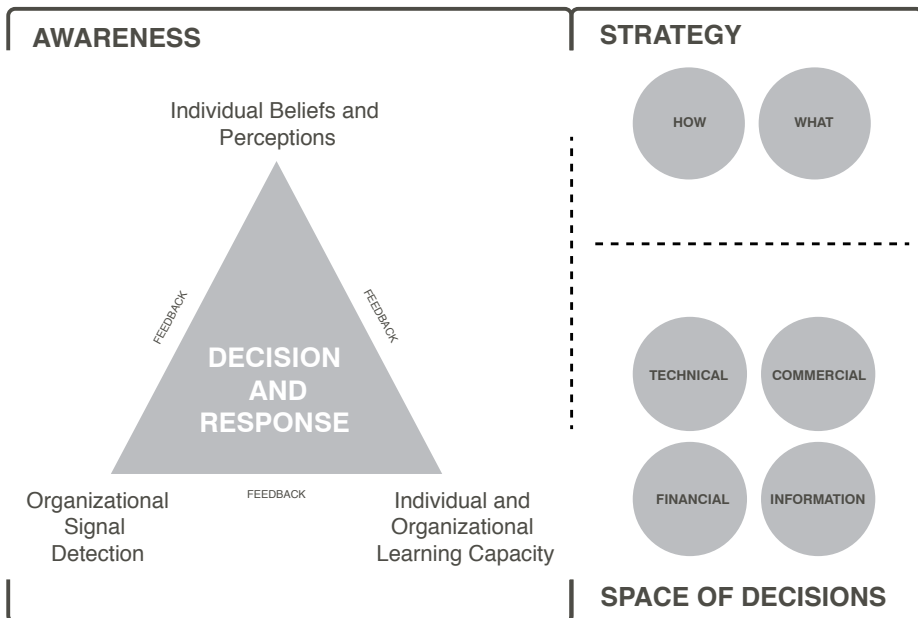
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<sup>2</sup> This is perhaps the most extreme example of “robo-signing.”



scenario, as the inverse could also be true. Fankhauser, Smith and Tol (1999) conceptualized the interrelationship between autonomous and planned adaptation by noting that the relationship between the two could be framed as a matter of economy. The measures could be ‘complementary’ in that “[planned] adaption increases the marginal benefit of [autonomous] and vice versa.” (Id., p. 70). By example, a planned measure to change acquisitions strategy away from flood prone buildings may increase the marginal utility of autonomously imposing flood gates on the limited number of existing buildings in one’s portfolio. The expensive unit costs of flood gates may not have a reasonable return on investment (i.e., lower insurance premiums or deductibles) for the entire portfolio, but may have a greater utility in a limited number of select buildings. The other linkage between autonomous and planned adaptation measures is that of ‘substitute’ measures (Id.). In this scenario, planned measures may completely substitute autonomous measures. Substitutes are more capital intensive and are based a relative confidence of occurrence which makes their pure application somewhat suspect as a practical matter. As such, Fankhauser, et al. suggest that there is balance between these two which are in constant flux as information, vulnerability and general capacity change and evolve.

**FIGURE 2.1:** Framework for Adaptive Capacity of Firms (User / Manager)

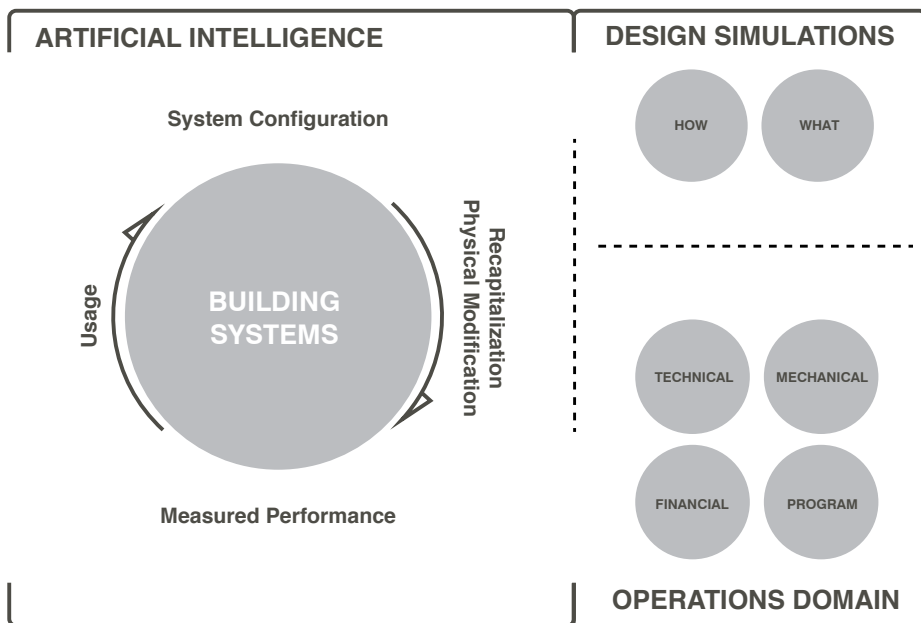


Source: Berkhout, et al. (2004); Amell & Delaney (2006); Fankhauser, Smith & Tol (1999)

This balancing act is precisely the nature of the aforementioned duality of buildings. In practice, a building might have its own autonomous adaptive capacity to learn and take action through software reconfiguration, but it is also subject to the

human judgment of an owner and/or operator which is generally undertaking, in the best case scenario, planned and ex post adaptation. As represented in Figure 2.1, intelligence and beliefs within an organization are a critical component of adaptive capacity within a social construct—in this case firms which are a proxy for owners, users and managers (Fankhauser, et al. 1999; Berkhourt, Hertin & Arnell, 2004; Arnell & Delaney, 2006). The capacity to gather, filter, and interpret data both as an individual act and as an act within an organization are dynamically related to and reciprocally dependent on both strategy development and the space of decisions from which they can act with the intent to be resilient and/or adaptive. A recent study of commercial real estate firms in New York City found that corporate and building level strategies were entirely ex post and resulted in planned measures (Keenan, 2014). There were no observed actions or strategies which could be defined as autonomous or ex ante. Likewise, it was determined that the adaptive capacity of subject firms was largely driven by human and organizational intelligence (Id.)

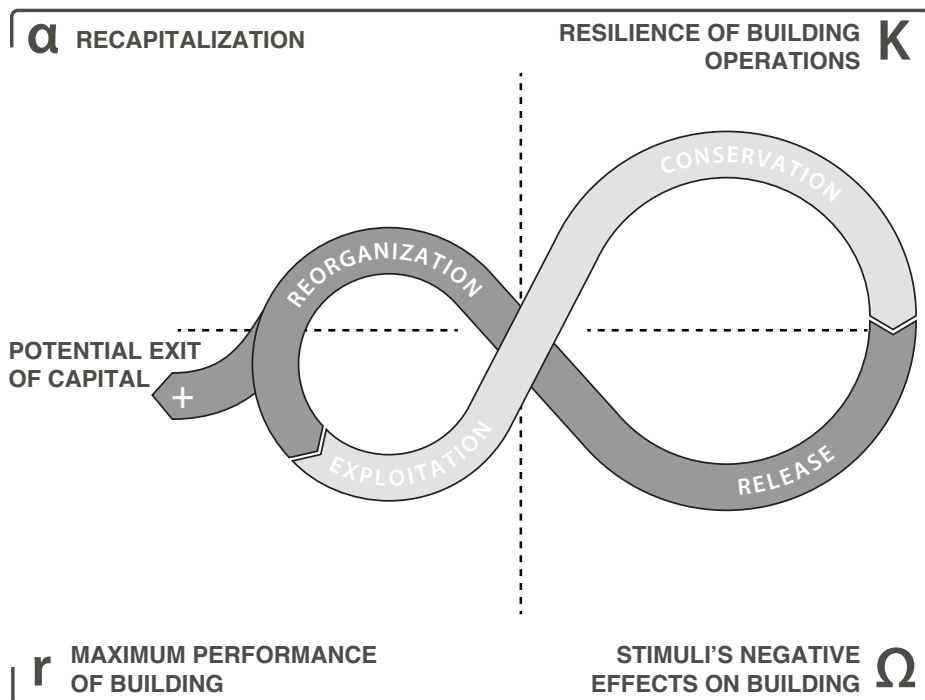
**FIGURE 2.2:** Framework for Adaptive Capacity of Buildings (Objects)



As a consequence of the duality of buildings, there is also a certain duality of adaptive capacity. Buildings as objects have the potential for an autonomous ex ante capacity, as per Figure 2.2. Instead of beliefs and organizational intelligence gathering leading to strategies, the artificial intelligence of buildings operationalized by measuring and reconfiguring the operations of systems leading to and responsive of simulations based on a domain of operations, which itself is subject to re-registration. In both capacities, the underlying intent is to recognize, process and respond to stimuli based on a complex set of values.

This relationship (i.e., *ex post* v. *ex ante* or top-down v. bottom-up) highlights a critical debate within adaption scholarship as to whether there is a hierarchy or panarchy of influence in stimulating adaptive cycles within systems (Gunderson & Holling, 2002; Walker et al., 2006; Gotts, 2007; Allen et al., 2014). Systems have been observed to go through fairly predictable cycles of growth, development and decay. In an adaptive cycle, elements of a system interact at various scales to propel a system across phases of exploitation (r), conservation (k), release ( $\Omega$ ), and reorganization ( $\alpha$ ) (Holling, 1986). While it is not opined that all social, material and ecological phenomena are reducible to systems theory, there is an argument to be made that the design, production, and technical operation of buildings falls within clear parameters of one or several systems with discrete inputs and outputs. Likewise, it can analogized that buildings are subject to adaptive cycles often aligned with component life and financial cycles, as represented in Figure 2.3. For instance, the perpetuation of the operations of the status quo, or resiliency, are occurring within the conservation (k) phase. The recapitalization of increasingly adaptive building happens in the reorganization ( $\alpha$ ) phase following the negative effects of stimuli during the release ( $\Omega$ ) phase. The high point in the efficiency and productivity of the building in terms of use and capital accumulation occurs during the exploitation (r) phase, at which point capital may exit the cycle (i.e., sale or mortgage refinancing).

**FIGURE 2.3:** Building Adaptation Cycle under Theory of Panarchy



The conventional theory of Hierarchy is that there are large slow moving variables of influence and small fast moving variables (Allen & Star, 1982; Simon, 1991; see Figure 1, Brand & Jax, 2007). As such, a stable system regime is a state mediated between the fast and slow variables which resist and promote change, respectively. It has been theorized that the top-down slow variables create restraints on fast variables below it. As Gibson, Ostrom and Ahn notes, “[t]he levels immediately above and below the referent level provide environmental constraints and produce a constraint ‘envelope’ in which the process or phenomenon must remain” (2000, p. 225). This theory has been challenged on numerous grounds with the principle critique being that complex systems often operate in non-linear dimensions of time and space and that cause and effect across scales is empirically troublesome to isolate in an intermediate state of analysis (Id.)

In contrast, the prevailing theory of Panarchy argues “that control is not just exerted by larger-scale, top-down processes, but can also come from small scale or bottom-up processes....Because of the potential for cycling within adaptive cycles to affect both smaller scales and larger scales, panarchy theory emphasizes cross-scale linkages whereby processes at one scale affect those at other scales to influence the overall dynamics of the system.” (Allen et al., 2014, p. 578).<sup>3</sup> This is precisely the nature of the continuous linkage along points of the adaptation cycle as represented in Figure 2.3. While top-down design and management of buildings is subject to social, organizational and institutional processes, the realized adaptation cycle of buildings is also subject to ground-up autonomous processes from the building as artificially intelligent object. These processes link across scales and reciprocally influence their respective capacities, as represented in Figure 2.4.

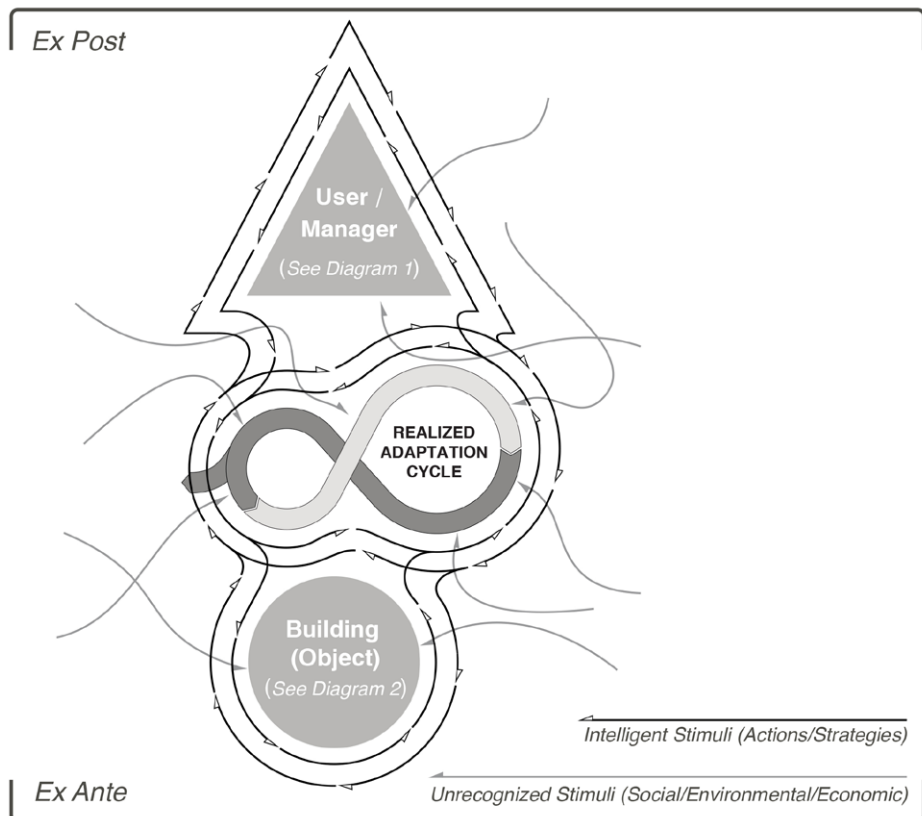
It is helpful to conceive of two types of stimuli in the framework. The first set of stimuli are unrecognized stimuli which may be social, environmental and/or economic in their origins. The second set of stimuli are those stimuli which have been intelligently processed based on the respective dual capacities. For example, information from a building system may inform where along the adaptation cycle the building is so as to inform a corporate portfolio strategy which may in turn dictate the capitalization of a related building system that results in greater realized adaptation along the reorganization ( $\alpha$ ) phase. Without the artificially intelligent system to translate unrecognized stimuli to recognized stimuli, the same or similar outcome as to the foregoing example is less likely in terms of realized adaptation. More precisely, artificial intelligence leads to mitigation and resilience—even homeostasis—in the short-term. What makes it adaptive is its capacity to simulate and recognize stimuli which are unanticipated by human and/or organizational capacities and which themselves can be reconfigured as circumstances evolve. To this end, the framework links capacities with realized adaptation as positioned with the adaptive cycle of a building which is driven by a variety of intelligent and unrecognized stimuli.

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<sup>3</sup> For application of Panarchy Theory to urban systems, see Bessey (2002); Garmestani et al. (2005); Garmestani et al. (2008).

Together these processes which are made up of multiple sub-processes which are dynamically interlinked across scales. Therefore, it would be a gross simplification, for example, to argue that financial investment criteria will exclusively dictate adaptation of a buildings in the future, as is the present dominant rationality of mitigation and sustainability. Financial criteria may have a principle influence on the capacity and actions of the top-down processes of an owner/operator organization but are not necessarily determinate of the bottom-up capacities which may or may not be determinate of the long-term realized adaptation of a building. In this sense, realized adaptation is the actual adaptation which is subject to bottom-up and top-down processes. This doesn't mean that there is equal weighting of influence from these differing modes of adaptation (i.e., capital may still dominate realized adaptation, for instance), but it acknowledges a more dynamic system of influences which itself has the capacity to adapt as technology and innovation respond to change. Therefore, the capacity of a building is composed of the two sub-capacities identified in Figures 2.1 and 2.2 and whose sum is greater than its parts, assuming the non-occurrence of maladaptation.

**FIGURE 2.4:** Framework for Multiscalar Dynamic Adaptation of Buildings



Finally, it should be cautioned that this system of adaptive capacity can also promote maladaptation. While a robust capacity may increase the likelihood of adaptation, there may be forces at work, willful or otherwise, which may reduce capacity to a point which results in a state of maladaptation. As one moves out of the built environment and beyond the scale of the building framed herein, it is also worth acknowledging that adaptation of buildings may conflict with other societal responses to climate change. For instance, if the global real estate community in cities subject to high-risk of flooding were to fortify their buildings with more concrete and steel, then the energy, resources and pollution expended in this effort might conflict with climate mitigation goals and might draw resources away from other modes of societal adaptation. As such, this framework should be contextualized across urban, regional and global scales to give meaning not to its inherent utility but to the implications of the broader impacts of the adaptation of buildings.

From the designers point of view this complexity underscores the necessity to frame the design and operation of buildings within a complex array of processes with varying levels of human and artificial intelligence. A fundamental aspect of the concept of adaptation is an ability to be flexible while traversing through a state of transformation. Transformation may manifest itself in everything from changing programs (i.e., from hospitality to senior housing) to the intensity of existing uses. The conventional problem set of designing flexible interiority to a building to accommodate future alternative programs is just one of several exercises in conceiving of a comprehensive design (Sinclair, Mousazadeh, & Safarzadeh, 2012). In this sense, interior adaptability is just a method within adaptation. Architecture has struggled with adaptation as demonstrated by several generations of failed experiments in modularity. However, there is an opportunity to develop practices in adaptive design beyond the rules of thumb for open plans, durable materials, passive systems, low maintenance and an accommodation for future expansion.

As such, thinking about how a building is used and operated and how those criteria can be measured to inform both artificial and human intelligence will be critical in the future. Likewise, having a sensitivity beyond the physicalities of the building to understand management processes and their influence on the intermediate resilient state of operations is also critical to contextualizing design within human and environmental conditions. Each of these scales and sensitivities require a facility in a variety of skills and disciplines, including architecture, process engineering, computer science, real estate development, urban planning, facilities planning, material science, operations planning and a multitude of other disciplines. This requisite diversity of knowledge reinforces the notion that professional practices within the built environment are both an art and a science—or, in this case, social science. Ultimately, one or several professions will need to be positioned to mediate language and values by and between the various disciplines in the advancement of adaptation. Will this be the role of the architect?

## 4. Explanatory Scenario within Framework

It should be acknowledged that a number of key architectural figures in recent history, such as Buckminster Fuller, Christopher Alexander and Frank Duffy, have endeavored to synthesize these varying domains of knowledge into an contemporary architectural discourse. However, it is the work of Stewart Brand, notably in *How Building's Learn: What Happens After They're Built* (1995), which weighs heavily on the application of the framework developed herein. Brand's perspective on the adaptation of buildings was one grounded in the necessity to develop internal designs which can accommodate inevitable human adaptations. Brand went so far as to draw reference to a Theory of Hierarchy in his own work in that he conceptualized fast bottom-up and slow top-down influences—largely social and economic (Id., p. 17). Although, with a measure of clarity not quite ripe at the time, he tempered that conceptualization by citing Holling and the theoretical extent to which fast and slow variable may shift hierarchical functions across scales (i.e., consistent with Panarchy)(Id.). In many ways, the framework developed herein picks up where Brand left off in that it accounts for technologies—adaptive sensors and buildings system and their associated modes of artificial intelligence—which simply did not exist at the time of Brand's research.

Therefore, the questions are: (i) what are some of the existing adaptive technologies; and, (ii) how could they be referenced to explain the framework of adaptation? By example, currently adaptive lighting, ventilation, façade and energy management systems are being developed and selectively utilized in the U.S. (Hoberman & Schwitter, 2008; Erikson, 2013; Hansen, 2013). These systems are being utilized in new buildings, which for the sake of argument will be subject to changing climactic conditions in the future. One example of adaptation is a scenario wherein the energy management system measures the performance of the other systems and forces calibration on the time and mode of use so as to promote energy efficiency. This serves to both mitigate the risks of overconsumption, for instance on hot days, and it is adaptive because it forces utilization of the building systems beyond their initial configured domains of operation. Likewise, the energy management system outputs could also be adaptive to the extent that building managers utilize the outputs of the energy management system to inform tenant use (e.g., incentivize night time super-computing).

In this scenario, as excessively hot days occur more frequently, let's assume the mechanical façade systems are being utilized beyond their intended design for durational stress and the façade system malfunctions. The building owners and managers now have to decide whether the capital costs for fixing or upgrading the façade system justify the amortized return on investment relative to the modeled reduction in energy costs. In this scenario, the owners and managers decide that the replacement costs far exceed their benchmark for amortized returns. They also realize that by reallocating some fraction of the façade replacement cost to upgrading the software configuration for the other systems they will be able to realize a net efficiency gain. The scenario could be extended to assume that thirty years later the

super-computing tenants no longer remain and the building transforms programs (i.e., domains) to accommodate tenants with much lower energy consumption. At a point in time when the life cycles of the original lighting and ventilation systems require a similar evaluation under a cost-benefit analysis, it is determined that both systems justify recapitalization because the reduction in energy use from newer more efficient tenants doesn't offset the greater demands from ambient, radiant and convective heat caused by global warming.

The realized adaptation at each stage could have only been accommodated with this measure of precision and corresponding efficiency with the benefit of outputs from the artificially intelligence building systems and the judgments of the owners and managers, which were informed on some measure by the artificial intelligence. The question then is could adaptation have happened without these intelligent building systems? Yes, the owners could have kicked out all of the super-computing tenants to reduce their energy burden. However, the high priced rents the super-computing tenants would have paid could have resulting in lower levels of overall capitalization resulting in a shorter life cycle of the building. In either event, the scenarios for adaptation and maladaptation are nearly endless in their manifestations one way or the other. The framework herein only reinforces the capacities of users and managers who will never be completely substituted in their judgments by artificially intelligent buildings. It is likely not possible nor is it desirable that this substitution takes places given that buildings ultimately serve the interests of human habitation. If buildings were truly artificially intelligent, then it is likely that humans would be excluded from occupancy in the advancement of adaptation. The advantage of this framework is that it sets the stage for developing more robust human capacities which promotes the effective, efficient and timely allocation of resources along the adaptation cycle of a building with the intent of maximizing the probability occurrence of adaptive versus maladaptive outcomes.

## **5. Conclusions and Future Research**

The academy of architecture has long struggled to manage complexity without succumbing to the external parametric applications of systems theory. While not explicit, one could argue that this reservation has been grounded in a variant theory of Hierarchy wherein influences outside of the hand of the architect are dictating aesthetic and programmatic gestures which dilute—or more formally limit—the creative capacities of architecture which sits within an hierarchy of capital and culture. It is not a pure coincidence that architecture complains of the limitation of the “envelope.” Must applied systems theory in architecture be reduced to an architecturally void “technological sublime”? (Wolfe, 2006, p. 5). At the same time and at a different scale, hierarchy has been deemed, with all of its classical sensibilities, to be the Third Law of Structural Order (Salingaros & Mehaffy, 2006; Tracada, 2013). However, this rhetorical tension is largely one of aesthetics and itself represents a certain panarchy of influence between the ordered, random and chaotic gestures of architectural expression.



But, analysis and expression are process and outcome. While this division is not so clear in light of the aestheticization of data visualization and the practice of improvisation, it highlights the role of the framework developed herein as analytical with very limited generative applications. This is perhaps both a strength and a weakness. But, this framework fits within an analytical theory of architecture which acknowledges the practice as both an art and a science (Hillier, 1999). At best, its implications are for propelling the professional domain into realms of intelligence and knowledge which modify workflows and processes to accommodate changing conditions. While the current set of professional ethics apply to the lawful state of construction of a building on day one, would or should that ethic be extended throughout the building's useful life? At worst, it is a framework which is not quite ripe in light of the current reality of buildings which are not so intelligent. To this end, it serves as a challenge to give greater dynamic consideration to the autonomy of the building as an object—albeit a systemized object.

By giving resolution to the dual capacities of human and artificial intelligence of a building defined by its material and social construction, the framework for the dynamic multi-scalar adaptation of buildings draws a nexus between the adaptation cycle of a building and the varied social, economic and environmental forces which are shaping the built environment. Ultimately, artificial intelligence serves not only as an adjunct for human judgment but as a powerful barometer of unrecognized stimuli. The future development of this framework will be advanced by case studies which inquire as to the nature of the decisions which frame the selection, operation and recapitalization of adaptive building systems. Thereafter, the framework could be advanced by understanding the methodologies associated with these decisions along varying trajectories of the adaptation cycle as mediated by the dual modes of intelligence (Wilkinson, Remøy & Langston, 2014). Implicit in this exercise is an elucidation of the values which speak to the weighting of priorities for the allocation of limited resources.

Future research in architectural technology could therefore explore how technology is actually interpreted and utilized by owners and operators. To this end, research could be extended to give consideration to positive behavioral modification through not only conventional building systems but latent and patent spatial constructions—which themselves may be systematized in the future. Deeper explorations of technology which serves not just efficiency seeking ends but are themselves reconfigurable to changing conditions wherein efficiency in one state might be inefficient in another. Research into various simulations which are responsive to a litany of stimuli which are configurable to a mode of action is a task with no end in light of a world subject to constant and accelerated change. Ultimately, this framework for adaptation acknowledges a duality of material and social construction in buildings which is ripe for the appropriation of developments in scientific and social scientific knowledge in the willful steering of adaptation cycles which are informed by natural and artificial modes of intelligence. In this context, design research is uniquely positioned to further develop synthetic lines of knowledge which are responsive to a world defined by conflicting realities grounded in art, science and social science. Architects and the society to which they serve cannot afford to be the 'dumb farmers' any longer.

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# CHAPTER III | Adaptive Capacity of Commercial Real Estate Firms in New York City to Urban Flooding

This chapter 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 chapter 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.

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On October 29, 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 chapter identified an estimated \$950 million dollars of repairs and associated capital improvements in private commercial real 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 meter in the next 50 years and almost 2.1 meters 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 commercial real 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 commercial real estate (CR) 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 commercial real estate (CR) 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 dialogue 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. This chapter 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.

## 1. 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 chapter attempts to reframe and answer these questions through the meta-analysis of the individual case study of the adaptive capacity of 6 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, Smith & Tol, 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 (Hallegatte, 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, McNabb & Smithers, 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, Hertin & Arnell, 2004; Horbulyk, 2005; Arnell & Delaney, 2006) and energy (Huang, et al., 2005; Bansal & Gao, 2008; Fuss, et al., 2012) dominating the literature with over 54 published cases (Nitkin, Foster & Medalye, 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.

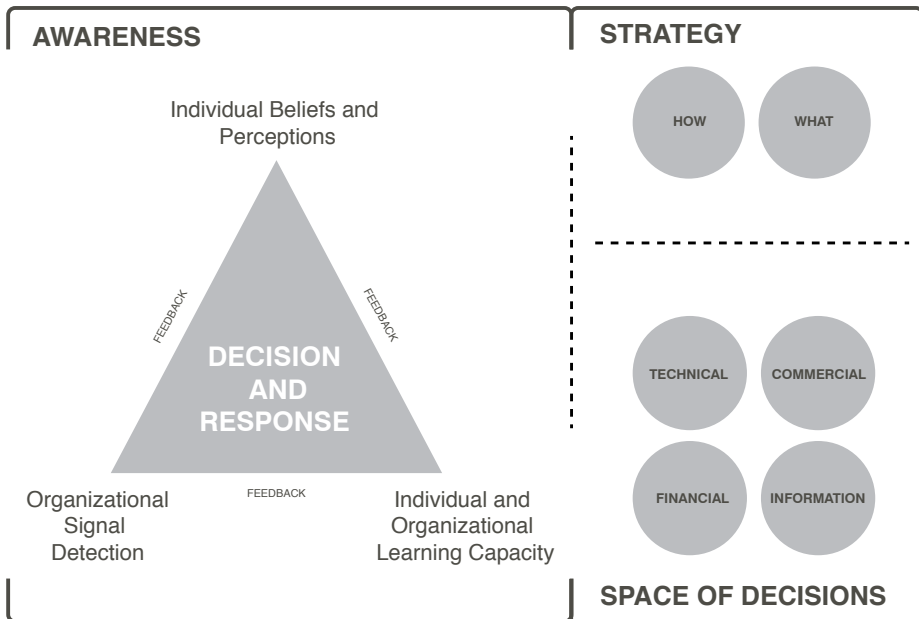
However, Hertin, et al. (2003) highlighted a central debate in the scholarship between one camp that views adaptation of business organizations as a process of economic and financial optimization (Mendelsohn, et al., 1994; Mendelsohn, 2000; Haites, 2011) and another camp which rejects optimization as 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. 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 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.

## 2. 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, Hertin & Arnell (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 3.1. 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, Smith & Tol, 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.

**FIGURE 3.1:** Framework for Adaptive Capacity of Firms (User / Manager)



Source: Berkhout, et al. (2004); Arnell & Delaney (2006); Fankhauser, Smith & Tol (1999)

## A. 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 and 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 author’s 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

<b>Table 3.1: Measured Factors of Awareness</b>				
<b>Organizational Signal Detection</b>				
Designated Processes	Designated Personal	External Relationships	Market Signal Detection Process	Physical Detection Process
<b>Individual Beliefs &amp; Perceptions</b>				
Management Philosophy	Causality of Flooding to Climate Change	Perceived Vulnerability	Timing of Flood Risk	Observations
<b>Learning Capacity</b>				
Education Background	Professional Membership	Literature Reviewed	Training	External Review

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 and Shakley (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 3.1. 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.

## **B. Strategy and Space 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, 2013). However, this chapter 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 3.2.

**Table 3.2: Identifying and Classifying Strategies**

<b>Adaptation Measures</b>	<b>No Regret Strategy</b>	<b>Reversible/ Flexible</b>	<b>Safety Margins</b>	<b>Soft Strategy</b>	<b>Reduced Decision Horizon</b>	<b>Positive Synergies with Mitigation &amp; Sustainability</b>
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  
 (+) = Option yields benefits if urban flooding, but not with inundations from climate change.  
 (-) = Option yields loss without occurrence of climate change or flooding.  
 Adapted from Hallegatte (2009)

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., 2003). Those measures in Table 3.2 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 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 3.2, 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 adaptation 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 3.2 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 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.

### **3. 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 (NFIP) 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 0-20% of the portfolio; a moderate level is between 20-49%; 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 3.3) was a useful and a practical way for managers to reference immediate and known risks over the course of the interviews.

<b>Table 3.3: Firm Characteristics</b>			
<b>Large Firms</b>	<b>Portfolio At-Risk</b>	<b>Small Firms</b>	<b>Portfolio At-Risk</b>
L1	High	S1	High
L2	Medium	S2	Medium
L3	Low	S3	Low

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 chapter in order 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 (GIS) 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 three 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 & 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.

The second phase of interviews was 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 3.4–3.6, 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. 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.

## **4. 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.

### **A. 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 3.1). 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 3.3. 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 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 3.2). 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 3.4). 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

<b>Table 3.4: Summary Results of Organizational Signal Detection</b>				
<b>Firm</b>	<b>Designated Processes</b>	<b>Designated Personnel</b>	<b>External Relationship</b>	<b>Market Signal Detection Process</b>
L1	Yes	No	Active Government & Professional	Active Market Analytics
L2	Yes	Yes	Active Government & Professional	Occasional Market Analytics
L3	Yes	No	Active Government & Professional	Active Market Analytics
S1	Yes	No	Active Government & Professional	Occasional Market Analytics
S2	No	No	Semi-Active Professional	Occasional Market Analytics
S3	No	No	Semi-Active Professional	Occasional Market Analytics

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 3.5).

**Table 3.5: Summary Factors for Awareness**

<b>Firm</b>	<b>Relevance of Beliefs and Perceptions</b>	<b>Learning Capacity</b>	<b>Capacity of Organizational Signal Detection</b>
L1	Moderate	High	High
L2	High	High	Moderate
L3	Low	High	High
S1	High	Moderate	High
S2	Moderate	Low	Low
S3	Low	Low	Low

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 relative long length of commercial tenancies. Therefore, as more leases roll-over, there is a chance that consumer preference may become more transparent.

## B. 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 3.3 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 it 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 3.3, 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 acquisitions strategy 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 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). 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—that 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. To 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 relates 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 the 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, operations 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 New York City (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 previously 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 3.6).

**Table 3.6: Summary Factors for Adaptive Capacity**

<b>Firm</b>	<b>Awareness</b>	<b>Robust Strategies</b>	<b>Space of Decisions / Options</b>	<b>Overall Capacity</b>
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

## 5. Conclusions

The results of this research suggest a measure of complexity to the often misperceived short-term financial biases of corporate 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 the 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 who advanced strategic evacuation, all other reasoning and economic logics were primarily oriented towards 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 evaluated, 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 changing 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 adaption 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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## **CHAPTER IV | From Sustainability to Adaptation: A Case Study of Goldman Sach's Corporate Real Estate Strategy**

This chapter is premised on a conceptual framework which attempts to draw theoretical and practical connections between sustainability, resilience and adaptation. The framework is explored through a case study of the corporate real estate strategies of Goldman Sachs developed over the course of the consolidation and development of its corporate headquarters. This case seeks to identify the existence and nature of the relationships by and between sustainable corporate real estate strategies, resilient operations planning and the firm's adaptive capacity. A secondary proposition seeks to evaluate whether the capacity of the firm to adapt and be resilient to changing conditions has been positively advanced by the firm's sustainable corporate real estate strategies. The findings support the proposition that these connections do exist, as well as the proposition that sustainability was promoting adaptive capacity and operational resilience. However, it remains an open question to what extent these practices and capacities are deterministic of one another. This chapter sets the stage for future research that seeks to measure and model organizational adaptive capacity and to understand the potential co-benefits that may serve the interests of firms who struggle to rationalize the costs of sustainability.

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When Hurricane Sandy hit New York in 2012, news reports were quick to highlight a remarkable photograph by Eduardo Munoz that showed the office towers in Lower Manhattan under a veil of darkness, except for the brightly lit headquarters of Goldman Sachs located at 200 West Street (the “GSHQ”)(Reuters, 2012). How and why did this come to be? This chapter is premised on a framework which draws the theoretical connections between sustainability, resilience and adaptation. This framework is explored through a case study of the corporate real estate (CRE) strategies of Goldman Sachs (GS) developed over the course of the consolidation and development of its corporate headquarters. The principal research question relates to a fundamental inquiry as to the substantive relationships by and between sustainable CRE strategies, resilient operations planning and the firm’s adaptive capacity. Pursuant to the conceptual framework, the core proposition is that there are positive relationships that do exist whether recognized or not by CRE actors (‘First Proposition’). By extension, a secondary proposition seeks to evaluate whether the capacity of the firm to adapt and be resilient to changing conditions has been positively advanced by the firm’s sustainable CRE strategies (‘Second Proposition’).

The conceptual framework seeks to advance a broader application of adaptation research in an attempt to draw a closer nexus between climate adaptation in the scientific literature (Swart, Biesbroek & Lourenco, 2014) and economic and organizational adaptation in the literature of various business academies (Hallen, Johanson & Seyed-Mohamed, 1991; Schindehutte & Morris, 2001; Keeping & Shiers, 2009; Warren-Myers, 2012). Much of the empirical and theoretical work in the management, marketing and finance academies relating to adaptation and adaptive capacity has only been superficially incorporated by climate adaptation researchers (Engle, 2011). This under-evaluated area of inquiry has the potential to serve reciprocal advances in the respective fields—particular as private enterprise becomes more sophisticated in accommodating changes in business and environmental conditions, which are not necessarily mutually exclusive (Berkhout, Hertin & Arnell, 2004).

Based on a single firm, this case is only the first step in addressing the validity and generalizability of the framework. However, this case provides a valuable narrative for a firm which is subject to very complex and constantly changing market and business conditions that necessitate constant adaptation. In addition, the CRE strategy is defined, in part, by fairly conventional sustainability goals and practices that suggest potentially more generalizable outcomes. By focusing on the firm’s CRE strategy, this case provides a window into many aspects of the firm’s adaptive capacity, which are insightful across disciplinary boundaries, including organizational culture, communications, intelligence and leadership (Allard & Barber, 2003; Martin & Black, 2006).

The findings of this case suggest that positive and practical relationships between sustainability, resilience and adaptation do exist. However, the extent to which specific actions or strategies are deterministic of outcomes or capacities remains

the subject of future research. These findings provide the impetus for future research which will address not only the broader application of the framework but also the key research questions relating to the measuring and modelling of organizational adaptive capacity and the extent to which co-benefits exist between various actions and strategies defined or motivated by sustainability, resilience and/or adaptation. The answers to these questions are key for the advancement of CRE actors who will be called upon to maximize limited resources not only to manage risk but also to create value in the face of evolving economies and changing climates.

## 1. Conceptual Framework

The conceptual framework developed herein attempts to resolve the theoretical conflicts between sustainability and adaptation by acknowledging that resilience and adaptation are theoretically dependent on sustainable resource allocation and are practically benefited by the diffusion of sustainable practices and innovations. It is also conceptualized that a robust adaptive capacity may also reciprocally promote the diffusion and execution of sustainable practices. To understand these conceptual underpinnings it is first useful to explore their practical execution.

Sustainable real estate is defined by investments in technology and design that reduce consumption and promote efficiencies that limit a building's consumption of resources and minimizes its waste to such an extent that the value created and/or money saved justifies the alternative investment. The practice of the design and management of sustainable real estate has been professionalized and codified over the last 20 years through various systems, including the U.S. Green Building Council's (USGBC) Leadership in Energy and Environmental Design (LEED) accreditation system (Del Percio, 2004). However, LEED—like many other comparable systems—has not received widespread support by the real estate industry for a number of reasons, including an ambiguous performance record and a failure to economically justify the low returns on cost. For this latter reason, the ambition of this research to identify co-benefits is particularly relevant. While prescriptive systems have yet to be fully incorporated or developed, fundamental metrics and business cases for sustainable real estate investment have proliferated on a global scale, including those developed by the Property Working Group of the United Nations Environment Programme (UNEP) and the non-profit organization Global Real Estate Sustainability Benchmark (GRESB).

Concepts of adaptation in building design have transitioned from a holistic ethos of context and environment (Brand, 1995) to more technical approaches in adaptive engineered building systems, which have the capacity to transform to alternative operational domains based on changing environmental and user conditions (Brager & de Dear, 1998; Dounis & Caraiscos, 2009; Klein, et al., 2012). However, the adaptive capacity of a building should be distinguished from that of an organization, which can be defined, in part, as the ability of an organization

to transform its operations in response to known and unanticipated changes so as to promote the stable functions of the organization. The understanding of organizational adaptive capacities within the context of real estate management has largely been overlooked by scholars and practitioners. Despite the varying modalities of execution between sustainability and adaptation in real estate, they share a common goal in promoting efficient performance of a building over the course of the building's life cycle, as well as in the promotion of positive health and environmental conditions for building users and associated environments.

However, CRE extends beyond considerations of the performance of a building in that it is often both the delivery of a product (i.e., real estate) and a service (i.e., facilities, IT, etc...). In this regard, CRE is closely connected to all aspects of a firm from the culture the organization engenders (Duffy, 1974, 2000) to the operations it supports through its facilities (O'Mara, 1999; Singer, Bossink & Vande Putte, 2007). Therefore, it can be argued that not only is CRE closely connected with the operations of a firm, but also it is critical to the capacity of that firm to accommodate changes in its operations and hence its business model(s). As firms are dependent on the evolutionary economy of markets, they are uniquely dependent on their CRE operations and strategies to respond, to adapt and to even add value (Krumm, Dewulf & De Jonge, 1998; Lindholm, Gibler & Leväinen, 2006; Reeves & Deimler, 2011). To this end, there has been no theoretical or empirical research into the relationship between CRE strategy and the adaptive capacity of a firm. Until now, these spheres of practice have been conceptualized to be independent of each other. The following framework seeks to resolve their theoretical conflicts in order to draw the practical connections by and between sustainability and adaptation, as well as the closely related concept of resilience.

## **A. Conflict in Sustainability and Adaptation**

It is helpful to draw conceptual distinctions by and between sustainability and adaptation, as the contradictory and complimentary aspects of each line of thought are underappreciated by the science and business academies. In many ways, adaptation and resilience are the endpoint of a continuous environmental discourse that began with the environmental protection movement in the 1960s (Finkbeiner, et al., 2010). Table 4.1 highlights the many aspects that sustainability and adaptation/resilience share, including a broader framework oriented towards resource trade-offs, cooperation and a focus on products, processes and innovation. In more immediate terms, the ends to these common values are seemingly drawn only by the distinction between climate mitigation and risk mitigation.

However, the conceptual conflict between sustainability and adaptation has been widely cited in various domains of scientific literature. While the definitions may vary significantly depending on the agency or application, in this context, sustainability "[is] a human intervention that is imposed on a system as part of

a human activity and is totally controlled and managed by humans in order to preserve the system in a state that is desired” (Voinov & Farley 2007, p. 105). The climate science academy defines adaptation as the “adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits mutual opportunities” (IPCC, 2007, p. 869). This adjustment is conceptualized as the ability of a host (e.g., firm) to transform across alternate domains of operation based on both internal and external designs (Vogus & Sutcliffe, 2007; Woods & Wreathall, 2008; Keenan, 2014). A more holistic definition of 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.”[Emphasis Added] (Adger, Arnell & Tompkins, 2005, p. 78). As will be discussed, it is the capacity of an organization to adapt that is the useful reference for this framework.

**Table 4.1: Paradigm Shift from Environmental Protection to Adaptation**

<b>Characteristics</b>	<b>Environmental Protection</b>	<b>Sustainability</b>	<b>Adaptation / Resilience</b>
Social Construction	Control Risks & Immediate Hazards	Triple Bottom Line Balancing	Manage Risks & Long-Term Hazards
Primary Policy Principle	Command & Control	Resource Tradeoffs (natural capital)	Resource Tradeoffs (human financial capital)
Actors	Governments & Industry	Multi-Actor	Multi-Actor
Policy Setting	Confrontation	Cooperation	Cooperation
Tasks	Individual Solutions	System Solutions for Individuals	Individual Solutions for Systems
Principle for Action	Reactive	Proactive	Reactive & Proactive
Primary Scope	Local, National	Global	Local
Focus	Production & Single Processes	Products & Process Networks	Products & Process Networks
Technology	Separate Process, End-of-Pipe	Integrated Processes, Innovations	Integrated Processes, Innovations

Source: Adapted from Finkbeiner, et al. (2010).

Resilience is defined as the elasticity function of a host to maintain its status quo operations based on internal designs (Gunderson, 2003; Laprie, 2008; Lee, Vargo & Seville, 2013). Likewise, resiliency is conceptualized to have a threshold in that not all hosts can be “100 percent resilient to all changes....[b]eyond that threshold adaptation is the only option” (Wiggins, 2009, p. 79). Therefore, the transformational capacity of adaptation mandates a new type of consumption and/or performance in an alternate domain in contrast to resilience that speaks to the elasticity of a host to revert to the status quo. For example, a coastal town may adapt by relocating to a new geography when sea level rise overtakes their resilient flood defenses.



While resiliency and sustainability may be oriented towards the status quo operations of a system, resiliency is positioned within the conservation (k) phase of an adaptive cycle with the acknowledgement that there will ultimately be a release ( $\Omega$ ) of capital within the cycle (Holling, 1986)<sup>1</sup>. In the context of real estate, buildings have been argued to fall within an adaptive cycle as the building and its systems depreciate and/or are otherwise recapitalized with the acknowledgement that a building will eventually be torn down and the capital will be reallocated to a new development (Keenan, 2014). However, some researchers have suggested that sustainability is fundamentally oriented towards breaking the adaptive cycle. Voinov and Farley argue that,

Within the framework for the renewal [i.e., reorganization ( $\alpha$ )] cycle, sustainability would conventionally be interpreted as the goal of breaking the cycle, of extending a certain stage in the system [...] Many economists talk about sustainable growth, which implies an indefinite extension of the growth cycle. The more cognizant of the laws of thermodynamics recognize that all physical production requires raw material inputs, so that sustainable growth in the physical output of an economy is a thermodynamically impossible oxymoron. Sustainability in this case implies an indefinite extension of the conservation stage. Both approaches are in distinct contrast with the renewal cycle, in which growth and conservation are followed by breakdown, release and recombination (2007, p. 106).

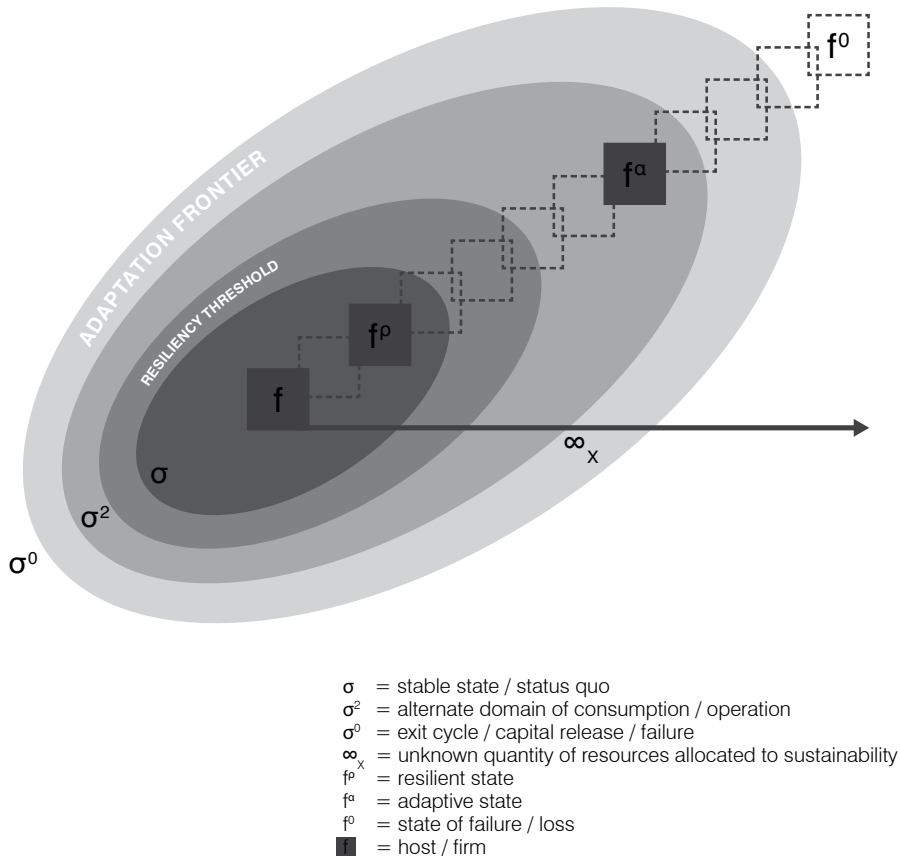
As the authors highlight, empirical evidence suggests that perpetuation of the sustainability of one system often comes at the cost of decreasing sustainability in subsystems, global systems or both. (Id., p.107). More specifically, sustainable conservation may be maladaptive (Werners, et al., 2013). Examples of this include scenarios where countries that promote sustainable timber practices end up deforesting other counties with less formal sustainability requirements (Mayer, et al., 2005; Perlez & Suhartono, 2006). To this end, some have observed that the efficiency seeking applications of sustainability rarely keep up with the gains in consumption (Hockerts, 2001). Therefore, in these cases, to promote the stability of a global timber ecosystem, these countries must adapt by transforming to alternate domains (i.e., consume less timber). However, this counterpoint highlights the limitations of adaptation, as consuming less timber may result in consuming more plastics or steel, for example. Therefore, conversely, adaptation may conflict with sustainability in that alternative domains of operation and/or consumption may have unintended consequences for destabilizing other systems from which hosts (e.g., construction firms) may be dependent or co-dependent (Preston, Down & Berkhout, 2013).

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<sup>1</sup> The four phases of the adaptation cycle are exploitation (r), conservation (k), release ( $\Omega$ ), and reorganization ( $\alpha$ ) (Holling, 1986).

Preston, et al. conceptualize this adaptation frontier “not as discrete and static threshold, but rather an uncertainty or probability space characterized by a gradient that reflects increasing likelihood of crossing into an unsafe operation space,” that might result in loss or failure (Id., p. 1014). Therefore, adaptation may be reliant on the periodic sustainability of certain systems to provide the resources and capital for the adaptation processes that prevent the subject host and/or system from crossing the frontier that results in loss or failure. This same logic may also extend to resiliency, which is dependent on resource availability and allocation for the preservation of the status quo after slack has been consumed. In carrying forward the adaptation example above, it would theoretically require the sustainability of a regional labor economy to support the adaptive relocation of the coastal town. Figure 4.1 highlights both the resiliency threshold and the adaptation frontier as contextualized by the variability of sustainability which theoretically cuts across all states to influence the continuum by and between stability and failure. The nature to which sustainability influences these states is a core question at the heart of this research.

**FIGURE 4.1:** Conceptual Continuum Between Stability and Failure



## **B. Adaptation, Resilience and Sustainability in Business**

The concept of preventing loss or failure has been at the heart of the study of adaptation within the business academies. Early work in strategic organizational scholarship focused on the belief system of managers and the extent to which reorientation of management beliefs and styles contributed to the turn-around of firms in crisis (Miles, et al., 1978; Grinyer & Spender, 1979). The empirical research then shifted to a focus on: (i) strategic management and marketing and the relationship between firms, suppliers and customers; and, (ii) the firm's capability to fit within a market niche or to localize global standards (Hallen, Johanson & Seyed-Mohamed, 1991; Lukas, 1999). The focus on the former aspect with regard to inter-firm relationships then shifted to further development in the processes of modelling the modes of negotiation and communication between firms, as firms adapted in parallel sequence to changing conditions in a market that were fairly uniform in their impact (Canning & Hanmer-Lloyd, 2002).

Similar analytical models were also applied in the evaluation of firms who were adapting to new markets—particularly markets oriented towards new technology and innovation (Chesbrough & Rosenbloom, 2002; Andries & Debackere, 2007; Di Valentin, et al., 2012). The analytical elements within this literature revolve around the strategy of the firm, the capacity or resources to execute that strategy and the network or market intelligence gathering capacities of the firm (Di Valentin, et al., 2012). This is in very close parallel to Keenan's analytical framework for adaptive capacity, which is focused on a tripartite analysis of: (i) the firm's organizational and human intelligence; (ii) the firm's strategy; and, (iii) the firm's space of decisions (2015). The 'space of decisions' is defined as the range of resources and capabilities which may be feasibly utilized to advance a particular intended or emergent strategy. As will be discussed, it is this framework from which the adaptive capacity of the subject firm will be referenced.

It is also worth highlighting the role of the application of resiliency in the business scholarship. In returning to the heuristic of resiliency relating to the elastic functions of a firm, resiliency has been co-opted in the literature with reference to a firm's ability to manage crises and occurrences of shock or market disruption (Bhamra, Dani & Burnard, 2011). This research has also been scaled up to analyze supply chain networks, such as the significant global supply chain disruptions following the Great Japan Earthquake of 2011 (Todo, Nakajima & Matous, 2014). Resiliency case studies have even been extended to firms subject to a spate of data breaches (Müller, Koslowski & Accorsi, 2013). Likewise, the crisis events of 9/11 and the recent global financial collapse have also spawned a global management consulting practice in enterprise resiliency (Starr, Newfrock & Delurey, 2003; Jüttner & Maklan, 2011). A review of this literature suggests an analytical approach very similar to the intent of the early scholarship in adaptation relating to the temporality of crises but with the strategic elements of the later scholarship. Citing Comfort, et al. (2001), Bhamra, Dani and Burnard summarize the practical and applied distinction between adaptation and resiliency when they postulate that,

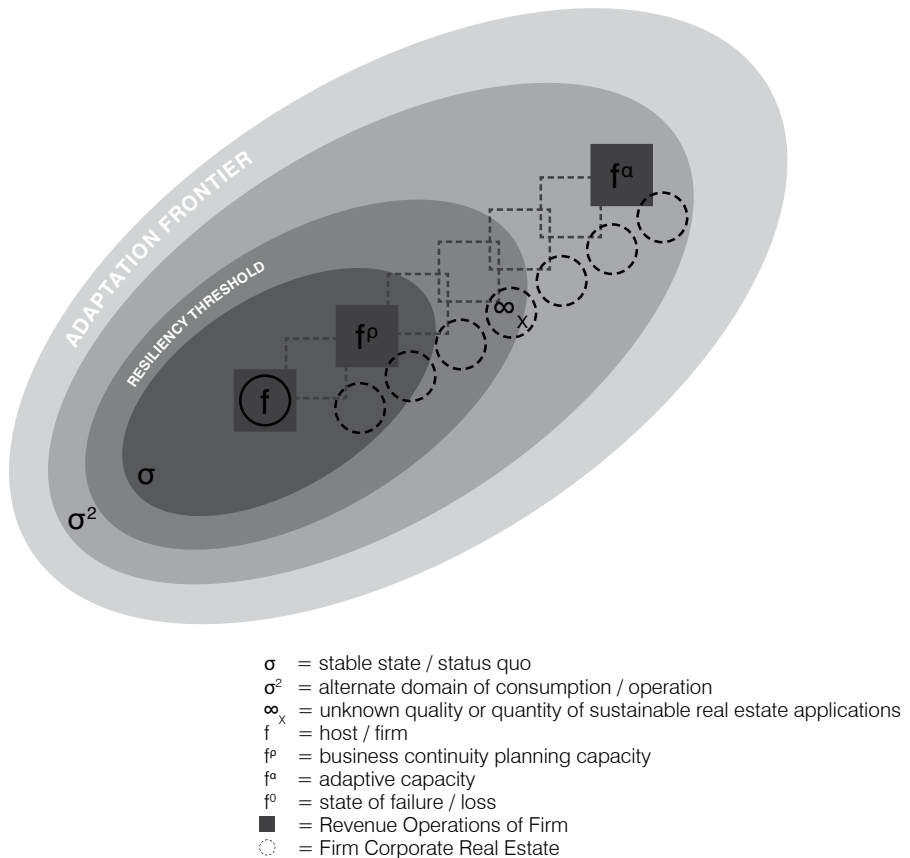
[W]hen an environment's complexity increases, possibly through high impact or disruptive events, a systems performance decreases, as the system is unable to process the amount and range of information to adequately establish the coordination required across the components of the system response. This is a result of the system requiring a significant increase in information exchange, communication, and coordination in order to integrate the multiple levels of system operation and decisions caused by the increase in environmental and system complexity. As a result of this, in order to establish a strategy for reducing risk in uncertain environments,...a system should create a balance between anticipation or preparedness [i.e., adaptive capacity] and resilience (2011, p. 5385).

The practical application of organizational resilience relates to business continuity planning (BCP). As such, this case focuses on BCP as a proxy for the larger resilience of the subject firm. The authors above cite the necessity for information exchange and communication, which is also critical to a firm's adaptive capacity. Therefore, a robust adaptive capacity may also strengthen a firm's resiliency. The distinction is that BCP seeks to maintain the status quo operations of the firm—usually to a specific anticipated event or risk—and a firm's adaptive capacity can be referenced to a dynamic transformational capacity to accommodate the often evolutionary and/or continuous changes in markets or even climate change. This important distinction in time, mode and frequency of risk is consistent with the emerging scholarship which attempts to balance resiliency and adaption of businesses in the face of systematic and periodic risks stemming from climate change (Linnenluecke & Griffiths, 2010; Thompson & Matthews, 2012; Weinhofer & Busch, 2013; Akgün & Keskin, 2014; Linnenluecke & Griffiths, 2015).

While the literature in adaptation and resilience in private enterprise is emerging, it is overshadowed by the dominant and comparatively more mature paradigm of sustainability. There are few consistently applied definitions of corporate sustainability and it has been questioned whether it is even desirable to have one (Constantinescu & Kaptein, 2015). To this end, sustainability in corporate governance is a significant area of inquiry well beyond the scope of this chapter (see *generally* Crane & Matten, 2010). Some have even argued that corporate sustainability is obsolete as an independent construct as sustainable operations and strategies are simply just good business practices (Parker, 2015). Based largely on the widely cited Brundtland report (1987), Hockert's opines that, "[a] strategy for corporate sustainability must meet the needs of a firm's stakeholders without comprising its ability to also meet the needs of future stakeholders. Firms must develop a capability to anticipate change in the needs of their stakeholders. They must also acquire the capacity to *adapt* their strategy to the new requirements" (2001, p. 3, emphasis added). It is with this definition that we come full circle in conceptualizing a link by and between sustainability and adaptation.

Although, sustainability herein is referenced to the strategies and applications of sustainable CRE, it is conceptually consistent to also conceive in broader terms that one function of sustainability is the requirement to adapt.

**FIGURE 4.2:** Range of Conceptual Relationships Evaluated between Sustainable Real Estate, Business Continuity Planning & Adaptive Capacity



### C. Applied Relationship between Sustainability and Adaptation

In order to reconcile the theoretical conflicts between adaptation and sustainability, it is necessary to acknowledge for purposes of this framework: (i) that sustainability is not perpetual, as a sustainable host or system (i.e., building) fits within an adaptive cycle; and, (ii) that adaptation—including the adaptive capacity of a firm—is dependent on the periodic sustainability of resources to offset the costs of change. If true, this framework would suggest some sustainability actions could promote the adaptive capacity of the firm because the firm's ability to adapt to changing markets or environment is

partially dependent on the sustained viability, flexibility and transformability of the firm's real estate and facilities. In addition, as previously referenced, a robust adaptive capacity is also likely to promote a firm's resilience. Finally, it is also logical to argue that a robust adaptive capacity could promote sustainability because it provides the intelligence and communications tools to identify what resources or investments should be sustained.

As graphically represented in Figure 4.2, it is conceptualized that sustainability, resilience and adaptation are potentially in dynamic relation to one another along a continuum of stable and unstable states. The firm has been conceptually and graphically divided between CRE and revenue operations, as sustainable behavior of revenue based actors within the firm are not subject to evaluation in the case. However, these behaviors are potentially important contributors to identifying and accounting for innovation and alternative values by CRE actors—a potentially valuable area of future research. Specifically, because sustainability is a known objective and strategy at the beginning of this research, it is propositioned that sustainable strategies could be a deterministic driver of the promotion of both adaptive capacity and resilient operations. This case seeks to explore the exact relationship of these phenomena so as to highlight the potential validity and application of the conceptual framework.

## **2. Research Design and Methodology**

The research design of the empirical portion of this research is based on an exploratory descriptive case study. This case study research was undertaken over the course of two and a half years and involved alternating periods of internal and external investigation (Gerring, 2007; Yin, 2014). The initial exploratory intent of the case was narrowed after a year to focus on the sustainable practices and adaptive capacities of the firm consistent with the aforementioned propositions. Thereafter, the theoretical framework was developed and refined pursuant to a parallel review of literature that was reinforced by ongoing external theoretical and empirical research in adaptive capacity. The case study research was initiated with a review of internally and externally sourced documents relating to the design, construction, development and operations of the GSHQ and GS's various global facilities. External interviews were undertaken with CRE professionals external to the subject firm on general topics relating to the positioning of the financial service industry's CRE practices and strategies. These initial interviews (n=12) were semi-structured and were intended to provide context for understanding and interpreting the CRE strategy identified in the internally sourced documentation. These external interviewees were not made privy to the identity of the subject firm. The document review and the external interviews provided a foundation for developing a timeline and an initial narrative as to the nature of the design and development of the various facilities, as well

as to some objective reasoning behind such actions. Documents included design guidelines, operations guidelines, contractor produced memorandum and reports, published press, internal communications and firm-generated presentations and media. Finally, detailed site visits to GS facilities were undertaken at different periods to observe operations and design elements.

The principal method for data collection came through a series of semi-structured interviews with a variety of firm personnel including the Global Head of Corporate Services and Real Estate (CSRE)<sup>2</sup>, General Manager of Corporate Services and Real Estate for the Americas, Global Head of Facilities, Regional Manager of Facilities, Head of Real Estate Strategy, Chief of Staff to the Global Head of Corporate Services and Real Estate, Vice President for Capital Projects in the Americas, Managing Director of Corporate Services and Real Estate, Head of Workplace Planning and various other persons with expertise and responsibility in facilities, real estate, hospitality and capital projects (n=13). In total, 35 individuals were interviewed. A more detailed memorialization of the selection, process and content of the interviews may be found in the Appendix. In some cases, multiple interviews were undertaken to provide greater clarification on data as they were collected through the interviews or through the document review. To the extent possible, internally sourced data were triangulated with data collected from internal interviews and internally sourced documentation. However, due to the proprietary nature of the subject of this case, internally collected data were generally not triangulated through third-party interviews, although some data from third-party interviews helped triangulated internally sourced data.

### **3. Case Narrative**

#### **A. Urban Strategy**

In line with the tremendous economic growth in the U.S. in the 1990s, GS had expanded its principle business operations into 7 buildings accounting for over 278,000 m<sup>2</sup> in Lower Manhattan by the turn of the century. When GS went public in 1999, there began to emerge internal recognition that the firm must transition to become more competitive and efficient in the housing and delivery of its operations. The piecemeal legacy system of different divisions in different buildings resulted in highly inefficient use of space in older buildings with nearly unabated energy and infrastructure costs. In response, the initial strategy centered on a new consolidated corporate campus across the Hudson River in Jersey City, New Jersey, which began construction in early 2001.

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<sup>2</sup> CSRE is the non-revenue division of the firm from which all cited interviewees and their respective units fall within. CSRE is also in charge of service delivery in addition to facilities and other more conventional CRE functions. References to CRE strategy made herein are a reference to the strategies made by the CSRE.

However, the events of 9/11 ushered in a new era of contemplation as to the future of Lower Manhattan and GS's position there. With the loss of nearly 1,000,000 m<sup>2</sup> of space on 9/11, many firms had no other choice but to relocate to midtown and other suburban locations. As early as 2002, the firm had decided to make a commitment to revitalizing Lower Manhattan with the construction of a new headquarters building that would allow the firm to consolidate its operations. However, with the push to develop the GSHQ in Lower Manhattan, the firm was forced to down-scale its Jersey City campus development at 30 Hudson Street by nearly US \$1 billion. The firm carried forward the concept of a campus by conceptualizing an integrated continuum between GSHQ and 30 Hudson Street, which would be connected across the Hudson River by firm-operated ferries. While the larger urban strategy highlights some of the initial logics (i.e., efficiency and consolidation) of the firm's strategy, the more finite nature of the firm's CRE strategy is best understood in the design and development of the GSHQ itself, as well as in guidelines and practices which would later be translated to facilities across the globe.

## **B. Consolidation Strategy and Firm Culture**

To lead this consolidation strategy, in 2002 the firm brought in a leading CRE executive from the Walt Disney Company. In shaping a transformational repositioning of CRE, facilities and services, the Global Head of CSRE immediately recognized the analytical capacity of the firm as a tremendous cultural strength that could be utilized to rationalize and communicate "the facts." While the executive anticipated some measure of resistance to the consolidation efforts and the changes they engendered—particularly those relating to the consolidation of the workplace as strategized by the firm—this propensity for the facts helped create a pathway for effective change management. He highlighted the deeply engrained cultural attributes of the firm to "respect the facts" and to harness its analytical capacity utilized in the markets to solve its own internal management and operations challenges.

To this end, 6 of the top level executives within CSRE regularly cited the cross-divisional aspects of the firm as being a major advantage in a variety of aspects ranging from planning and development of facilities to the contracting of third-party vendors. Although the firm is organized into revenue and non-revenue divisions with some measure of autonomy, interviewees consistently cited a general culture of collaboration, which was cited as flexibly moving across organizational delineations on paper. Several interviewees speculated that the ever changing aspects of the diverse markets and lines of business of the firm contributed to the necessity to build a culture that facilitated the allocation and movement of resources by and between more conventional organizational structures. However, "[t]his was not always the case [leading into the late 1990's] when different [units] of the firm operated almost completely independent of each other and often competed for resources and space," noted a senior facilities manager.



While the culture of the firm was cited as amenable to change, the complexity of the larger consolidation strategy required an equally complex change management regime to execute. Therefore, it was one thing to know and respect the facts and an entirely different process to communicate the relevance of those facts to the right people. “[They] faced a significant pushback from senior staff who felt entitled to their personal space and this presented a challenge to the formulation and execution of any change management plan,” observed a senior CSRE staff member. One fact at the core of the transition revolved around the costs to the bottom line of excessive consumption. The firm’s per capita occupancy expenses were nearly double those of the financial services industry in Manhattan. Prior to occupying the GSHQ and 30 Hudson Street, the per seat expense for occupied seats was approximately US \$37,500 (PV) a year. By 2014, those costs were down to nearly US \$20,000 (PV). The cost per occupied seat was an aggregate metric that accounted for energy, taxes and a weighted distribution of owned versus rented space. However, it was very clear that “these [rented] buildings were older and simply didn’t have the infrastructure to support the IT growth of the firm, and the expenses of upgrading the infrastructure were cost prohibitive given our lease structure,” said a senior capital projects manager. Combined energy and IT costs were determined to be the underlying cost drivers for justifying the consolidation strategy. Therefore, the sustainability and resiliency of these systems were a top priority from the early stages of the conceptual design.

The consolidation strategy included the development of protocols oriented around a pyramid concept, which prescribed the allocation of personal and working space for every level of employee within the firm. Going forward, with very few exceptions, only the highest ranking partners of the firm would be able to avail themselves of a private office—and, only in one city. Thereafter, inferior, yet senior positions, such as directors and vice presidents would be obligated to work in a much more efficient modularized open-plan office setting. While this change faced some elements of pushback derived from cultural entitlements of senior employees, the clearly articulated facts relating to global standards, the anticipated efficiency of operations and the indirect costs of excessive consumption were communicated as part of the change management strategy.

It is worth noting that this pyramid protocol was observed to be one of the few highly rigid codifications of the CSRE strategy. Each of the foregoing plans and protocols were observed by interviewees as highly dynamic and in a constant state of evolution. For instance, ongoing data reporting and experimentation were often cited as drivers for modifications of the various guidelines, which cover all aspects of the workplace, workspace and facilities operations. Senior executives recited the positioning of a value system that allowed for a type of executive legislative intent to guide a fluid range of parameters for the guidelines and protocol. As such, the fixed objective structure existed to support and inform fluid subjective judgments. One of the guiding values which translated from the executive management down was the value system behind sustainability.

## **C. Sustainability and Efficiency**

Sustainability was broadly interpreted across CSRE division, with the most consistent heuristic relating to efficiency first and the moralism of environmental stewardship second. “From the point of view of [CSRE], the principal priority is to support the profitability of [the firm],” explained the global head of CSRE. While sustainability within building design and performance was deemed critical, the firm also acknowledged the necessity for behavior modification in the use of the facilities and the consumptions of services. This ambition even extended to the advancement of alternative, more efficient states of thermal conditioning. Each of these sustainability measures were evaluated in terms of the bottom-line implications, which were often represented as savings of cents on the square foot, with the acknowledgment that small incremental actions aggregated to significant savings. Ultimately, the energy costs post-consolidation were nearly cut in half when controlled for varying rates of technology usage.

Another value set that ran parallel to sustainability was flexibility and efficiency. As the firm had grown, contracted and adapted to various business models, CSRE metrics were highly sensitive to slack in the system. This was particularly relevant when, in 2008, the firm converted to a bank holding company. This conversion resulted in a new demand for compliance spaces for the physical separation of units out of the legal obligation to minimize the risk of potential conflicts of interest. One observed implication of this new category of space was its inherent lack of flexibility. To help manage both non-compliance and compliance spaces, reporting and internal controls initially designed to promote sustainable consumption were adapted. Therefore, if a unit was over consuming what would later be determined to be under-utilized space, that division was financially responsible for that slack. “[Revenue units] could no longer simply have empty sections of floors for long periods of time when they were in a down cycle,” observed one CSRE staff member responsible for reporting. This was a significant change from prior consolidation events where divisions would expand and contract into and out of entire floors of office buildings with little internal accountability. This transformational event (i.e., bank conversion) for the CRE system highlights the relative robustness of the adaptive capacity of the firm to the extent that modularity of interior designs and operational controls were able to facilitate new space constraints as the business models adapted to changing market and/or regulatory conditions. Ultimately, this adaptation was benefited by interventions which were initially motivated by sustainability.

## **D. Designing Sustainability and Efficiency**

In returning to the design of the GSHQ and 30 Hudson Street, these projects provided an opportunity to set design and operations standards that would become the framework for CSRE assets comprising over 1 million m<sup>2</sup> in 160 offices, in 98 cities across 31 countries. To promote

greater degrees of flexibility and operating efficiency, every aspect of the size, timing, dimensions and materiality of the operations of the firm were measured. Contrary to the conventions of CRE, the firm identified these parameters prior to fully engaging architects. Engineering disciplines were brought in during the internal assessments to provide spatial parameters to the fixed systems. It was these parametric rule sets that would guide the designs of the architects. It was cited that the precision of these measurements in other global facilities developments would later shave many square feet off of ongoing designs and would result in millions of dollars of annual savings that would have been spent on un- or under-utilized space.

One application of these sustainability efforts led to the standardization of the workspace—often with some measure of material modularity. To accomplish this, various experiments with removing personal storage, trashcans and printers were undertaken at the time of planning. For instance, the contents of file cabinets were systematically surveyed and classified so as to better understand what aspects of the workflow absolutely required paper storage versus alternative digital storage. As a consequence, personal file storage was largely removed, and printers were set up by work group. Systematically removing paper from the workplace reduced a tremendous amount of weight on the structure and reduced wear and tear on the facilities for the moving and storage of the paper. Second, it reduced the thermal mass and load of the building, as the costs of unnecessarily heating and cooling paper were significant. It was also speculated by some of the interviewees that, by forcing employees to get up and walk to critical storage and printing facilities, there were likely positive implications in terms of occupational health. Specifically, the levels of occupational health regulation relating to the workplace in London were observed to have positive reciprocal influences which translated to other office locations outside of London. While there were little empirical data to support overall productivity gains (e.g., fewer sick days) by encouraging physical activity, a positive implication for occupational health could have immediate implications for the resilient operations of the firm.

Beyond the workspace, the firm expended significant efforts in evaluating the dynamic operations of various units, including providing a sensitivity to each unit's historic variability in space and service consumption. A process of reverse engineering workflows, consistent with contemporary space planning practices, were undertaken at a variety of scales. These performance parameters were integrated with the material prescriptions of the workspace to formulate a set of working operational plans that provided the basis for more sophisticated parallel processes of evaluation by various engineering practices ranging from electrical to heating, ventilation and air conditioning (HVAC). It was only after the operations planning and engineering performance requirements were resolved that architects were fully engaged.

During the process of developing the larger CRE strategy, an additional transformational change occurred—cloud computing. At the beginning of the process, computers were assumed to be fairly constant in their space, energy and support requirements. However, with the evolution of cloud technology, the decentralized processing technology and the requirements of greater robustness in BCP, the idea of the desktop computer soon became nearly obsolete. This significantly challenged the spatial and operational parameters of the workspace and the workplace. Again, this technological disruption highlights the relative robustness of the firm's adaptive capacity by virtue of CSRE making a transition across multiple integrated operational platforms in a fairly short amount of time with little reported disruption to operations.

Integrated coordination between IT, facilities and operations was cited as critical to accommodating this change—particularly as it related to systematic calibration of building systems to accommodate alternative thermal and energy loads. “[This] shift in understanding the implications of cloud computing happened late in the design process. But, the existing channels of [integrated] communication allowed us to make some accommodation—although many aspects were incorporated post-construction,” observed a senior IT and facilities manager. In fact, cloud computing was internally referenced as a sustainable application by virtue of the energy savings. Desktop computers simply consume a lot of energy and produce a lot of heat. This change was also internally referenced to promote flexibility for workplace management. This allowed the firm to adapt by experimenting in some divisions with the policy of being seated in patterns consistent with temporary work groups or randomly assigned based on availability. Cloud computing also allowed for the promotion of working off-site which represented a larger CRE trend and was also internally referenced as a significant advantage for BCP. “During [Hurricane] Sandy, nearly everyone was able to work from home that week,” noted one facilities engineer. This would not have been possible prior to not only cloud computing but secure cloud computing. However, interviewees expressed some ambiguity about the extent to which off-site working would proliferate or was otherwise desirable. Some argued for its efficiency and others argued that it thwarted the collectivity embedded in firm culture. To this latter point, off-site working may conceptually work to reduce the resilience of the firm.

While this process of seat assignment experimentation is still ongoing across various units, it was cited as having significant potential in helping units better manage their spaces, which are always subject to some measure of expansion and contraction incidental to changing market conditions. This type of experimentation speaks to the larger fluidity of protocol and guidelines, which were cited as adaptable to changing circumstances. “The [firm] prefers guidelines over rigid protocols,” noted a CSRE staff member. With the design and development of GSHQ as a platform for memorializing, validating and calibrating these practices, their dynamic nature is interpreted, as will be discussed, as an outcome of the arguably robust adaptive capacity of the firm motivated by sustainability.

## 4. Discussion

This case features several moments of shock (i.e., Hurricane Sandy) or transformational change (i.e., banking conversion and cloud computing), which highlight the conceptual connections referenced in the framework. Perhaps the clearest connections are defined by actions motivated by sustainability logics which promote operational resilience. The material, operational and computing actions at the scale of the workspace and workplace all lead to greater flexibility that promotes resilient operations. Whether it is a more tenuous connection between physical activity and absenteeism or a very clear connection between computing and remote working, actions motivated by sustainability that promote the stability of workers and their work promote resilience. Likewise, the firm's adaptive capacity defined in terms of cultural elements that promote cross-cutting analysis and communication also positively promoted resilience, as exemplified by the cited collaboration in successfully weathering Hurricane Sandy. However, these very same sustainability and resiliency attributes can be said to reciprocally promote adaptive capacity. Therefore, it is necessary to explore the parameters of the firm's adaptive capacity before understanding its complex relationship with the sustainability aspects of the CSRE strategy.

### A. Adaptive Capacity

Consistent with Keenan's framework for adaptive capacity, the findings of the case can be broken down into several analytical elements (Keenan, 2015). First, the organizational and human intelligence of the firm were observed to be robust. Interviewees regularly cited the cross-divisional capacity of the firm to utilize its analytical power to addresses problems for which the investment in such analytical functions was not originally intended. An example of this includes traders using algorithms to better understand and model internal circulation to maximize efficiency and minimize trip times. Other aspects relate to the culture of the firm to respect 'the facts' and to systematically reduce management biases in favor of objective analysis based on a vast collection of data—often premised on an experimental basis. As one CSRE staff member responsible for data collection observed, “[w]e aren't quite sure what to do with all of this data sometimes...But, [we] are constantly thinking of new ways to make the data [we have] useful without being a burden on other [units] to comply with additional reporting.” These phenomena highlight a cultural element of the firm that suggests that information may be more readily transmitted across heterophilous units of the firm and filtered between signals and noise. This cultural of collaboration was cited as being solidified as a consequence of the sustainability driven CRE strategy that fostered open exchange. Collectively, these attributes speak to a robust organizational intelligence for identifying and managing change.

The other two analytical prongs of the cited adaptive capacity framework—strategy and space of decisions—are limited in this case to the CRE strategies and not the strategies and operations of the revenue side of the firm. In addition, the decision

space which gave parameters to the range of resources available for the execution CSRE's strategies was referenced by internal and external interviewees and reviewers to be on par with other similarly scaled firms. This highlights a limitation to Keenan's analytical framework in that a strategic evaluation of adaptive capacity is only somewhat useful for evaluating in isolation in absolute terms (unless a particular innovation is discovered) and is most useful or relevant when referenced to specific experiences and/or strategies across multiple firms (2015). However, this limitation sets the stage for future research which could evaluate these generalizable CRE and sustainability strategies across multiple firms whose adaptive capacity may vary depending on the firm's line of business. As will be discussed, the observed strategies for CRE which were motivated in part to meet sustainable goals likely did promote the adaptive capacity of the firm.

**Table 4.2: Parallel Relationships between Sustainability, Resilient Operations & Adaptive Capacity**

<b>Sustainability Applications</b>	<b>Climate Mitigation Implications</b>	<b>Resilient Operations</b>	<b>Adaptive Capacity</b>
Less Paper	Less Consumption of Trees	BCP: Remote Working	Cloud Computer Allows Non-Spatial Workplaces
Less Furniture	Less Material Consumption	N/A	More Flexible Utilization of Space as Business Changes
Less Power Consumption	Less Air Pollution and Carbonization	BCP: Greater Autonomy for On-Site Generation	Less Operating Overhead and Organizational Constraints
Consolidated Campus Plan	Lower Per Capita Consumption	N/A	Greater Flexibility for Managing Human Resources
Workplace Standards & Occupancy Mgt. System	Lower Per Capita Consumption	N/A	Greater Flexibility for Managing Human Resources
Preventative Maintenance & Life Cycle Management	Less Material Waste	BCP: More Easily Recover When Events Cause Material Loss or Damage	Maximum Facilities Utilization
Integration of Design & Operations Planning	Less Building Materials and Operational Consumption	BCP: Greater Working Knowledge of System Dependencies & Vulnerabilities	Asset Management and New Construction; Can More Readily Accommodate Change in Business Operations
Organizational Integration of Facilities & Engineered Systems	Less Building Materials and Operational Consumption	BCP: Greater Working Knowledge of System Dependencies & Vulnerabilities	Asset Management and New Construction; Can More Readily Accommodate Change in Business Operations

## **B. Sustainability Supports Adaptive Capacity**

Consistent with the Second Proposition, evidence suggests that sustainability driven strategies did promote the adaptive capacity of the firm. This relationship was reinforced by horizontal communication and organization, but the initiating motivation was from top-down leadership. As a matter of corporate governance, GS made a commitment to incorporate sustainable practices across the firm and specifically in its CSRE division. This was more formally made with the utilization of LEED and its international equivalents in its design and construction of facilities, including the GSHQ. However, there were many other elements of sustainability which were not codified in LEED. “We were very aware of the systematic limitations of LEED and we thought we could build a system that was far superior [in its performance],” noted a senior facilities engineer. Collectively, these sustainability actions were rationalized primarily in terms of bottom-line economic and resource efficiencies. As previously noted, outdated leased facilities with inefficient energy performance were a primary cost driver for consolidation and a subsequent important value for future design. This case highlights a number of sustainability applications which arguably advanced the adaptive capacity of the firm.

As listed in Table 4.2, the first example of sustainability relates to the planning of design and workplace standards which reduced paper, furniture and material consumption. The process of planning a workflow and workspace around less paper actually advanced the adaptive capacity of the firm. This was highlighted with the disruptive transition to cloud computing. Although sustainable workplace planning didn’t originate cloud technology incorporation, it helped make the transition much smoother by conditioning behavior and designing a workspace and workflow for a purely digital interface. This correlation was observed by a number of interviewees. Likewise, the incorporation of cloud computing was internally rationalized as sustainable by virtue of the reduction in power consumption. As a consequence, the adaptive capacity of the firm was enhanced for a number of reasons. First, it allowed greater flexibility within the firm to move people around as projects and work-groups evolved and changed. Second, it allowed a greater transmission of information across the firm. Prior to consolidation, it was not uncommon to have “entirely separate server systems [for different units] that were not interoperable,” as one IT engineer reflected.

A similar set of logics can be extended to the sustainable designs of having less furniture and utilizing current furniture more efficiently. The modularity of the furniture advances the adaptive capacity of the firm by virtue of a great flexibility and predictability for moving people around as operational changes so dictate. It allows spaces to be more easily manipulated so as to also accommodate people who may otherwise have more static space constraints, as was the case for the aforementioned compliance spaces. “Our playbooks [(i.e.,guidelines)] for operations were integrated right down to the [modular] furniture on the floors... and this allowed us much more flexibility in planning for [unit] needs over varying time frames,” noted a CSRE staff member responsible for seat assignments.

The sustainable reduction in consumption that advanced adaptive capacity occurred at two additional scales. First, the larger urban strategy for campus consolidation greatly reduced consumption in terms of per capita energy, water and material consumption. However, it also made for a much more efficient platform for flexibly managing the repositioning of people who are all subject to the same ecosystem of performance, measurement and reporting. Arguably, the result is a more robust capacity to accommodate change by being able to more flexibly move people to new or different workspaces and workplaces as business models change, as cited in the conversion to a banking corporation. This exact same logic extends to the scale of the workplace standards, as mediated by the occupancy management system. For instance, as different divisions expand and contract with the changes of the markets, so too can the firm more readily adapt to these fluctuations.

Second, the integration of design and operations to maximize, in part, the designed efficiencies and sustainability of the building also promote the adaptive capacity of the firm. This happens because the design process is predicated on a rule set that acknowledges the dynamic operations of the firm which are in a constant state of change. This integration which is memorialized by a fluid evolution of guidelines and standards allows for an adaptation to future changes whether radical or transformational. For instance, without the sustainability measures put in place as a consequence of this integration, it was speculated that the bank conversion would have resulted in additional redundant space consumption and that Hurricane Sandy would have resulted in greater economic losses because many fewer people would have been able to work remotely.

Likewise, the integration of engineered systems, facilities and CRE management in an effort to promote sustainable and efficient operations can also advance adaptive capacity. In theoretical terms, it allows for a greater range of strategic options. For instance, sustainability elements of managed life cycling of material facilities, which promotes less waste and more efficiency in the building, arguably advances the adaptive capacity of the firm as there is more predictability in the performance and availability of spaces to accommodate change. Simply knowing in near real time what space is available as result of regular data collection is valuable in its own right. For example, if there is a floor scheduled to undergo a replacement of a particular system which would otherwise impact operations, the precise management of the life cycling of systems allows for minimal disruption and would cue CSRE not to make a particular adjustment in space allocation that conflicts with the system maintenance. "Sometimes we go ahead and replace carpet ahead of its useful life, if we are already replacing other [elements] on a floor...thanks to the integration of [our] inventory management system with operations," noted an asset manager. This interaction happens at every scale from the small disruption of replacing carpet to the moving of units of the firm for larger systematic interventions, as happened with the bank conversion. In this sense, the physical adaptive capacity of the building relates very clearly with the adaptive capacity of the firm (Keenan, 2015).



A general application of designs to reduce the consumption and to promote the efficient use of energy also advanced the resiliency of the firm by reducing the overall energy load of the GSHQ for on-site power generation, thereby lengthening the duration of onsite operations in the event that external power sources are compromised. As referenced in the introduction to this chapter, this was the case during Hurricane Sandy when the firm was able to weather initial power outages that provided the time to fully implement its BCP functions prior to removing the building from the power grid. Energy management also speaks to how elements of adaptive capacity relating to the integration of power management, facilities and operations also advance the sustainable operations of the larger designed energy system, as well as the resiliency of the overall operations of the firm. As extreme weather events become more regular as part of a transformational change in the environment, maintaining moments of resiliency will be dependent on the adaptive capacity of the firm.

### **C. Reciprocal Influence: Adaptive Capacity and Sustainability**

The evidence supports the First Proposition that there is an applied relationship between sustainability, resilience and adaptation. The evidence also supports the Second Proposition that sustainability advanced the adaptive capacity and resilience of the firm. From a macro-perspective, CSRE's strategy framed largely by sustainability set in motion connections across the firm in terms of data, intelligence and communications that had not previously existed. However, GS did not intentionally promote sustainability with the knowledge that it might advance their adaptive capacity. On the contrary, only a handful of the observed connections were internally recognized by individual actors. The challenge to understand intent or motivation also reflects practical limitations to case study methodologies for understanding corporate strategies (Mintzberg, 1978; Snow & Hambrick, 1980). While sustainability is referenced as a deliberate strategy by the firm, adaptive capacity was not. Therefore, an analysis of the results of this case may be biased towards interpreting sustainability as the mechanism for driving the positive relationships because the investigator is focused on data collection that memorializes the intent of the subjects. Likewise, it is conceivable: (i) that negative relationships and/or feedback loops may exist; and, (ii) that unobservable exogenous factors may have deterministic impact on influencing the observed outcomes.

There were a number of observations that suggest that adaptive capacity may have also reciprocally advanced sustainability. For instance, in the above cited example relating to the integration of engineered systems and facilities, it could be argued that the adaptive capacity of the firm—for example, the previously referenced robust organizational intelligence—could be a contributing factor for integration in the first place as it sets in motion the process of identifying what should be sustained under what conditions. This argument could also be extended to the integration of design and operations planning that might

have been a consequence of a robust adaptive capacity of CSRE to be able to consolidate a single decision space based on superior cross-cutting intelligence. This possibility for conceptual reciprocity raises the question as to whether it is useful or desirable to frame an initiating or deterministic factor or whether the relationships herein should be referenced in isolation to their outcomes. However, it can be argued that framing initiating factors may lead to normative development of operational models that promote both adaptive capacity and sustainability—particularly if co-benefits can be underwritten into the initial investment calculus. Therefore, this case demonstrates that sustainability did in fact promote the adaptive capacity of the firm; but, future research may be able to more definitely demonstrate how otherwise robust adaptive capacities may or can lead to greater sustainability.

## 5. Conclusions

The findings of this case are the first steps in uncovering the wide ranging implications, if not validity, of the theoretical framework that attempts to demonstrate the potential for practical connections between sustainability, adaptation and resilience. Consistent with the First Proposition, the demonstrated co-benefits by and between these strategies and capacities are likely strong motivations for future research in developing methodologies for identifying and valuing innovations that have broader implications than they were initially designed. This is particularly important at a time when the economics of sustainability struggle to find value beyond the immediate returns on cost. The findings also highlight the multifaceted dimensions of framing a firm's adaptive capacity in that the integrated data driven management of people and facilities is likely a key factor for promoting the organizational transformations necessary to accommodate structural changes in technology markets and eventually even climate change. They also highlight the reciprocal advancement of resilience in the face of known and anticipated shocks.

Future research is tasked with giving definition to the measuring and modelling of organizational adaptive capacity. This case suggests that modes of intraorganizational communication and intelligence are likely a compelling place to begin the normative development of operationalizing adaptive capacity—particularly within the context of CRE, which is uniquely positioned to cut across all aspects of firm operations. Future research will need to identify biases and preferences of management or internal organizational structures which distort intelligence processes for identifying, preparing for and responding to change. As demonstrated in the case, the role of leadership within executive hierarchies is also likely to have major role in overcoming institutional constraints in everything from burdensome data collection to a broader management of risk. As firms expand already existing adaptation units from a focus on supply chains to

internal operations, these research questions will require new methodologies such as simulated stress testing to advance an understanding of adaptive capacities not as means to merely manage risk but as a means to identify opportunity.

This chapter identifies of a number of changes that are illustrative of the radical and transformational changes facing firms. As the values of sustainability continue to permeate corporate governance and management, this chapter highlights the extent to which sustainable processes may have transformative impacts in adapting to change in both material and organizational terms. Likewise, this chapter presents the theoretical and empirical possibility that robust adaptive capacities may also promote the execution of sustainable practices. As these dynamic relationships are explored in future research, CRE is the prime beneficiary of this knowledge by virtue of its central role in firm operations. With CRE on the front lines of the intersection of changing markets and environments, it could very well serve as the future platform for both the maintenance and survival of firms as they both sustain and adapt.

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# **CHAPTER V | Understanding Conceptual Climate Change Meanings and Preferences of Multi-Actor Professional Leadership in New York**

This chapter sets out to evaluate the range of meanings and preferences for the concepts of adaptation, resilience, mitigation and coping of a variety of professionals in New York who are undertaking leadership positions in developing climate change policies and practices. This chapter positions a normative set of simplified meanings for each of the aforementioned concepts based on a review of existing literature. Utilizing a survey, these normative meanings are evaluated by and between the: (a) concepts and meanings; (b) concepts and applications; and, (c) applications and preferences, as applied to various risk based scenarios ranging from sea level rise to heat waves. This survey tests the hypotheses that the respondents: (i) are unable to consistently match the concept of resiliency with the normative meanings or applications: and, (ii) will not consistently show a preference for resilience applications or outcomes ahead of other concepts. The results of the survey confirm both hypotheses, which is demonstrative of the inadequacy of the current framework dominated by a narrowly defined framework for resilience. It is anticipated that the results of this chapter will advance an argument for the necessity to develop consistent meanings for concepts which bridge the scientific, policy and popular domains.

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As the science for adaptation branches off into the science of adaptation, one of the most significant challenges facing academics and practitioners is a lack of consistent meanings in conceptualizing various responses and preparations for dealing with climate change (Swart, Biesbroek & Capela-Lororencio, 2014). Interviews with practitioners have suggested that the lack of consistent meanings of coping, mitigation, resilience and adaptation (the 'Concept(s)') are arguably holding back the development of comprehensive plans, laws, resource allocations and investment strategies by actors in the public, private and civic sectors. Each Concept varies in its core meaning and can be additionally categorically distinguished by actor orientation, time horizon, and application. Specifically, the domestic American practice has in recent years been dominated by the rhetorical usage of the Concept of resilience, whose various applications and meanings have offered little consistency with scientific and social scientific scholarship or with emerging internationally recognized frameworks. If a clear division of Concepts is left unattended, then the current narrowly drawn and inconsistent framing of resilience may lead to long-term maladaptation (Klein, Nicholls & Thomalla, 2003).

This chapter sets out to evaluate the existing range of conceptual perspectives of a variety of professional actors in the metropolitan region of New York City (NYMR) who are undertaking leadership roles in developing policies and practices which address a multitude of risks associated with climate change (collectively, the 'Respondents'). While scholarly consensus is still emerging by and between various academic domains, this chapter positions a normative set of simplified meanings for each of the aforementioned Concepts based on a review of existing literature ('Conceptual Heuristics'). Then, utilizing a survey, these Conceptual Heuristics are evaluated by and between: (a) Concepts and simplified meanings; (b) Concepts and applications of those meanings; and, (c) applications and Respondents' preferences, as applied to various risk based scenarios ranging from sea level rise to heat waves. This survey tests the hypotheses that the Respondents: (i) are unable to consistently match the Concept of resilience with the heuristical meanings or applications of those meanings; and, (ii) will not consistently show a preference for resilience applications or outcomes ahead of other Concepts—despite the predominance of its rhetorical usage. This chapter concludes with a discussion on the implications for continued misapplication of the aforementioned Concepts with regard to policy development. It is anticipated that the results of this chapter will advance an argument for the necessity to develop a set of consistently applied Concepts that bridge the scientific, policy, and popular domains. A failure to develop consistent and objective meanings is likely to result in the dilution of legislative and design intent of critical strategies and interventions.

## **A. Heuristics and Framing**

The study of heuristics can be traced to ancient Greece with modern conventions over the last 150 years falling into the fields of psychology, behavioral science, economics, and, more recently, computer science. One definition of heuristics is that they "are strategies that guide information search and modify problem

representations to facilitate solutions... [and have] been used to refer to useful and indispensable cognitive processes for solving problems that cannot be handled by logic or probability theory" (Goldstein & Gigerenzer, 2002, p. 75). However, this definition assumes that an individual is challenged by a complex problem which defies an individual's capacity for logical reasoning as opposed to an individual's desire to more quickly frame and evaluate the problem. To this end, Gigerenzer and Gaissmaier offer a more compelling definition of a heuristic as a "strategy that ignores part of the information, with the goal of making decisions more quickly, frugally and/or accurately than complex methods" (2011, p. 454). With time, the focus in the scholarship—including climate scholarship—shifted from evaluating the positivist substitute functions to how those substitutes or heuristics impact reasons, judgments and decision-making based on certain illusions and/or biases (Nicholls, 1999; Grothmann & Patt, 2005; Sunstein, 2006; Chen, 2011; Kahan, et al., 2012; Preston, Mustelin & Maloney, 2013).

While this chapter acknowledges the inherent limitations to utilizing Conceptual Heuristics (i.e., balancing efficiency and accuracy), it returns the focus to the necessity to develop simplified substitutes which can serve as a foundation for decision making in the advancement of policy development. Developing Conceptual Heuristics is particularly desirable given the complexity of climate science. As a unit of analysis, heuristics should be contextualized within a related body of theory regarding framing. If heuristics are about reducing information, framing is about constructing or selecting salient pieces of data to define problems, to diagnose causes to problems, to make moral judgements, and to define remedies (Entman, 1993, p. 52). In this sense, heuristics are single elements of substitution within a larger framing process (Fiske & Taylor, 1991). In methodological terms, framing is generally understood by and between the synergies and conflicts of multiple actors under multiple realities working at the same or similar scales, and these subjectivities are often evaluated through focus groups and case studies (Fünfgeld & McEvoy, 2014). This research is focused specifically on a single objective reality and is limited in its inquiry to conceptual nomenclature, meanings and preferences under bounded conditions and not the wider ranging aspects of framing, including moral judgements and the identification of potential remedies. However, future framing research may utilize the methods and results of this research to refine objective meanings of Concepts that highlight synergies and conflicts in subjective framing.

## **B. Practical Problem: Subjective Steering and Resilience**

At present, moral judgements about the allocation of resources in the advancement of resilience and adaptation are assumed to be steering meanings that have the potential to lead to inefficient and morally ambiguous outcomes (Sunstein, 2005; Klinsky Dowlatabadi & McDaniels, 2012). By developing consistent objective meanings in planning practice, it is anticipated that this level of criticality grounded in scientific and social scientific scholarship will

minimize the occurrence of morally subjective steering of Concept usage. There are multiple examples of how subjective steering of Concepts—notably resilience—are leading to less than desirable processes and/or outcomes. In theoretical terms, one argument rooted in critical theory against the exclusive utilization of resilience as a meta-concept for responding to change is that through the perpetuation of the operations of the status quo—as will be discussed—one is perpetuating existing power regimes which possess a certain latent moral foundation which does not necessarily serve the ends of a socially equitable distribution of common pool resources (Vanderheiden, 2008; Whitehead, 2013).

In more practical terms, there are a number of examples in the NYMR where the exclusive promotion of resilience for the benefit of specific social groups is rationalized to advance reconstruction of coastal buildings and infrastructure whose useful life fits well within probabilistic estimates for sea level rise and storm frequency (Enterprise Community Partners, Inc., 2013). As such, while these efforts may be resilient in the short-term, they are likely to be maladaptive over the long-term. In practice, the promotion of the resilience of social systems or groups is viewed as an objective absolute good even though at different scales and time horizons it may be maladaptive. For instance, a public policy focus reinforced by civic frameworks for promoting resilience for low and/or moderate income people often works to exclude a universal class of people who are also subject to risks from extreme weather and climate change and may themselves become impoverished with long-term exposure to extreme weather and climate change (Rockefeller Foundation, 2014; White House, 2014). In addition, a focus on social resilience often distracts from aspects of environmental resilience and adaptation within a larger ecosystem analysis. In practice, resilience and sustainability are often conflated to rationalize sustained and continued consumption. These narrowly drawn subjective meanings of resilience highlight the necessity for the development of objective meanings that offer critical sensitivities in the construction of Concepts that reinforce comprehensive analysis in decision-making and policy development.

## **1. Conceptual Heuristics and Climate Change**

### **A. Heuristics as a Foundation from Discourse to Policy**

In order to understand the NYMR's professional leadership's varying conceptual meanings, applications and preferences, it is necessary to first position a normative set of interpreted Conceptual Heuristics for adaptation, resilience, mitigation and coping. Arguably, these normative Conceptual Heuristics could serve as an objective substitute within the complexity of meanings associated with each Concept. To this end, we

reject the strict division of heuristics between affective and associative reasoning and analytical reasoning under the assumption that heuristics will build supplemental meanings with greater depth as the diversity of their usage and application proliferate (Evans 2008). As such, as heuristics become more sophisticated in the depth of their multiple—yet hopefully consistent—meanings, they have the propensity for application within conventional modes of analytical reasoning. For instance, heuristics may drive a professional discourse that leads to the foundation of laws and policies, which may become part of a more sophisticated framework for the application of analytical reasoning. Conversely, addressing complex problems with inconsistent meanings and applications presents a significant challenge for policy development. As interviews with drafters of model climate change legislation in the NYMR have suggested, the lack of consistent conceptual meanings poses a significant barrier to drafting laws and plans that possess a clear legislative intent (Kass, 2014). Without a clear legislative intent, laws, policies and plans may be difficult to execute and interpret, particularly if these laws are to be challenged in judicial proceedings.

## **B. Normative Heuristics for Concepts of Change**

By and between the Concepts of coping, mitigation, resilience and adaptation there exists a number of overlapping and inconsistent meanings that make it difficult to ascertain an emerging consensus in the academic literature (Moser & Ekstrom, 2010). However, this work attempts to track what is arguably the beginning of a conceptual consensus across various disciplines. Following the literature survey methods of Downes, et al. (2013) for resiliency and Preston, Mustelin & Maloney (2013) for adaptation, definitions for each Concept in both social science and ecological science were distilled against a common set of criteria, including time horizon, mode and design of host response and ontological disposition. Thereafter, through a textual analysis of each definition, the common criteria and phrases were interpreted and transposed to their most simplified Meaning(s). For example phrasing such as: (i) "...before the system change its structure..." (Hollings & Meffe, 1996, p. 330); (ii) "system...changes stable states" (Gunderson 2000, p. 427); and, (iii) "...before the system changes in structure..." (Berkes, Folke & Colding, 2000, p. 12) can all be transposed to the concept of—in whole or in part—maintaining the operations of the status quo. While it is possible that this transposition neglected to include important meanings associated with the Concepts, the intent to reduce information dictated a distillation of only the language and meanings that had some basis for emerging scholarly consensus. As represented in Table 5.1, the transposed and simplified meanings assigned to each Concept provide the foundation for a set of normative Conceptual Heuristics.

**Table 5.1: Normative Heuristics for Responsive Concepts to Change**

	<b>Core Meaning</b>	<b>Time Horizon</b>	<b>Literature</b>	
<b>Coping</b>	Maintain Minimal Operations of Status Quo	- Short-term	- Fuller, et al. (2010) - Lazarus and Folkman (1984) - Ojala (2012, 2013) - Reser and Swim (2011)	- Reser, Bradley and Ellul (2012) - Salovey, et al. (1999) - Swim, et al. (2009)
<b>Mitigation</b>	Prevent Risk from Occurring in the Future	- Short-term - Mid-term - Long-term	- Golkany (2005) - IPCC (2007a) - IPCC (2007b) - Klein, Schipper and Dessai (2005)	- Swart and Raes (2007) - Vijaya, VenkataRaman, Iniyana and Goic (2012) - Walsh, et al. (2011)
<b>Resilience</b>	Maintain Full Operations of Status Quo	- Short-term - Mid-term - Long-term (conceptual)	- Adger, et al. (2005) - Carpenter, et al. (2001) - Cumming, et al. (2005) - Folke et al. (2002) - Gunderson (2000) - Holling (1973) - Hamel and Valikangas (2003)	- Holling and Meffe (1996) - Klein, Nicholls and Thomalla (2003) - Laprie (2008) - Lee, Vargo and Seville (2013) - Manyena (2006)
<b>Adaptation</b>	Maintain Flexibility to Accommodate Change through Transformability to Alternate Domains of Operations	- Short-term (conceptual) - Mid-term - Long-term	- Angelucci, Di Sivo and Ladiana (2013) - Folke et al. (2010) - IPCC (2014) - Nelson, et al. (2007) - Nelson (2011) - Pelling (2010) - Pelling, O'Brien and Matyas (2014) - Ribtot (2011)	- Rickards (2013) - Rosenzweig and Solecki (2014) - Vogus and Sutcliffe (2007) - Walker, et al. (2006) - Wiggins (2009) - Woods and Wreathall (2008)

In short, the history of the usage and conceptualization of coping, predominately in the fields of psychology and organizational management, suggests that its core meaning relates almost exclusively to maintaining the critical, core and minimal functions in the short-term of a host in response to external stimuli (Fuller, et al., 2010; Reser & Swim, 2011). This simplified meaning is consistent with popular usage of the word. By contrast, mitigation is consistently conceptualized to speak to the prevention of the occurrence of a stimulus (e.g., risk) or the occurrence or manifestation of a stimulus in some magnitude that results in negative impacts and/or loss (IPPC, 2007(a),(b)). Scholarly usage of mitigation either relates to climate mitigation (i.e., prevention of climate change through a reduction in greenhouse gases) or risk mitigation (i.e., prevention of risk). Both of these applications are conceptually consistent; however, risk mitigation is most closely aligned in its simplicity with the normative meaning assigned herein. As a final distinction, risk mitigation herein relates to the prevention of the occurrence of a risk and not to the prevention or mollification of the harm or consequence of a risk as connoted in popular lay usage.

Resilience on the other hand is related to coping in that it speaks to the preservation of the operations of the status quo; but, as opposed to coping which preserves the minimum functions, resilience is a process that preserves the entire functions of the status quo based on the host's internal designs (Swart & Raes, 2007; Lee, Vargo & Seville, 2013). The concept of the status quo should be conceptualized to speak to a relative elasticity of a system or host to revert to a stable environment within the same or similar pre-stimuli boundaries (Ulrich, 1987; Caswell & Neubert, 2005). These pre-stimuli boundaries can be conceptualized to speak to the operational threshold of the host, which is a relative post-stimuli state. Resilience is generally conceptualized to apply in the short- and mid-term but may extend over the long-term (Ingram, et al., 2006; Nelson, Adger, & Brown, 2007; Smith & Stirling, 2010). However, because resilience is based on known risks, with greater lengths of time, there exists a greater likelihood that unknown risks may come to fruition and therefore impede the stability of the host and the long-term process of resilience.

In applied terms, this can be conceptualized to speak to maintaining a certain relative standard of living or stable mode of consumption and production. One iteration of the popular usage of resilience speaks to resilience resulting in a "stronger" state which has the ability to "bounce back" (Manyena, O'Brien, O'Keefe & Rose, 2011; Freudenberg, 2015). This is consistent with the assigned heuristical meaning herein to the extent that the parameters of the status quo is a relative concept. This elasticity function to the status quo of the process of resilience is also acknowledged to be an outcome, in part, on the reduction of vulnerability through risk mitigation (Berkes, 2007; Adger, Kelly & Ninh, 2012; Menoni, et al., 2012). However, this elasticity is not exclusively a function of mitigation (i.e., reducing risk), as a reduction of vulnerability (e.g., reducing impacts) may also be accomplished, for example, through the promotion of other activities such as the development of social networks and the investment of



social and financial capital for emergency response (Cote & Nightingale, 2012; Scheffran, Marmer & Sow, 2012; Lorenz, 2013). Therefore, certain actions may serve both resilient and mitigation ends depending on the scale and timing of the action. This has led to a considerable amount of popular confusion between the concepts, as will be referenced in the next section.

Adaptation can be distinguished in that it does not necessarily preserve the relative status quo, but represents a state in the future, which is progressive to the predicate state by virtue of its flexible capacity to transform to alternate domains of operation (Keenan, 2014). It is the language of transformation across domains of operation, consumption and geography that is consistent across the cited literature (Angelucci, Di Sivo & Ladiana, 2013; Rickards, 2013; Pelling, O'Brien & Matyas, 2014). Although, it should be noted that consistency of these meanings is by no means certain in terms of a cross-disciplinary consensus. For instance, there is still some debate within the adaptation literature as to whether it is a function of transformative or incremental change—although a process of transformation is getting the upper hand in empirical terms, particularly in the NYMR (Rosenzweig & Solecki, 2014). In addition, resilience has sometimes conflated adaptation to incorporate aspects such as capacity and transformation. While these concepts may have synergies at one scale, they are distinct processes as demonstrated by the notion that they may have conflicts at an alternative scale or under an alternative time horizon. Adaptation is generally oriented towards a long- to mid-term time horizon because of the complexities associated with transformational change; however, short-term adaptation—perhaps in response to extreme events—is conceptually possible. The transformation function of adaptation has wide ranging implications from institutional change to consumer behavior in that there is a certain assumed inevitability of the occurrence of climate change which dictates that consumers of all types will not be able to consume products, services and resources in the same manner as they do today.

Therefore, perpetuating resilience of existing social behaviors may lead to maladaptation in that maintaining existing modes of consumption and production may not be a wise economic or equitable allocation of resources. The classical example of this potential friction is the scenario where resilient flood barriers on properties simply funnel the water inland to flood properties that would not have been flooded but for the installation of the flood barriers. In the NYMR, one could argue that resource allocation of resilient interventions in certain highly vulnerable geographies may be an unwise capital allocation if sea level rise causes these resilient interventions to fail (i.e., exceed threshold) prior to the end of their useful life. However, this same scenario may also highlight a conceptually possible synergy between resilience and adaptation in that those resilience interventions (e.g., flood barrier) may be: (i) part of “Reduced Decision Horizon” adaptation strategy which essentially buys time as a function of parity between cost and the reduction in risk (Hallegatte, 2009); and/or, (ii) able to accretively bare additional physical and capital

inputs which can accommodate, in this case, sea level rise (Youn, Hu & Wang, 2011; Dircke, 2015). In this case, the conflicts and synergies are dependent on risk exposure, vulnerability and capital inputs. Therefore the relationships between the various Concepts should be contextualized across multiple scales and time horizons wherein conflicts and synergies may exist. However, for the purposes of this research, the Concepts are being evaluated under bounded hypotheticals that offer unambiguous examples of applications of the Concepts consistent with the normative interpreted meanings.

The distinction between resilience and adaptation (i.e., domain of the status quo vs. transformation to alternate domains) has significant ramifications in policy development because resilience intuitively preferences existing actors that bear their own moral and economic biases for self-preservation and the status quo, which may or may not be aligned with future populations impacted by and responding to the same or similar stimuli. If existing frameworks in America are exclusively driven by narrowly defined aspects of social resilience then it obviates around the necessity to make difficult decisions about the allocations of resources that run the risk of being mono-functional, limited in their duration and utility, and biased towards an existing political constituency. This research evaluates the extent to which the foregoing Conceptual Heuristics are consistent with existing heuristical meanings and applications for responding to and planning for climate change by and between the Respondents. More precisely, this research evaluates the extent to which Respondents really have preferences for resilience or whether their preferences show an awareness of the long-term implications of the necessity to adapt.

## **2. Research Design and Methodology**

### **A. Hypothesis Development**

The initial impetus for undertaking this research was based on the observations from the participation of the lead author in the development of the 4th Regional Plan for the New York metropolitan region by the Climate Change Working Group of the Regional Plan Association (RPA) and in the deliberations of the Municipal Art Society's Resilience Roundtable (MAS). Observations over the course of one and two years, respectively, found widespread inconsistency and misalignment in the concepts and meanings utilized by the RPA and the MAS participants and those Concepts and meanings that are cited in the scholarship. Likewise, when accounting for an inconsistent assignment of concepts and meanings, preferences were observed to be intransitive and unstable (see Regenwetter, Dana & Davis-Stober, 2011). Very often what was described as a resilience application was not an objective example of resilience. These observed inconsistencies served as the empirical basis for the two hypotheses of this chapter.

Late stage deliberations among the groups at the time of the survey began to draw distinctions between coping—referenced as ‘recovery’—and resiliency. In this case, resiliency was referenced to mean additional capital investments in infrastructure and in housing which mitigated known risks from flooding. Some participants were keen to point out that resiliency also included social aspects relating to a community’s or a household’s ability to cope. Finally, adaptation in these late stage deliberations was referenced almost exclusively to the withdrawal of housing units in highly vulnerable areas through various state-run buyouts—an objectively accurate application of adaptation. However, none of these deliberations resulted in any consensus in conceptual terms other than a highlighted tension between recovery (i.e., coping) and resiliency, with the primary focus of government actors being on matters relating to recovery that they rhetorically defined as resilient. A minority set of participants propositioned that adaptation was a long-term strategy which bore little to no relevance in the current state of affairs—particularly in the aftermath of the recovering from Hurricane Sandy. Collectively, the observations from the deliberations of these groups provided the impetus for the undertaking of this research with the underlying ambition that the results might be able to be utilized to build a consistent foundation for more complex analysis and deliberation.

## **B. Sampling Method**

Under the leadership of Mayor Michael Bloomberg, NYC developed over the course of the last decade to become a global leader in mitigating and preparing for climate change; and, as such, the associated professional ranks have benefited from an emerging set of practices and applied experiences. This level of comparative professional maturity highlights the value of understanding the perspectives of the Respondents. The survey was distributed electronically via personal invitations to a population (n=266) of individuals who are taking a professional leadership role in the deliberation and development of private and public sector policies relating to the risks of urban flooding and climate change.<sup>1</sup> The population count was derived from cross-referencing active professional participants of the aforementioned RPA and MAS working groups, together with active invited membership within the Metropolitan Waterfront Alliance, the Rebuild By Design initiative, the NYC Panel on Climate Change (NPCC), the NYC Building Resiliency Task Force and other individuals who were personally known by the authors, or the participating partner organizations, to be actively engaged in a senior professional capacity.

Although based on a nonprobability sampling strategy, the invited sample population is qualitatively estimated to be a fair representation of active professionals undertaking a leadership role in the NYMR. Within the target population of interest, the non-response error is random and therefore it is not expected to affect response quality.

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<sup>1</sup> See, [www.arch.columbia.edu/climatesurvey](http://www.arch.columbia.edu/climatesurvey)

However, it is not estimated to be a representative population of public employees assigned to climate related tasks who otherwise may have discretionary functions or academics who undertake applied research activities in the NYMR. In addition, due to NYC's history of robust climate change advocacy, this sample is most likely not representative of a similarly distributed professional population in other U.S. cities. As will be discussed, a very high response rate (87.5%, n=233) is attributable to actively engaging individuals through emails or personal phone calls to solicit their participation in the survey. Such solicitations were conducted over the course of a month and each communication was tempered in its content so as to not bias respondents as to the nature of the survey. However, such solicitations were deemed to be of limited utility as the completion rate (44.6%, n=104) for completing every question was comparatively modest. This may also be attributable to the overestimation within the survey design as to respondent's time and attention for completing an estimated 15 minute survey.

### **C. Survey Design**

The survey consisted of 36 questions and 6 scenarios. The survey was designed to evaluate: (i) Respondents' ability to match Concepts with the normative meanings of the Conceptual Heuristics ('Concepts and Meanings'); (ii) Respondents' ability to match Concepts with applications or examples (collectively, 'Applications') based on the meanings of the Conceptual Heuristics ('Concepts and Applications'); and, (iii) Respondents' preferences for scenario-based Applications ('Applications and Preferences'). Applications were derived initially by the researchers and then tested and edited following several focus groups made up of university climate change researchers. Finally, the edited list of Applications was subject to external review by peers operating as researchers within the previously cited partner organizations. It should be noted that most, but not all, Applications fit clearly within each categorical Concept. For instance, several Applications could be viewed as either mitigation or resilience, which is consistent with the larger debate within the scholarship that suggests that the division in terms of the implicit reduction of vulnerability is not always so discernable (Manyena, 2006; Béné, et al., 2012). Ultimately, each Application was assigned to just one Concept following internal deliberation and consensus of the researchers.

This tension in linking Applications and Concepts highlights a limiting qualification to the survey design in that these Concepts can represent both static and transient states and/or actions. This survey is fundamentally looking at the Application of Concepts under a set of scenarios that are limited in their time duration and horizon, as well as scale. The continuous state of action or being by and between these Concepts is not being evaluated as the ordinal data is not longitudinal or hypothetically positioned as being within a time frame other than a present action or inaction. However, this is an avenue ripe for future research in understanding how people frame what is theoretically regarded as moving to variable states of stability along a continuum from coping to resilience, and across the resilience threshold to adaptation—with the risk of moving across the adaptation frontier into a state of failure or loss (Wiggins, 2009; Preston, Dow & Berkhout, 2013; Keenan, 2015).

Every scenario within the survey is followed by Applications which could be classified as a means (i.e., process) or an ends (i.e., outcome) that could objectively be categorized as attributable to one of the Concepts. In some scenarios, Respondents were asked to evaluate each Application on a two point Likert scale. The resulting data was classified as ordinal data coded as binary, in that 'Strongly Agree' or 'Agree' were given a score of one (1) and all other selections were give a score of zero (0) (Gadermann, Guhn & Zumbo, 2012). In some scenarios, Respondents were then asked to select their absolute or preferred option among a list of Applications. In at least one question per survey, a randomized 'other' category was incorporated into these otherwise closed-ended questions to allow some insight into either the Respondents' preferences not listed or to highlight potential overlooked problems in the construction of the Applications themselves. Likewise, scenarios, Applications, Concepts and all options were randomized in terms of order and on the vertical and/or horizontal axis where applicable.

Finally, the substantive elements of the survey were prefaced by questions regarding the Respondents' professional background, professional membership and experiences attributable to climate change. It was initially anticipated that controlling for experience might be a useful undertaking for evaluating potential status quo or selection bias. Finally, inquiries were made as to the nature of the Respondents' belief in climate change and the underlying relevancy and urgency of those beliefs. These questions were asked in order to establish the extent to which the sample pool was representative of the beliefs and perceptions of climate change among the general U.S. population (Leiserowitz, 2005; Leiserowitz, et al., 2010).

### **3. Survey Results**

#### **A. Sample Characteristics**

The survey sample consists of 233 Respondents of which 104 (44%) completed all 36 questions. The professional distribution of the sample is weighted heavily in favor of architects, designers and urban planners (n=94, 40%), as well as real estate professionals (n=32, 19%). The balance of the professions represented include scientists, social scientists, engineers, community organizers, lawyers, bankers, public health professionals and insurers. The sample was also weighted towards the private sector (n=154, 66%), with the public sector (n=52) and civic sectors (n=27) accounting for 22% and 11% of the sample, respectively. Only 35% (n=83) of the Respondents cited being a member of a designated climate change related organization or initiative of a professional organization.

Respondents overwhelmingly believe that climate change is currently happening (n=223, 96%), while only 2.5% (n=6) do not believe climate change is happening and 1.7% (n=4) are unsure.<sup>2</sup> This is compared with 63% of the general American population who believe in climate change, 20% who do not and 17% who are unsure (Leiserowitz, et al., 2014, p. 13). Of those Respondents who believe in climate change, 68% (n=154) are extremely sure, 23% (n=52) are very sure, 6.7% are somewhat sure, and .90% (n=2) are not sure at all whether climate change is happening. This is compared with only 20% of the general American population who believe in climate change and are extremely sure in their beliefs (Id.).

Respondents cited a number of personal experiences or impacts which they attributed to climate change, including 70 Respondents (30%) who resided or worked in properties which were flooded. Of those who were flooded, 43 were flooded during Hurricane Sandy, which is 18.4% of the total sample. However, only 1 Respondent cited a total loss of real estate. A number of Respondents experienced a loss of power (n=109, 46%), as well as interruption of business or work (n=135, 58%). In addition, Respondents independently cited transportation disruption, community stress and instability and personal property losses. Only 18% (n=42) of Respondents cited no observations attributable to climate change.

## **B. Concepts and Meanings**

The results of the survey indicate that a majority of Respondents were correctly able to match the concept and meaning of coping (62%, n=79).<sup>3</sup> Pursuant to Table 5.2, Respondents can distinguish between: (i) coping and mitigation 96% of the time; (ii) coping and resilience 79% of the time; (iii) and, coping and adaptation 96% of the time. Mitigation is slightly less discernable among Respondents with 53% (n=72) correctly matching the meaning and the concept. However, 89% of the time Respondents could correctly discern between mitigation and adaptation and only 63% of the time could Respondents discern between mitigation and resilience.

Adaptation demonstrated a similar range of results to mitigation in that 53% (n=73) of Respondents correctly matched the concept with the meaning. Likewise, as previously cited, Respondents' were consistently able to draw distinctions between adaptation and coping and mitigation. However,

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<sup>2</sup> Given the limited definition of Respondent, it cannot be fully explained whether the 6 who do not believe in climate change qualify to be Respondents by virtue of their professional capacities or whether their answer is more nuanced in terms of their personal perceptions and/or observations.

<sup>3</sup> For descriptive statistics of Concepts and Meanings and Concepts and Applications results, see Appendix Table 5.1.

resilience demonstrated a much less clear conceptual perspective of the Respondents. Only 25% (n=31) of Respondents could correctly match the Concept and Meaning of Resilience. While Respondents were generally able to discern by and between resilience and coping, and to a lesser extent mitigation, there was a near statistically random outcome (51%, p-value .5) by and between resilience and adaptation. Likewise, Respondents were more likely to incorrectly match the concept of resilience with the adaptation meaning (38%) that they were with the correct resilience meaning (25%). As will be discussed, this is partially consistent with an affirmation of the first hypothesis.

<b>Table 5.2: Matching Concepts (x-Axis) &amp; Meanings (y-Axis)</b>				
<b>Ability of Respondents to Distinguish Between Two Concepts</b>				
<i>Percentage (%)</i>				
	<b>Coping</b>	<b>Mitigation</b>	<b>Resilience</b>	<b>Adaptation</b>
<b>Coping</b>		0.9615385	0.7941176	0.9615385
<b>Mitigation</b>	0.9615385		0.627907	0.8928571
<b>Resilience</b>	0.7941176	0.627907		0.5102041
<b>Adaptation</b>	0.9615385	0.8928571	0.5102041	
<i>p-value</i>				
	<b>Coping</b>	<b>Mitigation</b>	<b>Resilience</b>	<b>Adaptation</b>
<b>Coping</b>		0.000003231	0.0005601	0.000003231
<b>Mitigation</b>	0.000003231		0.06363	0.00003614
<b>Resilience</b>	0.0005601	0.06363		0.5
<b>Adaptation</b>	0.000003231	0.00003614	0.5	
Null Hypothesis, if p-value <0.05				
Chi-test_p-value correction rate=0.5. a=0.05 (Bonferroni Correction)				
Margin of Error Based on 95% Confidence, 2.81%				

### C. Concepts and Applications

On average across all scenarios, 64% (n=291) of Respondents correctly matched Coping with the various Applications of the concept. As represented in Table 5.3, Respondents were able to consistently discern between coping and all other Concepts. The one exception was by and between coping and resilience in the flooding scenario (59%, p-value .2207).

On average, only 32% (n=156) of Respondents correctly matched mitigation with the various Applications compared with 53% (n=72) who correctly matched mitigation with its normative heuristical meaning. Across all scenarios, mitigation was somewhat discernable with coping (75%, p-value .1055), marginally discernable with adaptation (59%, p-value .07428) and not statistically discernable

with resilience (45%, p-value .8693). The greatest deal of confusion between mitigation and resilience occurred in the sea level rise scenario (37%, p-value .892). This collective confusion between resilience and mitigation is consistent with the aforementioned confusion in practice.

<b>Table 5.3: Matching Concepts (x-Axis) &amp; Applications (y-Axis)</b>				
<b>All Scenarios / Aggregate: Ability of Respondents to Distinguish Between Two Concepts</b>				
<i>Percentage (%)</i>				
	<b>Coping</b>	<b>Mitigation</b>	<b>Resilience</b>	<b>Adaptation</b>
<b>Coping</b>		0.753846154	0.705882366	0.800000018
<b>Mitigation</b>	0.753846154		0.447761193	0.594202883
<b>Resilience</b>	0.705882366	0.447761193		0.405940586
<b>Adaptation</b>	0.800000018	0.594202883	0.405940586	
<i>p-value</i>				
	<b>Coping</b>	<b>Mitigation</b>	<b>Resilience</b>	<b>Adaptation</b>
<b>Coping</b>		0.0000361	0.0001131	0.00002055
<b>Mitigation</b>	0.00003607		0.8693	0.07428
<b>Resilience</b>	0.0001131	0.8693		0.9634
<b>Adaptation</b>	0.00002055	0.07428	0.9634	
Null Hypothesis, if p-value <0.05				
Chi-test_p-value correction rate=0.5. a=0.05 (Bonferroni Correction)				
Margin of Error Based on 95% Confidence, 1.40%				

Likewise, resilience was only marginally discernible with coping among all scenarios (71%, p-value .2207) and was not statistically discernible with any other Concept. Across all scenarios, only 22% (n=106) of Respondents could correctly match resilience with its Applications. Respondents were more than twice as likely to correctly match the concept of adaptation across all scenarios (46%, n=228) than resilience. Finally, adaptation was consistently discernible with coping in both the flooding (86%, p-value .004912) and sea level rise (80%, p-value .01943) scenarios. However, in both of these scenarios and across all scenarios (45%, p-value .7219), adaptation and resilience were consistently indiscernible. At the same time, Respondents were more likely to match the resilience Applications with the adaptation concept (30%, n=140) than they were to correctly match resilience across all scenarios (22%, n=106).

A chi-square test was used to assess whether the results shown in Table 5.3 were statistically consistent with those in Table 5.2. The results suggested that there is a consistent observational distribution in the Respondents' ability to match Concepts and Meanings (Table 5.2) and Concepts and Applications (Table 5.3). It was also considered whether Respondents who suffered flood damage (n=70) may be more likely to match correctly Concepts and Applications, as personal experience is a strong determinant of interest and knowledge in these matters. It was determined



that there was no statistically significant difference between responses of those who were affected and those who were not. Flood victims were no better or worse in matching Concepts and Meanings or Applications. The absence of an effect from personal experience may be explained by the population from which the sample was drawn, in that all Respondents are engaged in professional climate change activities and arguably have a greater level of contextual intelligence than a random sampling of flood victims, for instance. However, it may be that in the general population those who are directly affected do have more knowledge of the Concepts and Applications than those who do not by virtue of their experiences. To this end, this is a potentially valuable avenue of future research to the extent that those who are affected by extreme weather events often play a disproportionate role relative to the general population in guiding future planning efforts.

## D. Applications and Preferences

Applications categorically assigned to a specific Concept for each scenario and were evaluated on a two point Likert scale and by an absolute ranking of a Respondent's preferred choice. As represented in Table 5.4 with regard to the Likert rankings, Respondents consistently preferred adaptation and mitigation Applications in roughly equal measure in each of the scenarios and in the aggregate. Only in the flooding scenario was resilience (n=111, 35%) preferred among the other Concepts and only by a slim margin. In both the heat wave (n=49, 16%) and the sea level rise (n=18, 9%) scenarios, the resilience Application was the least preferred Application.

<b>Table 5.4: Matching Applications &amp; Preferences (Likert)</b>							
<b><i>Flooding Scenario</i></b>				<b><i>Heat Wave Scenario</i></b>			
	<b>N</b>	<b>Score</b>	<b>%</b>		<b>N</b>	<b>Score</b>	<b>%</b>
<b>Coping</b>	25	0.1572	7.84%	<b>Coping</b>	49	0.3657	15.96%
<b>Mitigation</b>	95	0.5975	29.78%	<b>Mitigation</b>	108	0.8060	35.18%
<b>Resilience</b>	111	0.6981	34.80%	<b>Resilience</b>	30	0.2239	9.77%
<b>Adaptation</b>	88	0.5535	27.59%	<b>Adaptation</b>	120	0.8955	39.09%
Margin of Error: 2.52%      95% Confidence				Margin of Error: 3.05%      95% Confidence			
<b><i>Sea Level Rise Scenario</i></b>				<b><i>Total (3 Scenarios)</i></b>			
	<b>N</b>	<b>Score</b>	<b>%</b>		<b>N</b>	<b>Score</b>	<b>%</b>
<b>Coping</b>	26	0.2203	12.94%	<b>Coping</b>	100	0.2433	12.09%
<b>Mitigation</b>	78	0.6610	38.81%	<b>Mitigation</b>	281	0.6837	33.98%
<b>Resilience</b>	18	0.1525	8.96%	<b>Resilience</b>	159	0.3869	19.23%
<b>Adaptation</b>	79	0.6695	39.30%	<b>Adaptation</b>	287	0.6983	34.70%
Margin of Error: 3.44%      95% Confidence				Margin of Error: 1.72%      95% Confidence			

Table 5.5 highlights the results from the absolute preference scenarios, which included additional scenarios regarding a subsidence of a residential structure, a post-Hurricane

Sandy reconstruction policy agenda and a drought impacting farmers. For the flooding, heat wave and sea level rise scenarios, adaptation (n=240, 62%) was the overwhelming preferred Application. Adaptation was also the preferred Application (n=322, 45%) for all scenarios followed by mitigation (n=243, 33%). Resilience ranked 3rd place (n=119, 16%) among the Applications and was the only absolute preferred Application in the drought scenario (n=44, 50%). Although, consistent with the Likert ranking for the flooding scenario, resilience (n=35, 26%) was within the margin of error to be a second preference behind adaptation (n=54, 40%). Overall, adaptation was a preferred Application ahead of all other Concepts in the absolute selection of preferences.

**Table 5.5: Matching Applications & Preferences (Absolute)**

<i>Flooding Scenario</i>				<i>Post Sandy Damage Scenario</i>			
	<b>N</b>	<b>Score</b>	<b>%</b>		<b>N</b>	<b>Score</b>	<b>%</b>
<b>Coping</b>	8	0.0503	5.97%	<b>Coping</b>	5	0.0442	4.42%
<b>Mitigation</b>	37	0.2327	27.61%	<b>Mitigation</b>	46	0.4071	40.71%
<b>Resilience</b>	35	0.2201	26.12%	<b>Resilience</b>	6	0.0531	5.31%
<b>Adaptation</b>	54	0.3396	40.30%	<b>Adaptation</b>	56	0.4956	49.56%
Margin of Error: 2.52%      95% Confidence				Margin of Error: 3.57%      95% Confidence			
<i>Heat Wave Scenario</i>				<i>Subsidence Scenario</i>			
	<b>N</b>	<b>Score</b>	<b>%</b>		<b>N</b>	<b>Score</b>	<b>%</b>
<b>Coping</b>	1	0.0075	0.75%	<b>Coping</b>	12	0.1062	10.62%
<b>Mitigation</b>	32	0.2388	23.88%	<b>Mitigation</b>	74	0.6549	65.49%
<b>Resilience</b>	4	0.0299	2.99%	<b>Resilience</b>	8	0.0708	7.08%
<b>Adaptation</b>	97	0.7239	72.39%	<b>Adaptation</b>	19	0.1681	16.81%
Margin of Error: 3.05%      95% Confidence				Margin of Error: 3.57%      95% Confidence			
<i>Sea Level Rise Scenario</i>				<i>Drought Scenario</i>			
	<b>N</b>	<b>Score</b>	<b>%</b>		<b>N</b>	<b>Score</b>	<b>%</b>
<b>Coping</b>	6	0.0508	5.08%	<b>Coping</b>	6	0.0545	5.45%
<b>Mitigation</b>	12	0.1017	10.17%	<b>Mitigation</b>	42	0.3818	38.18%
<b>Resilience</b>	11	0.0932	9.32%	<b>Resilience</b>	55	0.5	50.00%
<b>Adaptation</b>	89	0.7542	75.42%	<b>Adaptation</b>	7	0.0636	6.36%
Margin of Error: 3.44%      95% Confidence				Margin of Error: 3.66%      95% Confidence			
<i>Total (Flooding, Heat Wave, Sea Level Rise)</i>				<i>Total (All Scenarios)</i>			
	<b>N</b>	<b>Score</b>	<b>%</b>		<b>N</b>	<b>Score</b>	<b>%</b>
<b>Coping</b>	15	0.0365	3.89%	<b>Coping</b>	38	0.0503	5.26%
<b>Mitigation</b>	81	0.1971	20.98%	<b>Mitigation</b>	243	0.3219	33.66%
<b>Resilience</b>	50	0.1217	12.95%	<b>Resilience</b>	119	0.1576	16.48%
<b>Adaptation</b>	240	0.5839	62.18%	<b>Adaptation</b>	322	0.4265	44.60%
Margin of Error: 1.72%      95% Confidence				Margin of Error: 2.59%      95% Confidence			

## 4. Discussion

Respondents were more than twice as likely to correctly match the Concept and Meaning of adaptation as they were for resilience. To that end, ranking last among all correct matches, it can be inferred that resilience is the least understood Concept consistent with an affirmation of the first hypothesis. Only in the immediate context of a post-Hurricane Sandy damage and the sea level scenarios could Respondents clearly distinguish between resilience and coping (79%, p-value .01089)—or, by and between resilience and any other concept for that matter. With coping being synonymous with reconstruction, this result is partially explained by the current popular framing between resilience and coping in the NYMR following Hurricane Sandy. The political pressure to rebuild to the same general qualities in the same location (i.e., minimal functions of the status quo) is running up against the larger planning efforts for utilizing internal designs of replacement structures and infrastructure so as to be able to maintain operations in the face of the next known risk (i.e., resilience).

An evaluation of the assignment between meanings and Concepts is arguably only of limited value in that it is only testing to see if Concepts and normative meanings and/or Applications are consistent with present usage and conceptualization. As was observed in the hypothesis development stage of this research, any inconsistency in the results for Concepts and Meanings and Concepts and Applications were to be expected. However, these results do not speak to the capacity of individuals to correctly match Concepts with Meanings and Applications in the future. It can be argued that future consistency in usage may be a function of assigning Concepts to preferences and then demonstrating what individual and collective preferences are so that policy makers and/or Respondents have a benchmark for developing future applications which may be consistently applied to Concepts.

To this end, the results support a confirmation of the second hypothesis in that resilience preferences are scored and ranked low relative to the other Concepts. Adaptation Applications were shown to have a clear preference across almost all of the scenarios, with the exception of the subsidence and drought scenarios. However, these scenarios may demonstrate the existence of a status quo bias in that these are the only questions that put the Respondents in a second person orientation as a household or worker (e.g., farmer) to take action (Samuelson & Zeckhauser, 1988; Bazerman, 2006). In both of these scenarios, Respondents showed a preference for mitigation, and to a lesser extent resilience, which speaks to an outcome oriented in favor of the status quo.

Mitigation demonstrated a strong preference second only to adaptation. This can be explained in part by the professional orientation to construct material interventions that serve mitigation functions. Given the weighting in the sample for architects, planners, designers and real estate professionals, this argument is reasonable. This raises the question as to whether the long-term interests of

the NYMR are well served by leadership composed of professionals who are potentially biased by the material solutions and responses to climate change. In either event, the parallels of the preferences for mitigation and adaptation are consistent with the focus recommended by the NPCC who suggests further research into “transformative” adaptation and the extent to which mitigation and adaptation have co-benefits (NPCC, 2015a). It can be argued that even the NPCC recognizes that governments are biased toward material and/or technological solutions which are almost by definition serving mitigation and/or resilience functions. By contextualizing mitigation and adaptation together within an analytical framework, there is a practical acknowledgement that the present (i.e., mitigation/resilience) should be tempered with the future (i.e., adaptation). Therefore, there is evidence in this research to suggest that the Respondents are also struggling to balance mitigation and adaptation as reflected in their preferences.

However, when one acknowledges that the top three scenarios most imminently relevant to the NYMR are flooding, sea level rise and heat waves, the overwhelming absolute preference is for adaptation (62%, n=240). When viewed together with the confirmation of the two hypotheses, it can be argued that an exclusive focus on resilience by and between public, private and civic leadership is potentially problematic. At the very least, the current focus is certainly ineffective to the extent that there rests very little clarity in the communication of the concept as reflected herein. Even the NPCC has arguably been subject to what has been observed to be a political steering in favor of the resilience nomenclature as demonstrated in the shifting of the naming conventions from adaptation to resilience in the titles of their 2010 to 2015 reports, respectively (NPCC, 2010; NPCC, 2015b; de Blasio, 2015). However, the NPCC has been substantively consistent in that the Concepts of mitigation, resilience and adaptation are carefully and precisely discerned in their usage and application. Perhaps instead of highlighting the use of one Concept over the other in the naming conventions of policy and planning materials, the catch all phrasing of “responses and preparations to and for climate change” is more appropriate. At present, this research provides evidence that resilience in its current construction as interpreted by the Respondents is simply insufficient by itself as a meta-framing concept for guiding policies and plans.

## 5. Conclusions

The results of this Survey support a confirmation of the hypotheses in that Respondents are not quite sure how to define or apply the concept of resilience and that resilience is not their dominant preference. Equally as important, adaptation is demonstrated to be a clear and stable preference. This evidence suggests that it is incumbent upon policy and decisions makers to think beyond resilience as an exclusive meta-concept for framing policies and plans. This major shift could transition the domestic planning discourse from inconsistent rhetoric to consistent objective meanings that are in line with an international urban policy

discourse increasingly framed by adaptation as the ultimate goal over the long-term; this is particularly relevant with the acknowledgement that climate change is happening and is going to increase in its extreme impacts (Crawford & Davoudi, 2009; Keskitalo, 2010; Corfee-Morlot, et al., 2011; Carmin, Anguelovski & Roberts, 2012; Reckien, et al., 2014; Albers, et al., 2015; Carter, et al., 2015).

This is not to say that adaptation is in absolute terms superior to resilience (Davoudi, et al., 2012). Resilience—particularly social and physical resilience—has an important function in perpetuating the interests of residents and the operations of urban services, commerce and infrastructure. However, the potentially rapid and historically unprecedented changes associated with climate change will most likely necessitate a transformation to alternative domains of operation beyond the threshold of resilience. This means that individuals, organizations and institutions will need to rethink existing modes of production and consumption which are grounded in the logics of the status quo. Climate change will dictate not whether exiting modes of production and consumption are sustainable but whether they will exist at all. Likewise, one cannot be resilient to all risks. As such, the systematic impacts of climate change will likely be widespread and largely unanticipated, leaving adaptation and robust adaptive capacities as a crucial backstop for when the resiliency threshold is crossed (see Groffman, et al., 2006).

In the interim, the results of this survey provide a clear insight into the limitations of the current discourse driven exclusively by resilience and very often in rhetorical terms. However, on a positive note, this survey demonstrates that Respondents are able, within varying degrees of consistency, to discern and to apply the distinctions by and between the Conceptual Heuristics of adaptation, mitigation and coping. This suggests a potentially high degree of contextual intelligence. It is also a partial validation as to the normative meanings assigned to the Conceptual Heuristics. In addition, Respondents' preference for adaptation, together with mitigation, suggest a perspective which acknowledges that perpetuating the status quo is of a limited duration and utility in climate change planning and must be weighted between short-term interventions and long-term planning.

This research has already led to the early stage development of planning values and communication strategies for the development of a consistent framework for future planning efforts in the advancement of the 4th Regional Plan for the NYMR under the auspices of the RPA.<sup>4</sup> By acknowledging a framework which provides an un-weighted assignment by and between specific Concepts and Applications, together with the associated risk-adjusted costs and benefits of each strategy, there rests an opportunity to develop evidence based decision making processes that can provide clarity and transparency for the regional planning efforts. This measure of objectivity allows for a translation of strategies across scales and across the diversity of interests which define the NYMR.

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<sup>4</sup> For examples of planning applications in for the 4th Regional Plan, see Appendix Table 5.2.

With future research into the interrelationships of the Concepts on a continuum of stable and unstable states, policy makers will be able to extend frameworks which accommodate a variety of risks both known and unknown, isolated and systematic. Likewise, future research into the supplemental meanings for each of the Concepts may benefit from the utilization of Q methodology (Niemeyer, Petts & Hobson, 2005; Albizua & Zografos, 2014) and consensus-based assessment techniques to build consensus and give order in decision making contextualized by increasing systematic urban complexity. To this end, similar inquires and techniques may also be extended to advance private sector decisions and strategies that must underwrite new asset classes and find value in the prospects of the unknown (O'Brien & Wolf, 2010). As previously referenced, the results of this research may also provide a foundation for framing research that attempts to highlight synergies and conflicts in a diverse set of constructed realities by and between a diverse set of stakeholders (Fünfgeld & McEvoy, 2014).

The first step in advancing these capacities for accommodating change is to transition from theory to practice with a consistent conceptual foundation for describing social-ecological responses to and preparations for extreme weather and climate change. Research is tasked with defining benchmarks and developing a more complete taxonomy of practice that will support future policies and regulation, such as the incorporation of resilience and adaptation measures in comprehensive plans and environmental impact assessments. For now, the varying range of geographic risk, political will and economic resources dictate experimentation that is likely best served in the incorporation of scientific knowledge and scientific processes that utilize objective definitions and meanings. A failure to develop a consistent foundation is likely to result in an inefficient distribution of critical resources that may be the difference between stability and failure for an entire region in the face of changing climates, economies and societies.

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## CHAPTER VI | Findings and Conclusions

On the front lines of every aspect of civil society from commerce to public health is the built environment. While climate change to date has been largely the purview of the public sector, the emerging reality of a changing climate dictates that active participation in the private sector is not just essential—it is critical. Nearly all of the investment and management obligations of the built environment are in the hands of the private sector in NYC. The private sector will be unprepared without the tools necessary to adapt, not just in terms of buildings and real estate firms, but also within the context of a larger set of interconnected markets and institutions whose commercial operations are dependent on real estate (Tompkins & Eakin, 2012). Without such core concepts and tools, these dependent markets and institutions will serve as mere reactionary elements in broader global effort to adapt (Tompkins, et al., 2010; Ford, Berrang-Ford, & Paterson, 2011). It is not just real estate firms and architects that must internalize their own understanding of and capacity to adapt, it is also nearly every facet of economy and society that depend on the built environment.

As an empirical undertaking, this dissertation sets forth the current state of affairs of real estate firms in NYC that are arguably representative of the most sophisticated real estate firms in NYC. A contemporary understanding of the capacities of these real estate firms is critical for developing models that engage private sector actors based, in part, on their own self-interest, with the theoretical recognition that larger societal co-benefits may reside in their participation (Surminski, 2013). To fully engage the private sector, profit-seeking motivations have to be acknowledged and incorporated within analytical and explanatory concepts and organizational processes (Stern, 2007). Adaptation must create value, not only to off-set the costs of change, but also to invest in the capital necessary to accommodate and profit from the direct and indirect consequences of extreme weather and climate change. In theory, buildings with a designed capacity to adapt should arguably have a higher net operating income and retain a higher collateral value for longer periods of time than their less dynamic contemporaries. In equal terms, firms with a robust adaptive capacity can more quickly and efficiently accommodate evolutionary markets. Could they also be more adept at adapting to trends that waste resources and hence lead to maladaptation? Yes, this is always the risk. Adaptation is not an absolute good and is dependent ultimately on the judgement of people. At the core of the manifestation of these various capacities is the intelligence of a professional to understand critical conceptual and analytical models necessary for objective data driven decision making.

The papers and chapters in this dissertation contribute to a theoretical groundwork for advancing the development of tools and designs that operationalize adaptive capacity across the three principle perspectives of buildings, real estate firms and professionals. While subjectively applied along a continuum of stability and instability, the core concepts of adaptation, resilience and risk mitigation have



objective technical scholarly derived meanings that, in this context, could provide an epistemological foundation for practices in the built environment. These core concepts are not static states but dynamic processes varying across space and time that must be parceled in the process of building and maintaining an adaptive capacity. While this represents a critical research challenge in terms of contextualizing where any given data point is positioned along the aforementioned continuum, it does not mean that one cannot construct conceptual understandings which have immediate application and relevance. A robust adaptive capacity will benefit from intelligence, communication and networks that identify and manage change—in often unobservable and incremental occurrences—so that value-add innovation may be developed and diffused in order to manage the costs and opportunities of change. While this dissertation does not focus on the identification of value-add technological innovation—as it was found to be comparatively limited relative to other sectors—it acknowledges that innovation may be defined, in part, by process-innovation that represents a potentially positive relationship with a robust adaptive capacity.

This chapter serves to synthesize the general findings of this dissertation within the context of the specific research questions. Thereafter, a discussion of the broader research design is provided in order to reflect on the relative strengths and weaknesses of the findings that may vary in their degree of conclusiveness and applicability. This reflection is then positioned as a foundation for future research, wherein future research questions are identified within the context of new methodologies and approaches. Finally, there is a discussion on that collective body of research as it has been applied in practice by a diversity of actors. This chapter and dissertation are concluded with some final thoughts on the evolution of this research and the extent to which it has created not only new knowledge but also practical knowledge that transcends the original ambition of the researcher.

## **1. Discussion of Main Findings**

The main research aim of this dissertation is to develop an understanding of the adaptive capacity of: (i) buildings, (ii) real estate firms, and (iii) professionals in NYC. This main research question sought to understand how and to what extent the three aforementioned perspectives and systems have the capacity to manage, accommodate and otherwise adapt to the risks and opportunities associated with extreme weather and climate change. In order to fully understand the contribution of this dissertation in addressing the main research aim and question, it is useful to summarize the principle findings of each of the chapters as they correlate to the six principle research questions. It is also an opportunity to explore how chapters written and published as individual research papers can be interpreted by and between each other. While some of the chapters, such as Chapters II, III and IV, explicitly reference and build off of the work found in each respective chapter, the balance of the chapters represent free standing research exercises that are tangential aspects of adaptive capacity, such as professional intelligence

in Chapter V. The intent of this section is to demonstrate—through a variety of approaches and methodologies—that adaptive capacity can be understood to operate and apply across a variety of multi-actor and disciplinary perspectives.

**R1: How can the adaptive capacity of a building be conceptualized within the parameters of the adaptive cycle and prevailing ecological systems theory?**

This research question is explicitly addressed in Chapter II, which itself is partially dependent on the conceptual framework developed in Chapter III. To fully understand adaptive capacity in a building, one must understand adaptation and its closely related concept of resilience. Chapter II defines resilience as a process of maintaining an elasticity of the operations of the status quo based on internal designs. These internal designs represent the original intent of the construction and engineered operational designs of a building. In this context, adaptation is defined as a process that seeks to maintain stability through periodic resilience, if necessary, but with the flexible capacity to transform to alternative domains of operation based on both internal and external designs. It is the incorporation of external designs that is critical as a practical matter for adaptive design. As will be discussed in the Research Valorization section, external designs may represent additional technological imports—whether as a function of hardware or software—that may be incorporated into an infrastructural capacity, which itself is based on internal designs, such as in order to allow the building to transform to an alternative operational domain. Chapter II highlights the role of artificially intelligent building management systems that require the periodic incorporation of externally designed software in the short-term and externally designed hardware in the long-term. As will be discussed, the practical challenge in architectural and engineering terms is to design a passive capacity of buildings to accommodate externally designed technologies that may not yet have been designed but are likely to manifest within the useful life of the building.

To this end, the fundamental question of the chapter is what technology will exist within the useful life of the building that will allow a building to adapt to changing programmatic and environmental conditions? With the advent of building information management (BIM) design systems, a great deal of spatial compression has been engineered in the name of efficiency without contextualizing the life cycle of the building, which is often more capital intensive than the initial construction by a factor of five in commercial office buildings (Gluch & Baumann, 2004). This trend in favor of compression has worked against the spatial parameters of interoperable technologies and programs that vary in their spatial and temporal parameters. As will be discussed, the ongoing research in adaptive design is therefore focused on analytical capacities that balance internal and external designs within the entire life-cycle of the building. As discussed in Chapter II, this adaptation along a life cycle analysis is a continuation of the legacy of a previous generation of building theorists, including Stewart Brand, who understood buildings as part of a large adaptive ecology. Likewise, architectural

history has also shown us that buildings have always adapted over time. The question is how can we design them to efficiently and effectively adapt in the future? (de Arce, 2014).

To advance this research, it is necessary to contextualize the research and methodologies within a broader conceptualization of the adaptive capacity of a building. Chapter II posits a conceptual framework of a building as being defined by both its material and social construction. The material aspects of the building relate to the automated operations of artificially intelligent buildings systems which have in recent years been designed to adapt to changing environmental conditions, as well as user performance demands. The social aspects of the building are defined by users and managers who impose operational and design parameters that material aspects are ultimately dependent upon. What unites the material and social aspects of a building is a parallel framework for adaptive capacity that defines capacities in terms of: (i) human intelligence, strategy and space of decisions (or, resources) for the social construct; and, (ii) artificial intelligence, design simulations and operational domain for the material construct. Chapter II argues that each of these aspects are essentially parallel to the other in terms of operations that differ only by their mode of execution. A social construct represents an *ex post*, top-down adaptation approach and a material construct represent an *ex-ante*, bottom-up adaptation approach. It is argued that realized or actual adaptation is responsive to both recognized and unrecognized stimuli somewhere in between these constructions. This is consistent with adaptation across various scales and perspectives that are drive by both bottom-up and top-down influences (Adger, Arnell, & Tompkins, 2005). Furthermore, the life cycle of buildings is argued in Chapter II to fall within each of the process stages of the adaptive cycle prevalent in systems theory.

Chapter II extends the above theoretical understanding of realized adaptation caught in between multiple influences (i.e., social and material) of a building within an adaptive cycle to the prevailing theory of Panarchy ecological systems theory (Gunderson & Holling, 2002). Panarchy is a rejection of the mediated stable state, in a theory of Hierarchy, which is caught between fast bottom-up variables and slow top-down variables. Instead, a theory of Panarchy suggests that variables are in dynamic relationship to each other across a variety of perceptible and imperceptible scales of influence. The chapter concludes with some examples of the interrelationship between material and social processes as contextualized by the free-hand role of designers, which draws application to a range of dynamic influences that extend beyond a top-down influence, as may be conceptually the case with the role of capital dominating said adaptation decisions. The analytical processes of this interaction between the two constructs highlights the value of communication and information exchange in that the outcome may be inaction as much as it is a function of action. To give life to these designed capacities will require a multi-disciplinary professional that is fundamentally grounded in management, but with a near equally sophisticated facility in design and engineering.

## **R2: How can the adaptive capacity of a real estate firm in NYC be conceptualized and empirically evaluated?**

As previously discussed, the adaptive capacity of a building manager—and by extension its designers, constructors and developers—is critical for designing and executing operations that allow for transformative adaptation. However, adaptive capacity can extend not only to the manifestations of professionals in their individual capacities, but also to a firm as a whole. While Chapter III explores this perspective conceptually, as exemplified by real estate firms in NYC, Chapter IV explores firm adaptive capacity more broadly with a case study of Goldman Sachs. As will be discussed, Chapter IV specifically demonstrates, through corporate real estate operations, how the adaptive capacities of buildings and real estate firms are dynamically interconnected.

Although specifically applied within the context of real estate firms in NYC, the conceptual framework developed in Chapter III could be argued to apply more generically across a variety of firms. As previously referenced, the adaptive capacity of a firm can be conceptualized by an unweighted interaction between knowledge and awareness, strategy and the space of decisions. Awareness can be further broken down into measured factors of organizational signal detection, individual beliefs and perceptions and the learning capacity of both the organization and its personnel. Within each of these categories, Chapter III utilized several methods, notably interviews, to inquire as to the state of a number of such factors for each firm. For instance, within organizational signal detection, it was inquired whether there were any designated processes or personnel measuring risks and impacts that are directly or indirectly attributable to extreme weather and/or climate change. Likewise, it was inquired the extent to which external professional or governmental relationships provided a pathway for signal detection, and whether those signals were physical measurements or changing policies. By extension, these same capacities were evaluated within the context of detecting and interpreting market signals, with the argument that markets may provide valuable information—even though that information is likely to be a lagging indicator of impacts from climate change. Finally, it was inquired whether firms had any physical detection processes for measuring changing environmental conditions either on the site or within the building. The conceptual model included a variety of other empirical factors for individual beliefs and learning capacities, ranging from assessed vulnerabilities to ongoing training of personnel (see Table 3.1).

The second part of the conceptual framework relates to giving order and classification to the types of economic strategies of a firm. This classification includes: (i) no regret; (ii) reversible/flexible; (iii) safe margins; (iv) soft strategy; (v) reduced decision horizon strategy; and, (vi) positive synergy or co-benefits strategies. Each one of these strategies may be further classified by whether the strategy yields a benefit with or without the occurrence of extreme weather or climate change—which have two different time horizons and probabilistic profiles. While it was ultimately determined that the selection of any given strategic classification is best evaluated in terms of

historical performance, the framework developed in Chapter III suggests that a diversity of strategies undertaken by any given firm is likely to be consistent with a more robust adaptive capacity. However, the qualification is that this argument in favor of diversity is also dependent on some measure of performance, as an internal weighting of resource allocation by and between a variety of strategies may or may not be robust. For instance, one may apply many more resources to transferring risk as a soft strategy but that may be fairly expensive (e.g., insurance premiums) relative to putting those same resources into a reversible/flexible strategy. This may yield benefits that exceed the costs. As observed in Chapter III, a challenge for firms is to segregate and aggregate costs and benefits across internal divisions of a firm, wherein a cost to one division may be a benefit to another. Without processes in place to manage and mediate this intra-organizational tension, one runs the risks that the division that bears the costs has disproportionate influence on decisions even though net benefits may or do exist. In returning to the diversity of strategy argument, this perspective provides a starting point for research. But, ultimately, the historical performance of the strategies will need to be evaluated because a well-resourced single strategy may outperform a diverse set of under-resourced and poorly executed strategies—and vice versa. This is certainly an important aspect for development in future research and represents a limitation to the methodologies employed.

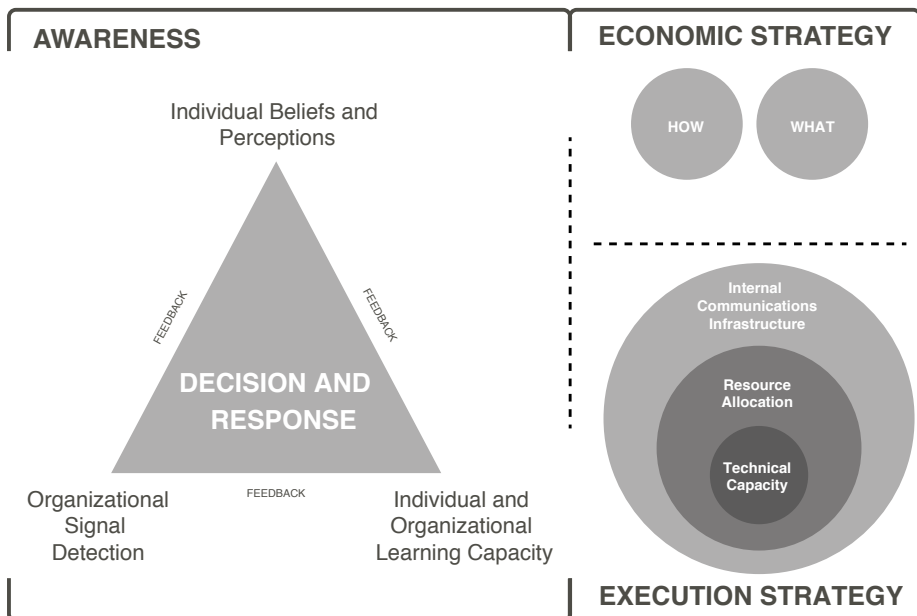
The final part of the firm framework relate to the space of decisions and/or resources available to accommodate known and unknown risks. This prong of the model was found to be useful for evaluation but only to the extent that it served an understanding of the two other prongs. Because real estate and infrastructure are fixed assets with limited operational parameters relative to other sectors, products and assets, the range of the space of decisions was found to be fairly limited—at least as it related to technological options for urban flooding in Chapter III. Or, conversely, the range of resource allocations (e.g., financial, informational, etc...) varies greatly by firm and the perceived and actual vulnerability of the firm. As will be discussed, it is likely that this part of the framework is less useful in terms of a discrete identification of resources than it is upon a more insightful framing of the capacity of the firm to execute with the resources that support the economic strategies.

Ultimately, it was found that the conceptual framework—which had no discrete inputs and outputs—was useful for organizing a qualitative evaluation of a firm. Absent a historical evaluation of performance, the evaluation was most useful when contextualized against the evaluation of other firms for purposes of benchmarking for which there is no empirical or conceptual foundation. Therefore, in the future, more cases studies and more data will be able to position not only a benchmark but some measure of weighting between awareness and strategy in terms of evaluating the overall robustness of a firm's capacity. Chapters IV and V suggest that awareness and the communications and intelligence systems behind this part of the framework are likely to be the critical factors for evaluation. This is based primarily on the argument that without a complete and comprehensive understanding of vulnerabilities, resources and technical capacities, emergent or stated strategies would be less impactful in their development and execution. However, this is theoretically dependent on the type

of risk and whether that risk is known or unknown, because a strategy to a known risk may not be dependent on a well-informed understanding of the total parameters of that risk or dependent on any superior level of communication for executing the strategy. The trend in favor of adaptation units (focused mostly on supply chains) in Fortune 500 companies suggests that the former is critical in terms of understanding the total range of vulnerabilities and operations necessary to address and manage those vulnerabilities.

Again, Chapters IV and V would suggest that a superior level of communications and intelligence is equally as critical in terms of execution. To this end, the conceptual model may be revised to include a more refined analysis of internal communications strategies and systems. While the existing model was geared more towards external intelligence and communication, factors such as internal data management, chain of command structures, and modes of internal communication may be critical for understanding execution strategies and not just economic strategies, as the current iteration of the model would suggest. Figure 6.1 reflects an alternative representation of the original framework for firm adaptive capacity. By separating execution strategies and economic strategies, the framework acknowledges a more complete definition of adaptive capacity than the more generic and ultimately less helpful classification of space of decisions. Both the original and revised frameworks will be reflected upon in the context of the empirical findings discussed in the subsection for question R5 below.

**FIGURE 6.1:** Revised Framework for Firm Adaptive Capacity



Source: Berkhout, et al. (2004); Arnell & Delaney (2006); Fankhauser, Smith & Tol (1999)

### **R3: How can the adaptive capacity of a real estate firm in NYC be normatively developed?**

This question is perhaps one of the most important practice-oriented questions to stem from this research. However, the research results suggests that a more refined set of questions relates to the 'who' and 'what' and not just the 'how.' As previously referenced, capacity is critically dependent on both internal and external intelligence and communication. Chapter IV highlights a case where these communication and intelligence regimes were advanced by corporate real estate and operations division. Goldman Sachs's approach included integrated facilities, operations, engineering systems, and human resources, as it interfaced with revenue divisions of the firm. However, this is likely to be an exceptional case given the size and sophistication of Goldman Sachs. In Chapter III, most of these communication and intelligence functions were being dictated by senior executive managers in what could be interpreted to be top-down mandates. In drawing an analogy to the adaptive capacity of buildings where there are top-down and bottom-up dynamics at work, then perhaps the same could be applied to firms where intelligence and communications functions benefit from both operations in a series of feedback loops. However, this may be as descriptive as it is normative, as this may represent an actual phenomenon to some degree. Certainly, climate scholarship has increasingly given credence to the value of senior executive leadership in terms of awareness, but that does not necessarily mean it is as effective in terms of execution (Karlsson, 2011; Lee & Koski, 2012; de Águeda, Corneloup, & Mol, 2014; Schwerhoff, 2015). This is certainly an important avenue of future research.

### **R4: How do the concepts of sustainability, resilience and adaptive capacity relate to each other in theory and NYC real estate practice?**

The popular and commercial advent of going "green" through sustainable design and operations has manifested into moderate success in terms of tenant demand and building supply in the U.S. (Szumilo & Fuerst, 2014). Given this emerging consciences of efforts that ostensibly serve co-benefits between building efficiency and climate mitigation, this research question is potentially important as global communities attempt to find co-benefits between climate mitigation and adaptation (Duguma, Minang, & van Noordwijk, 2014). Underlying this research question are sub-inquiries that address the extent to which diffusion and underwriting of sustainability can offer any lessons for adaptation. If, as discussed, organizational structure and processes are critical factors for adaptive capacity, then building sustainability has the potential to offer important lessons in terms of practical barriers and opportunities for execution, as was the case in Chapter IV. More fundamentally, Chapter IV provided a theoretical basis for the positive relationship between sustainability, adaptation and resilience. While, in theoretical terms, sustainability by virtue of its perpetual "sustained" consumption breaks the adaptive cycle, in practical terms, both adaptation and resilience are dependent on some measure of sustained resource allocation to offset the costs of change.

The case study of Goldman Sachs demonstrated that sustainable corporate real estate practices—or practices that were in part motivated by sustainability—also advanced the resilience of the firm, in terms of business continuity, and advanced the firm in terms of its capacity to adapt. By highlighting three external shocks (i.e., Hurricane Sandy, conversion to a banking corporation and cloud computing), the case demonstrated how co-benefits existed by virtue of a robust capacity to respond and adapt. The findings support the proposition that positive relationships between sustainability, resilience and adaptation can and do exist. The findings also support the proposition that sustainable practices did advance the adaptive capacity of the firm. However, the findings and the conceptual framework also left open the possibility for an additional proposition that the adaptive capacity of the firm helped advance its sustainable practices by virtue of its ability to identify and diffuse innovations, as well as an ability to identify which assets or practices should be sustained. While the research was unable to identify which elements were more or less deterministic in decision making, it does leave room for future research that seeks to identify feedback loops between sustainability and adaptive capacity. While this is important research for adaptive capacity, it is also potentially meaningful for sustainability, as it represents a positive unrecognized value to sustainability beyond the immediacy of return on cost.

A final contribution of this research is that it demonstrated a critical link between the adaptive capacity of a building and the adaptive capacity of a firm. A prime example is the situation where the firm designed a flexible office space oriented around a sustainable reduction of material and optimization of time. The firm also developed a robust adaptive capacity by designing a space management system that optimized usage of its sustainable designs. When, for instance, the external shock of the banking conversion occurred, the firm was able to adapt by utilizing these capacities to internally reconfigure an entire organizational structure that in some cases required legally partitioned spaces. Goldman Sachs did not internally recognize the physical aspects of design as part of an adaptive capacity. Instead, this was internally recognized as sustainable or an outcome of simply sound design or business judgment.

However, the case demonstrates how a corporate real estate and services unit (referenced herein as a sub-organization to the firm) may serve as the appropriate unit for advancing the adaptive capacity from both perspectives. This can be attributed in part to its cross-divisional position in a firm and its ability to uniformly communicate across a variety of actors. Likewise, while it is not responsible for external market data, it is the principal data collector for the internal operations of the firm and the external physical performance of the firm's buildings and spaces. As observed in Chapter IV, a corporate real estate and services unit could serve to mediate cross-divisional frictions that may arise because it is already undertaking such mediation in the competition for firm resources. Finally, the unit might serve as an appropriate adaptive capacity facilitator or manager because it has the professional capacity for a high level of intelligence that crosses design, engineering and management functions.



## **R5: What is the state of the adaptive capacity and current behavior of real estate firms in NYC?**

This question formed the basis of the initial intent of this research and dissertation. There was absolutely no peer reviewed scholarship on either the adaptive capacity of commercial real estate firms or the behavior of those firms as it related to extreme weather and climate change in NYC or elsewhere. This is still a critically important question that government officials and academics ponder as they strategize modes of engagement for the private sector. This dissertation represents not only a valid first attempt at addressing this question, but it also provides a framework and methodology for moving forward. While some of the findings vary in their degree of conclusiveness and representativeness (i.e., limited to the geography of NYC), the nuisance in the details provides an unprecedented picture of a largely unprepared sector that is only now beginning to recognize the value of understanding climate change beyond sustainability and climate mitigation.

The initial propositions in Chapter III were based on an unresolved debate in the scholarship that suggested that firms in the private sector either: (i) adapted as a process of financial optimization and equilibrium seeking in the short-term (Mendelsohn, et al., 1994; Mendelsohn, 2000; Haites, 2011); or, (ii) adapted by virtue of a process defined by a multi-criteria decision making that includes both internal and external considerations—often over the long-term (Schneider, et al., 2000; Kandlikar & Risbey, 2000). From a real estate perspective, one could argue that the latter may be true, as real estate is generally a long-term investment that is dependent on an external urban conditions defined by complex variables ranging from tenant demand to environmental quality. However, it could also be argued that real estate firms driven by the pressures of global capitalism for shorter holding periods might be driven largely by self-interest based on a conventional investment return analysis akin to optimization for seeking financial equilibrium. In addition, there is certainly an empirical basis for classifying real estate as a laggard in terms of innovation and productivity gains. However, no one had ever attempted to empirically evaluate these arguments within the context of one of the most important industrial sectors—real estate.

The findings in Chapter III suggested that there were a number of processes at-work. While most real estate firms tended towards financial optimization and gave very little credence to external factors (e.g., public policy, long-term tenant preferences, systematic urban risks, etc...) in their decision making, some firms that were especially vulnerable to flooding and climate change did have a more complex multi-criteria decision making process and a more sophisticated selection of adaptive economic strategies. This was highlighted by firms with buildings in Lower Manhattan that were deeply concerned with the long-term viability of their property and buildings. Other than Goldman Sachs, these were the only studied firms that gave serious consideration to collective action with public and private actors to develop risk mitigation infrastructure that served resilient and adaptive

ends. They were also the only firms that attempted to incorporate climate change into their long-term strategic planning. This was a surprising result because all of the evaluated firms had significant Manhattan holdings that, even though many buildings were not in immediate or long-term risk of flooding or inundation, would likely be extremely vulnerable to urban systems disruption and to potential tax burdens in the face of climate change and sea level rise.

While the space of decisions, resources and execution strategies varied by firm, those firms whose portfolios were most at risk were thinking beyond the limited constraints of short-term financial optimization. The most vulnerable firm was already taking steps to liquidate properties and assets now in order to not bear greater losses in the future. Of course, the qualification, if not limitation, to these findings is that they were based on a limited sample pool of just six real estate firms in NYC. However, these firms could be said to be representative of otherwise highly sophisticated firms, in terms of resources and managed complexity. It should also be noted that Goldman Sachs most certainly employed a multi-criteria analysis that thought well beyond the immediacy of financial optimization, even though many of its methodologies were oriented toward optimization. However, the firm is a bank and not a real estate firm, so it is not entirely equivocal. What these seven firms do highlight is that those firms with the most resources were not necessarily the same firms with the most robust adaptive capacity. It was a small firm that was highly vulnerable that had qualitatively developed the most robust capacity and had undertaken both *ex ante* and *ex post* adaptation measures. Again, the qualification is the limited number of sample firms that do not allow for a statistically significant sample. However, in qualitative terms, this sets the stage for future research questions that further delve into the relationship between vulnerability, intelligence and management.

An additional debate in the scholarship revolves around the nature of adaptation in firms in terms of being *ex post* or *ex ante*. The prevailing scholarship suggested that firms are nearly uniform in merely reacting to external stimuli (e.g., climate change) and that planned adaptation is not an efficient allocation of resources given the variabilities of the unknown (Mendelsohn, 2000; Aakre, et al., 2010). The findings in Chapter III largely supported this proposition. Firm adaptation processes were initiated after the fact, despite some limited *ex ante* planning by the most vulnerable firms. However, the findings in Chapter IV suggest just the opposite—that even though adaptation was not internally recognized as such, there was a latent adaptive capacity that led to processes that were able to respond *ex post* but the capacities and some of the plans existed *ex ante*.

These findings on firm adaptation processes raise a larger question as to the usefulness between *ex post* and *ex ante* classifications within the context of adaptive capacity. If, as previously discussed, all buildings and firms have some measure of adaptive capacity—buildings have always been adapted and firms would fail otherwise—then the distinction between *ex post* and *ex ante* is not entirely useful. What it may then reflect is where, at a given time along a continuum

of stable and unstable states, the researcher or observer has observed a single action within a process. Therefore, it is more accurate, if not consistent with this research, to say that one does not adapt after the occurrence of an event but that one takes action after the occurrence of the event that is part of an ongoing process which is recognized as advancing the process of adaptation. In the alternative, *ex post* and *ex ante* classifications may be understood as incorrectly defining adaptation as an outcome versus a process. By focusing on specific outcomes utilizing these classifications, researchers may be overlooking valuable knowledge on the predicate conditions (i.e., capacity) that underscored the “outcomes.” Again, these outcomes are merely points on a continuum and may be interpreted differently depending on the timing and mode of the observations. Likewise, if firms are said to be relegated to *ex post* financial optimization for seeking an equilibrium, then it assumes that the firms have some manifest control beyond their capacity to control. This is perhaps a dangerous analytical disposition to evaluate not just firm action but the consequences and preconditions of that action.

**R6: What is the facility of professionals in NYC to understand and apply core climate change concept in the built environment and what are their preferences for the application of these concepts?**

These research questions address the third and final perspective of the study of adaptive capacity undertaken in this dissertation: professionals. Without the requisite intelligence of professionals, then the prospects of designing and promoting adaptive capacity at either the building or firm perspective are largely moot. Arguably, there is little necessity or value to overly theorize the notion of individual professional adaptive capacity—it is simply a function of understanding existing knowledge, preferences and bias. In addition, it is assumed that a core function of this collective notion of intelligence and behavior is premised on each individual’s ability to understand concepts and meanings that are critical for more complex decision making. Subsequent research may be able to build upon this empirical research to develop normative or descriptive models for advancing professional intelligence and managing counterproductive preferences and bias.

Chapters III and Chapters IV suggest a great variation in the conceptual understanding of the core concepts of adaptation, resilience and risk mitigation. On one hand, engineers generally had a working facility in these concepts and how they are applied to their day-to-day and strategic practices. With the exception of those interviewed in Chapter IV, risk managers were consistently ignorant of the meanings, applications and relevancy of the core concepts. Surprisingly, extreme weather and climate change was referenced almost exclusively in terms of insurance. Asset and building managers consistently: (i) did not profess an understanding of adaptation; (ii) did vaguely assign the concept of resilience to their practices; and, (iii) did show a well-informed knowledge of a range of applications for risk mitigation. There were no consistent findings among senior managers and executives. Their conceptual facility varied greatly and had no

strong correlation to their education or the characteristics of their firms. Although, it was found among firms in Chapter III that high levels of knowledge among senior executives were correlated with high a greater robust adaptive capacity. While none of these qualifiable correlations hold any statistical significance, they do suggest a potentially fruitful avenue of future research in the role of executive leadership in promoting firm adaptive capacity.

This diverse and inconsistent range of professional knowledge was in line with the findings of the hypothesis development stage of the research in Chapter V. Among a broader field of professionals active in post Hurricane Sandy planning, design and development in the NYC metropolitan region, there existed a lack of consistent understanding for the core concepts. Very often, the concept of resilience was assigned to measures that are objectively classified as a function of adaptation, such as retreat. In other cases, resilience and risk mitigation were used interchangeably without distinction. Overall, the usage of resilience was rhetorical and lacked any consistent technical meaning or application. More importantly, resilience and adaptation were very often conflated as synonymous concepts.

This highlights a larger phenomenon that the author has coined as the 'Resilience Problem.' At the heart of the problem is the rhetorical use of the term that dilutes any attempts at developing objective technical meanings and applications. The proliferation of this usage can be attributed in part to politicians and foundations who are biased to advance the interests of the status quo (Bahadur & Thornton, 2015). It is the status quo that is their constituency and the source of the legitimacy of their power. Adaptation which allows for a transformation to an alternative domain of operation imposes costs and results, in not just winners, but also losers from a societal point of view. Therefore, politicians and some foundations view this transformational function as disruptive. Their concerns on some level are valid to the extent that inequality and matters of justice have not yet been conceptually drawn into a larger framework of socioecological adaptation (Bulkeley, Edwards, & Fuller, 2014; Steele, Mata, & Fünfgeld, 2015). However, in more immediate terms, these politicians are reluctant to make the tough decisions that may lead to transformational change. Few politicians want to be the first person to stand up and advocate for the retreat of an entire community that is highly vulnerable to inundation or forest fires. This problem has proliferated all the way to the highest levels of American politics. In an interview for a forthcoming paper on the National Resilience Disaster Competition, the head administrator for the competition for the U.S. government admitted that the naming convention of the competition was changed from adaptation to resilience to appease conservative Republicans in Congress who were necessary for funding the US \$1 billion competition (Kome, 2015). Conservative by definition means to preserve that status quo. Therefore, their ideological position to promote resilience is entirely consistent. However, progressives have also used resilience to mean a certain elastic function of communities and people to endure hardship. However, this usage has begun to backfire in a planning context in NYC following Hurricane Sandy, where storm

victims now view the word as a label for those who have struggled with poverty and other socioeconomic hardships (Rowe, 2015). Storm victims don't want to be resilient, they want their houses to be repaired (Id.). This larger 'Resilience Problem' which crosses boundaries between the public, private and civic sectors has done a great deal to thwart the development of objective and technical meanings for the core concepts. Whether you are a senior executive at a real estate firm or a municipal planner, anyone who has availed themselves of the public discourse in NYC—and much of America—cannot escape the pervasive rhetorical and inconsistent usage of resilience.

Chapter V provides a comprehensive survey that seeks to address two critical hypotheses. First, resilience has no consistent meaning and usage among the pool of professional respondents. Second, respondents do not actually prefer resilience over and above related concepts of adaptation, risk mitigation and coping. The findings confirm the first hypothesis. In looking at both the ability of respondents to match meanings and concepts, as well as their ability to match concepts and applications of those meanings, the statistics suggested that resilience was the least understood concept among the other concepts. To the contrary, there was a statistically significant demonstration that respondents could match concepts with meanings and applications for all concepts other than resilience. These results suggest that the observed rhetorical usage of resilience has likely done a great deal to confuse people when it comes to objectively giving definition to the concept. Second, the findings also confirmed the second hypothesis to the extent that resilience was the least preferred application assigned to the various concepts. These applications were tested across a variety of scenarios from sea level rise to land subsidence. To the contrary, adaptation was the preferred overall conceptual application. This is consistent with the perspective of this dissertation, which is that adaptation is the most appropriate concept for planning for and responding to the long-term incremental occurrence of climate change. Overall, the results of Chapter V suggest a high level of contextual intelligence—but for an understanding of resilience. Likewise, the results also provide, in part, an internal validation of the interpretation of the meanings assigned and developed throughout this dissertation. Consistent and objective meanings for these core concepts are critical for developing and refining analytical models and tools for promoting adaptive capacity.

Resilience is not inconsistent with the notion of adaptation or adaptive capacity. A strong adaptive capacity may help advance resilience, as was likely the case in Chapter IV. Adaptation itself can be conceptualized as periods of elastic stability or resilience that ultimately have the capacity to transform to alternative domains. To this end, adaptation is not superior to resilience, or vice versa. They should be conceptualized to have both complimentary and conflicting aspects depending on the scale, timing and the perspective of the object or beneficiary of the process. At one scale and one perspective, resilience may lead to adaptation. At another scale and perspective, that same process may be viewed as maladaptive. This is a healthy tension that is critical for moving both concepts beyond an assignment of absolute goods as they are popularly understood. The limitation of the research

of Chapter V is that it only evaluated these concepts in isolation. Future research will be tasked with developing an analysis that moves across scales, actors and perspectives to explore and understand this tension. In many ways, this is just one of many universal challenges in social behavior between short-term and long-term thinking and planning. Yet, it also has immediate implications for those analysts who seek to provide sensitivity to a variety of knowns and unknowns. This is a particular challenge in the context of real estate and the built environment where the cone of uncertainty with climate change extends well into the useful life of buildings and infrastructure. However, in the near-term, research into the multi-system and multi-stakeholder applications of these concepts will be critical for developing and educating the next generation of professionals.

## **2. Reflections on the Main Research Aim and Approach**

The main research aim of this dissertation is to develop an understanding of the adaptive capacity of: (i) buildings, (ii) real estate firms, and (iii) professionals in NYC. This central research question seeks to understand how and to what extent the three aforementioned perspectives and systems have the capacity to manage, accommodate and otherwise adapt to the risks and opportunities associated with extreme weather and climate change. This dissertation did provide a foundational framework for conceptualizing adaptation of buildings in their material and social construction. Likewise, this research not only developed a framework for firm adaptive capacity, but it also undertook an empirical exploration of the framework to begin the process of refining the framework elements to maximize their conceptual and practical validity and utility. Finally, operating on the assumption that professional adaptive capacity is premised on a contextual intelligence composed of individual knowledge, preferences and biases, the research set forth an empirical evaluation of the professional intelligence of professionals in NYC.

As more buildings are designed with adaptive capacities vis-à-vis intelligent automated operating systems and comparatively sophisticated paired human management systems, the framework from Chapter II will be more and more relevant for exploration. However, even the most mundane of contemporary commercial buildings can benefit from such a conceptual exploration to the extent that managers and designers can better understand the relationship between life cycling investment and adaptive capacity. As will be discussed, ongoing design and real estate research led by the author in Japan for designing buildings that have the ability to programmatically adapt over the course of its extended life-cycle is arguably an important extension of this research.

Given the necessity to develop a theoretical foundation as a predicate for further empirical exploration, this dissertation leaves much room for further empirical study. In particular, it will be desirable to strengthen the connections between the

adaptive capacity of a building and an organization. Chapter IV demonstrated a number of significant connections within the context of corporate real estate. However, in that case, the building was designed with a certain adaptive capacity and was managed accordingly. It will likely be valuable to evaluate situations in the future where buildings are in the midst of radical programmatic change or are being redeveloped within the context of significant environment risk, for instance, in order to explore the interrelationships between management and the building. Conversely, potentially valuable research could also focus on situations where firms are undertaking radical adaptation for different reasons (e.g., market shift) and then evaluate how this transformation is manifested in the firm's corporate real estate. In either event, identifying the external stimuli or shock and following the historical performance across the aforementioned perspectives, as was the case with Goldman Sachs, will be critical to selecting points along the adaptation continuum for evaluation.

One of the shortcomings of this research is the limited number of cases, as well as the fact that the subject real estate firms are all located in NYC. While the NYC real estate market is unique in many aspects, the case study firms are likely representative of many of the world's great commercial real estate and banking firms. However, this highlights the extent to which the empirical results are or are not generalizable outside of NYC to the many small firms that dominate local real estate holdings. An additional limitation of the research approach is the lack of complete access to financial statements and documents that would have helped paint a more precise quantitative and qualitative picture of the deliberations and strategies of the firms. While the author was given access to a great number of such documents, there was an unknown limit to that access. With a strong reliance on interviews, it is likely that some key analytical models and methodologies (or, inputs to those methodologies) were omitted that would have otherwise been insightful in interpreting data collected through the interviews and documents reviews. In addition, with the exception of Goldman Sachs, which was evaluated over multiple years, the six other case studies were evaluated over the span of a single year. As such, there is likely a limitation to evaluating their historical performance or selected or emerging economic strategies. Upon the occurrence of the next flooding or extreme weather event, the author intends to commence with a follow-up study of these firms to evaluate the pathways of the various capacities, strategies and resource allocations.

An additional set of limitations of this research relates to the limited range of the selected perspectives and the predominant focus on the internal operations at each firm. While interviewees were subject to questions about a range of external influences in Chapters III and IV, this dissertation did not delve into the role of public policy in conceptualizing or influencing adaptive capacity or acts that would advance or inhibit adaptation or resilience. The evidence in these chapters suggested that existing public policies were playing a very minor role in influence private actor behaviors. In addition, specific to Chapter II, the conceptual development excluded the urban scales of blocks, district, cities and

regions from the analysis. This is somewhat problematic given the recent focus on block and district level development that represents a type of adaptation to a range of risks from power reliability to flooding, such as the case with mega-block developments in Washington, DC. Pursuit to the theory developed in Chapter II (i.e., Theory of Panarchy), it can be argued that it is likely that activities at these various scales are or will have some measure of influence upon the subject research perspectives. In empirical terms, these broader spatial scales and social perspectives were found to be relevant only in terms of public perception and political will. To advance research at these scales and perspectives, the next steps would be to: (i) develop a synthetic understanding between adaptive and institutional capacities; (ii) extend an evaluation of adaptive capacity of regulatory agencies; and, (iii) then examine more discrete outcomes in terms of buildings codes, land use decisions, and other public acts. A current review of building codes in English speaking countries and territories (Hong Kong) that serve adaptive or resilient processes for the International Code Council suggests a quickly emerging alternative regulatory regime that is running into significant battles due, in part, to entrenched labor and commercial lobbies.

Historically, the government has led by example in terms of incorporating innovations into the built environment (e.g., LEED standards for public buildings). However, despite a limited number of resilience driven building codes that represent a type of 'no-regrets' adaptation strategy, there are few examples that scale to the building. This is complicated by the fact that the federal government does not usually have jurisdiction over the built environment in NYC or in the U.S., in general. With more frequent occurrences of extreme weather from the acceleration of climate change, it could be argued that this dynamic is likely to change as the private sector will demand more accommodation from the public sector at-scale. Interviews in Chapters III and IV suggested that experimental non-mandatory regulations, which enabled or promoted building technological or use innovation were optimal. However, with time, these innovations will prove to be more or less effective and this may lead to more mandatory regulations. This will require a tremendous amount of political will reinforced by the proliferation of technical standards that have not yet come to be in the U.S..

Despite the limitations of the empirical research approach, it is worth returning to the initial working proposition that underlined the main research aim. This working proposition suggested that the U.S. real estate industry lacked the understanding and applied mechanisms and designs necessary for effective planned or reactive adaptation to climate change. While this research speaks specifically to NYC, and not to the U.S., or other places more generally, it can be argued that the findings support a more robust adaptive capacity than was anticipated. While the capacities may not be internally recognized, referenced or operationalized, for those firms that are: (i) uniquely vulnerable; (ii) aware of that vulnerability; and, (iii) moderately sophisticated in their economic and execution strategies, their adaptive capacities are comparatively robust. As referenced in Chapter II, it will be seen as to whether these capacities are also reliable in addition to being robust.



However, the advancement of the operations that define these capacities have not been observed to be deliberate as a collective and willful act. They certainly do not represent an intent to consciously adapt, as not a single firm internally gave recognition to the concept of adaptive capacity. This suggests a natural tendency of firms to adapt once they are aware of what is driving the necessity to adapt. Again, this reinforces the value of the awareness aspects of the firm framework. The question then for future research is the extent to which operations and designs can advance the awareness of the firm and their executory capacity to evaluate and select a variety of economic strategies. For non-real estate firms, this executory capacity may very well be a function of corporate real estate, as was the case in Chapter IV.

### **3. Recommendations for Future Research**

Throughout this dissertation and this chapter, many aspects of future research have been highlighted. For as much as this research has addressed the principle research questions and the main research aim, it has provided a foundation for a variety of critical inquiries that span a variety of disciplines. Architects and architectural technologists have the opportunity to investigate the analytical potential for translating conventional designs into those that have the active and passive capacities to accommodate programmatic and environmental change. They also have the opportunity to conceptualize and design their buildings with a greater sensitivity over the entire life cycle of the building and for a more technical understanding of the nature and demands of commercial users that themselves are evolving by virtue of their own adaptive capacities. It would no longer suffice to design for a client in its current manifestation but to design for how and where that client will or could adapt to known and unknown manifestations of markets and environments. This isn't a function of clairvoyance, as it is a more articulated professional dialogue, that clearly defines operational parameters—and where those parameters are dynamically sensitive—to the core business models of the owners and occupiers. This is precisely the nature of the design process undertaken by Goldman Sachs when they designed their new headquarters, as discussed in Chapter IV.

The business and management academies are tasked with conceptualizing and operationalizing adaptive capacity. The first step is to refine aspects of the conceptual models in Chapters II and III that serve to measure external and internal intelligence and executory capacities. Thereafter, it will be important to develop a taxonomy of applications that fit within the various classifications of economic and execution strategies. Chapter III lists a limited number of applications within the context of urban flooding. As the diversity of risks proliferates, overall meaning to the concept of adaptation and adaptive capacity will likely be conceptually ascribed by assigning applications to strategies. This has been a consistent observation in NYC. Concepts are frequently defined by their applications and not their technical functions or operations. To accomplish this, analytical models

will need to be developed that accommodate the productive tensions between: adaptation and resilience; between the short-term and the long-term; and, between the known and unknown. For instance, the author is leading adaptive design and development research in Japan that utilizes stochastic modeling for understanding asset liabilities and valuations given a random variation for probabilistic distributions in everything from energy and construction prices to the future value of rents. These models allows for a 2- and 4-dimensional evaluation of 3-dimensional designs for buildings that are designed to programmatically adapt. The implications of this analytical modeling are to advance iterative design exercises that synthetically integrate the various disciplines which are necessary to accommodate the material and social constructions of a building.

More fundamental to this level of sophistication is core leadership and professional education. To advance these professional adaptive capacities, it will be necessary to further research the interrelationships between the core concepts, as they are applied to a variety of risks and opportunities associated with the direct and indirect impacts of climate change. Given the tremendous unknowns associated with the indirect consequences, it may be necessary to develop professional simulations and stress testing very similar to exercises that banks and emergency agencies undertake. It is imperative that the science of adaptation advance clear and consistent meanings, whether they are defined by heuristics, applications or technical specifications, which will translate across a diversity of actors with an equally diverse set of interests, skills and cognitive capacities for conceptualizing adaptation, resilience and risk mitigation. Without this core social translation in the name of science, capacities of buildings, real estate firms and professionals will be relegated to a limited professional class. To fully advance the sciences of adaptation and the built environment, it will be necessary to develop an objective epistemological foundation across perspectives, actors and objects that have uniform application in analytical and methodological terms. This dissertation has attempted to advance this larger body of knowledge.

## **4. Knowledge Valorization: From Research to Practice**

Engaging a wide variety of professionals, government actors and academics throughout the research was critical not just for collecting and analyzing data but also for formulating the appropriate questions. To reinforce this engagement, the research in this dissertation was the subject of 36 public lectures in 8 countries and 5 conferences. Likewise, the researcher was the co-curator of two major conferences in NYC, which benefited from the participation of U.S. Secretary of Housing and Urban Development, Shaun Donovan; U.S. Secretary of the Interior, Ken Salazar; and, Netherlands Minister of the Infrastructure and the Environment, Melanie Shultz van Haegen. The researcher also curated two minor conferences in Rotterdam and in Stockholm. Finally, design research was utilized as part of this broader dissertation research. A team of designers and engineers led by the

researcher evaluated the physical impacts of storm surge, flooding and inundation with sea level rise and climate change in Lower Manhattan. This research provided the basis for experimental designs for accommodating alternative housing of critical financial services infrastructure on Wall Street. This research also provided the basis for much of the background physical research that informed the design of Chapters II and Chapters III and was the subject of an exhibition at the Hong Kong Biennale for Urbanism and Architecture, as highlighted in the Appendix.

As previously referenced, this research has benefited from a variety of parallel research and professional projects that have enriched the understanding and utility of the research memorialized in this dissertation. Most notably, the framework for the adaptation and adaptive capacity of buildings in Chapters II and III has been adopted by the American Institute of Architects (AIA) as the theoretical foundation for its, *Principles of Resilience, Adaptation and Climate Change* (Minnery & Keenan, 2015). A review of these principles will immediately identify language from nearly all of the chapters of this dissertation. This initial range of principles is the first step towards developing an evaluation and classification of existing practices that will ultimately lead to a taxonomy of practice. As this field of practice is currently highly experimental, it will take many years of peer-review engagement before codes and standards are set forth. However, these initial principles provide a foundation for a potential discourse by and between the 83,000 members of the AIA.

Chapter III has initiated a new level of awareness among real estate firms in NYC, as the paper has been widely distributed and presented in professional and planning events, including the ongoing deliberations of the 4th Regional Plan. This is particularly true for owners of firms with buildings that are in vulnerable locations in Lower Manhattan. With the useful life of many of these buildings coming to an end, property owners and building owners (i.e., many buildings are on ground leases) are beginning to contemplate future development. The challenge ahead of them is that many of the buildings are over-built in terms of lawful density under the existing zoning code and any new buildings will need extensive and costly risk mitigation infrastructure and an ability to adapt to sea level rise. This latter element is key because it will be many decades before a fortification of the waterline will come to fruition. As one of the principle authors behind the multi-billion dollar multi-purpose levee project *Seaport City*, the author is keenly aware of this political and financial limitation (EDC, 2014; Sanders & Keenan, 2014). The evaluation and advancement of *Seaport City* was advanced in part by the conceptual meanings and applications developed in this dissertation, as well as the range of economic strategies developed in the second prong of the firm adaptive capacity framework (see Figure 6.1). To this end, this collective body of research has been applied on a variety of projects in a professional capacity undertaken by the engineering firm Arcadis.

The work in Chapters II and III has also advanced a multi-year research project in Japan with the firm Hulic, Co., Ltd—one of the largest publically-traded real estate firms in Japan. As Japan has entered into an unprecedented era, in terms of

demography, energy and climate change, this research began to operationalize the adaptive capacity frameworks developed herein. The core intent is to design and engineer a building that has the capacity to programmatically adapt and to accommodate—through both passive and active capacities—future technological advances in building systems. While this research is not ripe for inclusion as a chapter in this dissertation, it has provided a practical sounding board for conceptualizing the development of the work contained herein. Utilizing some of the methodologies and models previously referenced, together with a variety of organizational structures and processes from Chapters IV, the intent is at the end of the four year project to have developed a management system and prototype building in the Shibuya District in central Tokyo. As of the fall of 2015, work has begun on early stage construction and engineer drawings. The prototype building is set to commence construction in the year 2017. More information on this research project can be found in the Appendix.

Chapter IV has only recently been published, but the initial feedback from the work, as it has been presented at a conference and during multiple public lectures, has been positive. In addition, Goldman Sachs has recognized the need to further define and advance a more formal structure for an adaptive capacity unit within the firm. This will be many years in the making but the initial stage deliberations have internally begun to take shape. It also casts a new value set on sustainability that will likely reinforce their commitment to their own brand of sustainability. The larger impact from this work among the author's academic peers has been the theoretical contribution for highlighting the connection between sustainability and adaptive capacity. Although, the arguments presented in this chapter are very much the subject of debate. Sustainability in the private sector has been partially diluted and challenged for its subjective and rhetorical application. As such, Chapter IV highlighted its theoretical weakness at the same time it strengthened its utility for advancing an alternative and unrecognized values. It is hoped that this will shed a new light on sustainable real estate analysis.

Chapter V has had a recognizable impact on a broader urban and regional planning discourse in NYC and in the U.S. more broadly. The 'Resilience Problem' has increasingly been recognized as a significant scholarly and practical problem, and this research appeared at a critical right time when larger efforts have been acknowledged to be hampered by this rhetoric. As highlighted in the Appendix, the work has begun to be translated for the Climate Change section of the 4th Regional Plan for the metropolitan region of NYC. Likewise, this work has provided the basis for ongoing policy and planning development with the International Code Council, the American Society of Interior Designers and a variety of jurisdictions, including the Commonwealth of Massachusetts. This research has also been internally acknowledged as influential by the National Institute of Standards and Technology (NIST) of the U.S. Department of Commerce. To this end, the author was appointed to and currently serves as Vice-Chair of the Community Resilience Panel (CRP) for Buildings and Infrastructure, which is the designee authority under the White House's Climate Action Plan for advancing standards

and providing guidance for resilience and adaptation in the U.S.. As Vice-Chair, the author supervises panel chairs and staff in water, transportation, energy, economics, communications, data & metrics, and buildings. While the work of the panel is many years in the making, the initial framing, organization and strategic classification approaches have been heavily influenced by the work collected in this dissertation.

While the full application and implication of this research will take many years to manifest, the foregoing applications highlight the arguably positive impact of this scholarship. As the various applications of this research progress, the concepts and findings of this dissertation will continue to be refined and calibrated. Some of these findings may be shown to be incorrect or not an accurate reflection of a broader set of phenomena. However, to fail is to succeed when the benchmark for knowledge on adaptation in the built environment is at this nascent stage. The research contained in this dissertation represents merely a starting point for much research ahead. For now, this research has contributed not only to new knowledge, but also the capacity of a multitude of actors in the built environment to adapt.

## **5. Building an Adaptive Capacity for the Future**

This journey began with a disciplinary ambition to bridge the physical, financial and policy aspects of the built environment. Caught between the art and science of practice, the relevance of real estate management and development scholarship is increasingly manifest in a world that struggles to construct an ethical foundation in its greatest monuments and in its most mundane structures in the built environment. Who is to benefit from the knowledge of capital manipulation and technological diffusion in the built environment? To whom do our constructions benefit? Climate change accelerates this dialogue. It provides an urgency and it levels the playing field of humanity. As a society, we are all at risk and the built environment is on the front lines of this challenge.

The responsive discourse to climate change has largely been the purview of the public sector. However, the public sector alone lacks the resources and the political will to mitigate climate change, much less adapt to it. Therefore, it is incumbent upon the private sector, including real estate, to rise to the challenges ahead. The consequences of a failure to do so nearly defies comprehension. Despite tremendous advances in theoretical knowledge, data (which might not yet be knowledge) and technology, the future ahead is as unknown as it was at the dawn of humanity. We can never fully understand to what it is that we need to adapt to. Therefore, our only option is to build a capacity to adapt. That capacity itself must adapt, too. It must grow and learn. It must measure and verify. These are the functions of science and the scientific method.

While science will not allocate resources, and it will not impose a framework for equitable distribution of those resources, it will provide some basis for judgement necessary to make those decisions based on knowledge that itself is transient and never quite static (Popper, 1999). To adapt and to develop a capacity to adapt will require never-ending processes of exploration that seeks the knowledge necessary to best inform human judgement. This dissertation represents new knowledge that has informed the knowledge and judgement of a variety of designers, developers, planners and policy makers. With adaptation, the academies of the built environment are tasked with a frame of reference that has no end and perhaps has no beginning. Adaptation is a function of a timeless evolution that makes this work as descriptive as it is normative and as conceptual as it is empirical. But, a failure to develop a capacity to adapt may accelerate our place within the adaptive cycle of a global ecology wherein the release of capital is the collapse of civilization as we know it. For this effort, this dissertation has merely bought more time—the most priceless of all commodities.

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# APPENDIX I



# 1. List of Acronyms

<b>AIA:</b>	American Institute of Architects
<b>BCP:</b>	Business Continuity Planning
<b>BIM:</b>	Building Information Management
<b>CR:</b>	Commercial Real Estate
<b>CRE:</b>	Corporate Real Estate
<b>CRP:</b>	Community Resilience Panel
<b>CSRE:</b>	Corporate Services and Real Estate
<b>CURE:</b>	Center for Urban Real Estate, Columbia University
<b>FEMA:</b>	Federal Emergency Management Agency
<b>FIRM:</b>	Flood Insurance Rate Map
<b>GCP:</b>	Gross City Product
<b>GIS:</b>	Geographic Information Systems
<b>GRESB:</b>	Global Real Estate Sustainability Benchmark
<b>GS:</b>	Goldman Sachs
<b>GSHQ:</b>	Goldman Sachs Headquarters
<b>HVAC:</b>	Heating, Ventilation and Air Conditioning
<b>IFPS:</b>	Integrated Flood Protection System
<b>IPCC:</b>	Intergovernmental Panel on Climate Change
<b>LEED:</b>	Leadership in Energy and Environmental Design
<b>MAS:</b>	The Municipal Art Society
<b>MERS:</b>	Mortgage Electronic Registration Systems
<b>NFIP:</b>	National Flood Insurance Program
<b>NIST:</b>	National Institute of Standards and Technology
<b>NJDCA:</b>	New Jersey Department of Community Affairs
<b>NL:</b>	The Netherlands
<b>NPCC:</b>	New York City Panel on Climate Change
<b>NYC:</b>	New York City
<b>NYSE:</b>	New York Stock Exchange
<b>NYMR:</b>	New York Metropolitan Region
<b>PREA:</b>	Pension Real Estate Association
<b>REIT:</b>	Real Estate Investment Trust
<b>RPA:</b>	Regional Plan Association
<b>SIRR:</b>	Special Initiative for Resiliency and Recovery
<b>UNEP:</b>	United Nations Environment Programme
<b>USGBC:</b>	U.S. Green Building Council

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## 4. Supplemental Figures / Tables by Chapter

### Chapter III

Appendix Table 3.1: Summary Results of Individual Beliefs and 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 Interruption, 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	Flooding, Power Loss, Operations Interruption
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	Low	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



**Appendix Table 3.2: Individual and Organizational Learning Capacity**

<b>Firm-Actor</b>	<b>Education Background</b>	<b>Professional Membership</b>	<b>Literature Reviewed</b>	<b>Continuing Education &amp; Training</b>	<b>External Review</b>
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- Executive	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, Business Operations
L3- Risk-Management	Non-Technical	Yes, Industry	Yes, Industry	Yes	No
L3- Design & Engineering	Technical	Yes, Adaptation Related	Yes, Adaptation Related	Yes	Yes, Business Operations
L3- On-site	Technical	No	No	No	No
L3- Organization	N/A	Yes, Industry	N/A	Yes	Yes, Business Operations
S1- Executive	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
S3- Executive	Technical	Yes, Industry	Yes, Industry	No	No
S3- Asset Management	Non-Technical	No	Yes, Industry	No	No
S3- Risk-Management	N/A	N/A	N/A	N/A	N/A
S3- Design & Engineering	N/A	N/A	N/A	N/A	N/A
S3- On-site	Non-Technical	No	No	No	No
S3- Organization	N/A	Yes, Industry	N/A	No	No

**Appendix Table 3.3.1: Observed Large Firm Strategies**

Adaptation Measures	No Regret Strategy	Reversible / Flexible	Safety Margins	Soft Strategy	Reduced Decision Horizon	Positive Synergies with Mitigation & Sustainability
<b>Firm L1: Strategies</b>						
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		(-)			(-)	
<b>Firm L2: Strategies</b>						
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		(-)			(-)	
<b>Firm L3: Strategies</b>						
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 (+) = Option yields benefits if urban flooding, but not with inundations from climate change. (-) = Option yields loss without occurrence of climate change or flooding. [ ] = Selected Strategy Adapted from Hallegatte (2009)						

**Appendix Table 3.3.2: Observed Small Firm Strategies**

Adaptation Measures	No Regret Strategy	Reversible / Flexible	Safety Margins	Soft Strategy	Reduced Decision Horizon	Positive Synergies with Mitigation & Sustainability
<b>Firm S1: Strategies</b>						
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		(-)			(-)	
<b>Firm S2: Strategies</b>						
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		(-)			(-)	
<b>Firm S3: Strategies</b>						
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 (+) = Option yields benefits if urban flooding, but not with inundations from climate change. (-) = Option yields loss without occurrence of climate change or flooding. [ ] = Selected Strategy Adapted from Hallegatte (2009)						

## Chapter IV

### **SUPPLEMENTAL METHODOLOGY FOR INTERVIEW SELECTION AND PROCESS**

The selection process for internal interviews was based on an initial interview with the Global Head of CSRE and his senior staff who collectively identified a first round of potential interviewees. Upon review of the organizational hierarchy of the CSRE division and the firm, subsequent interviewees were identified for an initial round of interviews. Subsequent interviewees were selected based on their identification within initial rounds of interviews. On a few occasions, casual interaction with interviewees or employees not subject to a formal interview resulted in the identification of persons who either provided some data or submitted to a semi- or un-structured interview. No employee requested to speak “off-the-record” on a specific topic or in general. When the researcher deemed appropriate, interviewees were made aware of the fact that their response to questions were on-the-record. No interviewee requested to retract their statements. In some circumstances, the interviews were recorded with an audio device in addition to being memorialized by handwritten notes. No interviewees declined to be recorded. In terms of order, the initial and concluding rounds of interviews were with the most senior members of the CSRE. The intent was to identify policies and protocol which were an outcome of executive directives or were broadly applicable across CSRE or the firm. Specific to the latter, subsequent interviews with subordinates attempted to provide greater details as to the intent, application, execution and success or failure of these broader more general policies. In later stage interviews, the research propositions and the theoretical framework were recited to the interviewees and their interpretations were solicited. In some cases, this discussion led to the identity of either additional questions with known individuals or the identity of unknown individuals.

Prepared questions varied depending on the job title, expertise and level of engagement of each interviewee. However, basic questions were uniformly asked with regard to years of service, professional expertise, identification of various positions and projects undertaken within the firm, attributes of firm culture, personal knowledge (including the interpreted logics thereof) of the development of the firm wide CRE strategies and the development history of the GSHQ. In nearly all of the initial round of interviews, prepared questions were submitted to the interviewee prior to the interview. However, this was done as a courtesy to help prepare the interviewee and was not at the request of GS. Therefore, it should be noted that GS did not exercise any intent to shape, influence or edit any of the questions. No topics were deemed off limits; however, in rare cases, interviewees did highlight specific data points which were likely to be proprietary or subject to some legal obligation to maintain confidentiality or non-disclosure. Very often, spontaneously composed questions asked the interviewee to separate their interpretation of corporate reasoning from their personal reasoning and experience—and vice versa. In the event that an interviewee made reference to

a specific document or material data source that was not available at the time of the interview, these documents were collected and distributed via an online data management platform which the researcher was given access to.

All interviewees were questioned about their working knowledge of the meanings and applications of the concepts of resilience, adaptation and mitigation. Likewise, inquiries were specifically made about sustainability as a larger corporate mission and how that mission translated to everyday design, planning and development. In the event that the interviewee was able to communicate a working knowledge of these concepts, they were asked to provide concrete examples and to evaluate the success or failure of the outcomes, as well as to the extent to which successes or failures were attributed to be intentional or otherwise circumstantial. With few exceptions, only the most senior management and select professionals in facilities and engineering had consistent working definitions and applied frameworks for the concepts evaluated herein. The answers to these questions not only helped triangulate the veracity of the data collected but also provided valuable insight into the mechanics, processes, hierarchy and culture of the firm. As it was deemed important to understand intraorganizational communication and capacities, interviewees with specific expertise were questioned about practices outside of their organizational unit or area of professional practice. Likewise, they were asked to evaluate actual or hypothetical events from both their current or prior capacity and from the perspective of a unit or practitioner which they interacted with. In many cases, interviewees were able to reflect on their experiences outside of GS to draw comparisons under similar factual or hypothetical situations. The primary strategy behind these questions was to identify formal and informal policies, processes and protocols and to illicit candid and reflexive evaluation thereof based on actual experiences or substituted judgment.

Finally, as the conceptual framework and dependent propositions are dependent on being evaluated within the context of change, interviewees were asked to reflect on elements of change or moments of shock that took place during the course of the development of the CSRE strategy from 1999 to the present day. In particular, questions were framed which tried to understand the implications of these changes not just for CSRE but also for the firm at large. The intent of follow-up questions was to understand not only the firm's response but also the deliberations and reasoning behind these responses; the extent to which deliberate strategies became emergent strategies as a consequence of unanticipated external phenomenon; and, whether such responses were nuanced to the circumstances or were more generally still applicable within the context of what was deemed to be a more mature manifestation of the larger CSRE strategy at the time of the interview.

## Chapter V

**Appendix Table 5.1: Descriptive Statistics of Matching Concepts & Meanings/Applications**

<b>Concept (x-Axis) &amp; Meanings (y-Axis)</b>											
<b>Question #</b>	<b>Correct Answer</b>	<b>Coping</b>		<b>Mitigation</b>		<b>Resilience</b>		<b>Adaptation</b>		<b>Total</b>	
		(%)	(n)	(%)	(n)	(%)	(n)	(%)	(n)	(n)	MOE**
<b>9</b>	Coping	62%	79	19%	24	7%	9	12%	15	127	4.65%
	Mitigation	4%	5	53%	72	27%	36	16%	22	135	4.51%
	Resilience	36%	45	19%	24	25%	31	21%	26	126	4.67%
	Adaptation	4%	5	5%	7	38%	52	53%	73	137	4.48%
<b>Concept (x-Axis) &amp; Applications(y-Axis)</b>											
<b>15* (Flooding)</b>	Coping	50%	78	10%	15	17%	27	6%	9	129	4.62%
	Mitigation	15%	23	31%	48	26%	40	23%	36	147	4.30%
	Resilience	18%	28	25%	39	23%	35	31%	47	149	4.27%
	Adaptation	16%	25	20%	31	12%	18	47%	73	147	4.30%
<b>21* (Heat Wave)</b>	Coping	58%	77	12%	16	10%	13	12%	16	122	4.73%
	Mitigation	14%	18	35%	45	17%	22	29%	38	123	4.72%
	Resilience	39%	50	17%	22	11%	14	24%	31	117	4.81%
	Adaptation	6%	8	14%	19	38%	51	38%	51	129	4.62%
<b>28* (Post-Hurricane Sandy)</b>	Coping	65%	74	8%	9	8%	9	9%	10	102	5.05%
	Mitigation	11%	13	32%	37	26%	30	23%	26	106	4.99%
	Resilience	11%	13	22%	25	26%	30	37%	42	110	4.93%
	Adaptation	9%	10	9%	11	32%	38	45%	53	112	4.89%
<b>34* (Sea Level Rise)</b>	Coping	56%	62	12%	13	10%	11	15%	16	102	5.05%
	Mitigation	6%	6	24%	26	37%	40	31%	33	105	5.00%
	Resilience	36%	39	11%	12	25%	27	18%	20	98	5.11%
	Adaptation	6%	7	16%	18	27%	30	46%	51	106	4.99%
<b>Average (%) All Scenarios)</b>	Coping	64%	291	12%	53	13%	60	11%	51	455	4.86%
	Mitigation	12%	60	32%	156	27%	132	28%	133	481	4.75%
	Resilience	27%	130	21%	98	22%	106	30%	140	474	4.78%
	Adaptation	10%	50	16%	79	28%	137	46%	228	494	4.70%
<p>*Percentages do not add up to 100% because Respondents were randomly allowed to manually select an "other" category and input their own concept based on their own Application.  ** Based on a 95% confidence.  Note: p-values are uncorrected.</p>											

**Appendix Table 5.2: Early Stage Regional Planning Concept Framework**

	<b>Core Meaning</b>	<b>Practical Meaning</b>
<b>Mitigation</b>	Prevent Risk from Occurring in the Future	<b>Maintain:</b> the desire to maintain stability through preventing risks from occurring
		<b>Manage:</b> the need to manage immediate known risks
		<b>Marginal:</b> acknowledging that marginal risk is amplified across urban scales
		<b>Media:</b> the necessity to communicate risk across a variety of media to communities
		<b>Modified:</b> acknowledging that preventing one risk may come at the cost of overlooking another risk
<b>Resilience</b>	Maintain Operations of Status Quo	<b>Recover:</b> the ability of buildings, infrastructure and communities to recover from extreme events
		<b>Reduce:</b> the necessity to reduce vulnerabilities of people and places
		<b>Retain:</b> retaining water to live with the water
		<b>Resist:</b> building a material and social capacity to resist the negative impacts of change
		<b>Restore:</b> the desire to restore and preserve neighborhoods, communities and buildings
<b>Adaptation</b>	Maintain Flexibility to Accommodate Change through Transformability to Alternate Domains of Operations	<b>Accommodate:</b> the capacity to accommodate risks you aren't or can't be resilient to
		<b>Alternative:</b> changing how, where and what we consume from everything from energy to water
		<b>Analytical:</b> building intelligence to identify impacts from incremental changes in climate
		<b>Anticipate:</b> anticipate the need to be flexible as circumstances change
		<b>Ability:</b> the ability or capacity of everything from buildings to people to adapt

**Appendix Table 5.3: Survey Question & Scenario Matrix**

<b>Scenarios</b>	<b>Actor Orientation</b>	<b>Matching Concepts &amp; Meanings</b>	<b>Matching Concepts &amp; Applications</b>	<b>(a) Matching Applications &amp; Preferences (Likert)</b>	<b>(b) Matching Applications &amp; Preferences (Absolute)</b>
		Q. 9	X	X	X
Flooding	Mayor	X	Q. 15	Q. 10, 11,12,13	Q. 14
Heat Wave	Power Company	X	Q.21	Q. 16, 17, 18, 19	Q. 20
Post-Hurricane Sandy	First Person	X	Q.28	X	Q. 27
Sea Level Rise	Public Advisor	X	Q. 34	Q. 29, 30, 31, 32	Q. 33
Subsidence	Homeowner	X	X	X	Q. 35
Drought	Local Farmer	X	X	X	Q. 36

**Appendix Table 5.4: Professional Distribution of Sample**

	<i>Response Percent</i>	<i>Response Count</i>
Scientist	5.2%	12
Social Scientist	4.7%	11
Engineer	4.3%	10
Community Organizer	4.3%	10
Banker/Financier	2.1%	5
Insurer/Underwriter/Re-Insurer	0.4%	1
Real Estate	18.5%	43
Architect / Planner	40.3%	94
Policy Maker	3.4%	8
Public Health	0.4%	1
Lawyer	3.0%	7
Other	13.3%	31
<b>Total Respondents</b>		<b>233</b>

**Appendix Table 5.5: Matching Concepts (x-Axis) & Applications (y-Axis)**

***Flooding Scenario: Ability of Respondents to Distinguish Between Two Concepts***

<i>Percentage (%)</i>				
	<b>Coping</b>	<b>Mitigation</b>	<b>Resilience</b>	<b>Adaptation</b>
<b>Coping</b>		0.6521739	0.5925926	0.8666667
<b>Mitigation</b>	0.6521739		0.4102564	0.5238095
<b>Resilience</b>	0.5925926	0.4102564		0.4230769
<b>Adaptation</b>	0.8666667	0.5238095	0.4230769	
<i>p-value</i>				
	<b>Coping</b>	<b>Mitigation</b>	<b>Resilience</b>	<b>Adaptation</b>
<b>Coping</b>		0.1055	0.2207	0.004912
<b>Mitigation</b>	0.1055		0.8317	0.5
<b>Resilience</b>	0.2207	0.8317		0.7219
<b>Adaptation</b>	0.004912	0.5	0.7219	
Null Hypothesis, if p-value < 0.05				
Chi-test_p-value correction rate=0.5. a=0.05 (Bonferroni Correction)				
Margin of Error Based on 95% Confidence, 2.52%				



**Appendix Table 5.6: Matching Concepts (x-Axis) & Applications (y-Axis)**

**Heat Wave Scenario: Ability of Respondents to Distinguish Between Two Concepts**

<i>Percentage (%)</i>				
	<b>Coping</b>	<b>Mitigation</b>	<b>Resilience</b>	<b>Adaptation</b>
<b>Coping</b>		0.8571429	0.68	0.8571429
<b>Mitigation</b>	0.8571429		0.6071429	0.7777778
<b>Resilience</b>	0.68	0.6071429		0.25
<b>Adaptation</b>	0.8571429	0.7777778	0.25	

<i>p-value</i>				
	<b>Coping</b>	<b>Mitigation</b>	<b>Resilience</b>	<b>Adaptation</b>
<b>Coping</b>		0.1055	0.2207	0.004912
<b>Mitigation</b>	0.1055		0.8317	0.5
<b>Resilience</b>	0.2207	0.8317		0.7219
<b>Adaptation</b>	0.004912	0.5	0.7219	

Null Hypothesis, if p-value < 0.05  
 Chi-test\_p-value correction rate=0.5. a=0.05 (Bonferroni Correction)  
 Margin of Error Based on 95% Confidence, 3.05%

**Appendix Table 5.7: Matching Concepts (x-Axis) & Applications (y-Axis)**

**Post-Sandy Damage Scenario: Ability of Respondents to Distinguish Between Two Concepts**

<i>Percentage (%)</i>				
	<b>Coping</b>	<b>Mitigation</b>	<b>Resilience</b>	<b>Adaptation</b>
<b>Coping</b>		0.8095238	0.7894737	0.8
<b>Mitigation</b>	0.8095238		0.4285714	0.5833333
<b>Resilience</b>	0.7894737	0.4285714		0.5
<b>Adaptation</b>	0.8	0.5833333	0.5	

<i>p-value</i>				
	<b>Coping</b>	<b>Mitigation</b>	<b>Resilience</b>	<b>Adaptation</b>
<b>Coping</b>		0.004414	0.01089	0.01943
<b>Mitigation</b>	0.004414		0.7505	0.2701
<b>Resilience</b>	0.01089	0.7505		0.5
<b>Adaptation</b>	0.01943	0.2701	0.5	

Null Hypothesis, if p-value < 0.05  
 Chi-test\_p-value correction rate=0.5. a=0.05 (Bonferroni Correction)  
 Margin of Error Based on 95% Confidence, 3.44%

**Appendix Table 5.8: Matching Concepts (x-Axis) & Applications (y-Axis)**

**Sea Level Rise Scenario: Ability of Respondents to Distinguish Between Two Concepts**

<i>Percentage (%)</i>				
	<b>Coping</b>	<b>Mitigation</b>	<b>Resilience</b>	<b>Adaptation</b>
<b>Coping</b>		0.7857143	0.8571429	0.6923077
<b>Mitigation</b>	0.7857143		0.375	0.6
<b>Resilience</b>	0.8571429	0.375		0.4736842
<b>Adaptation</b>	0.6923077	0.6	0.4736842	

<i>p-value</i>				
	<b>Coping</b>	<b>Mitigation</b>	<b>Resilience</b>	<b>Adaptation</b>
<b>Coping</b>		0.03068	0.008078	0.1336
<b>Mitigation</b>	0.03068		0.892	0.3028
<b>Resilience</b>	0.008078	0.892		0.5
<b>Adaptation</b>	0.1336	0.3028	0.5	

Null Hypothesis, if p-value < 0.05  
 Chi-test\_p-value correction rate=0.5. a=0.05 (Bonferroni Correction)  
 Margin of Error Based on 95% Confidence, 3.57%

## 5. Curated Conferences, Symposia and Workshops



### CLIMATE CHANGE AND THE SCALES OF ENVIRONMENT

Conference  
 December 4, 2015  
 Columbia University  
 New York, NY.  
<http://events.gsapp.org/event/climate-change-and-the-scales-of-environment>



### HOUSING ADAPTATION

Symposium  
 October 13, 2015  
 STHLMNYC  
 New York, NY.  
<http://events.gsapp.org/event/cure-housing-housing-adaption>



### STHLMNYC: ADAPTIVE DESIGN + DEVELOPMENT

April 8-10, 2015  
 Stockholm, Sweden  
 RICK BELL / ANNA-ETINA BOKANDER / MARTIN EDEFELT  
 JESSE M. KERNAN / ROGER MOBERT / ELKE DIEN OUDEN  
 LINDA PETERSSON / ANETTE SCHEIBE LORENTZI  
 SANDER SCHUIJR / JEFFREY SHUMAKER / ERIK STENBERG  
 THOMAS STOLL / NIKLAS SVENSSON  
 STHLMNYC is a multi-disciplinary collaboration of designers, planners and public officials from New York City and Stockholm who regularly exchange knowledge and best practices in the field of climate adaptive design + development.

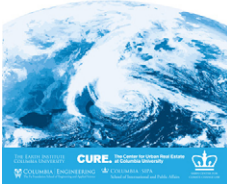
Conference  
 April 8-10, 2015  
 STHLMNYC  
 Stockholm, Sweden  
<http://events.gsapp.org/event/sthlmnyc-adaptive-design-development>

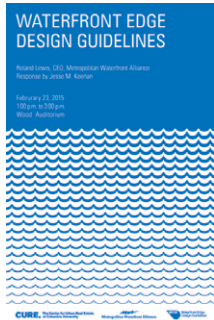


### EXTREME WEATHER & CLIMATE: HAZARDS, IMPACTS, ACTIONS

Extreme Weather and Climate:  
 Hazards, Impacts, Actions  
 ADAM BORN / RICHARD SANDER / GEORGE DEBORTIS / SARAH HENDON  
 ROBERT WILLIAMS / BEN TROTTIER / JOSEFIA CARABINO / VIVIANA RODRIGUEZ  
 TIM HALL / MARC VEY / JEFF SHANNAN / JESSE KEFANAN / SPRANDI LALL  
 MICHAEL TIPPETT / MICHAEL GERRARD  
 May 6, 2015, 8:30am - 5:00pm  
 Columbia University, Lerner Hall 555, New York, NY

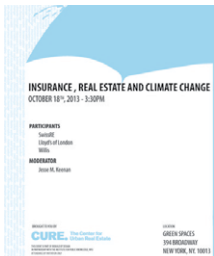
Symposium  
 May 6, 2015  
 Columbia University  
 New York, NY.  
<http://events.gsapp.org/event/extreme-weather-climate-hazards-impacts-actions>





**WATERFRONT EDGE DESIGN GUIDELINES**

Workshop  
 February 23, 2015  
 Columbia University & Metropolitan Waterfront Alliance  
 New York, NY.  
<http://events.gsapp.org/event/waterfront-edge-design-guidelines>



**INSURANCE, REAL ESTATE AND CLIMATE CHANGE**

Workshop  
 October 18, 2013  
 Rebuild By Design  
 New York, NY.  
<http://events.gsapp.org/event/insurance-real-estate-and-climate-change>



**H2O9 FORUM: WATER CHALLENGES FOR COASTAL CITIES**

Conference  
 September 9, 2013  
 Columbia University & Henry Hudson Foundation  
 New York, NY.  
<http://events.gsapp.org/event/ures-h209-forum>



**NYC+ ROTTERDAM CLIMATE ADAPTIVE DEVELOPMENT CONFERENCE**

Conference  
 July 4-5, 2013  
 Columbia University & RDM  
 Rotterdam, Netherlands  
<http://events.gsapp.org/event/cure-nyc-rotterdam-climate-adaptive-development-conference>



**SINK OR SWIM: PRINCIPLES AND PRIORITIES IN A POST-SANDY ERA**

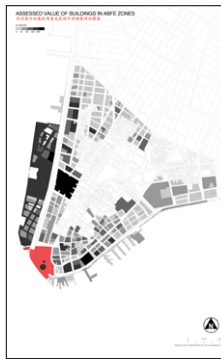
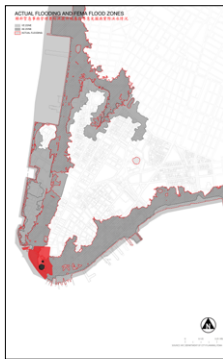
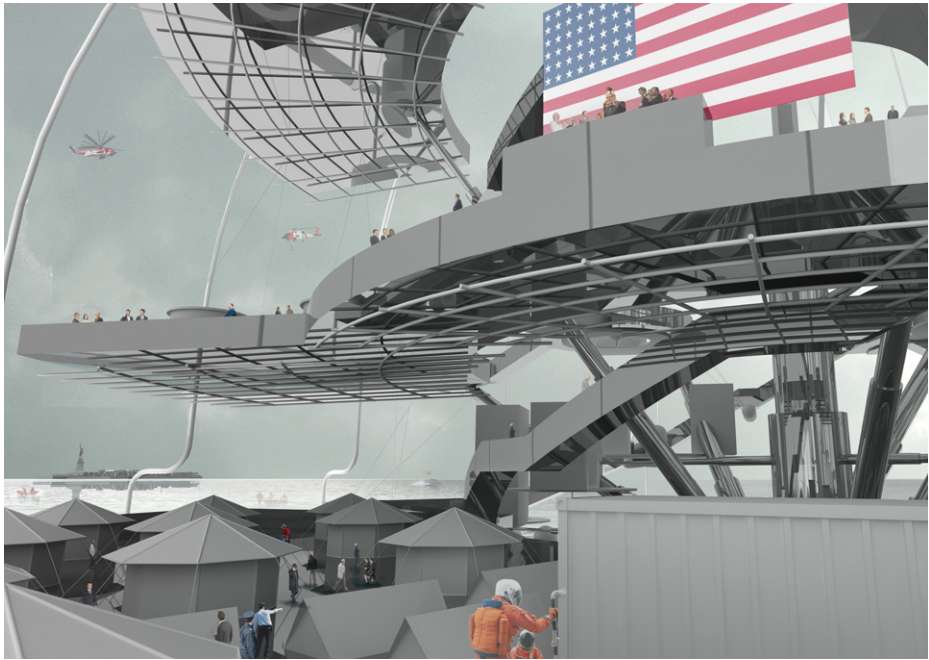
Conference  
 December 13, 2012  
 Columbia University & Municipal Art Society  
 New York, NY.  
<http://events.gsapp.org/event/sink-or-swim-sos-principles-and-priorities-in-a-post-sandy-era>

## 6. Hong Kong Biennale

As this dissertation highlights, awareness and communications are 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 New York Stock Exchange (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. While an unlikely adaptation, the risks are based on rigorous scientific estimation of a future potential reality.

<http://events.gsapp.org/event/archigram-on-the-margins>

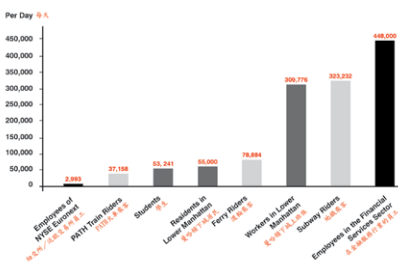
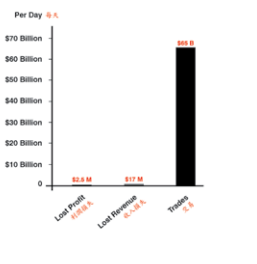
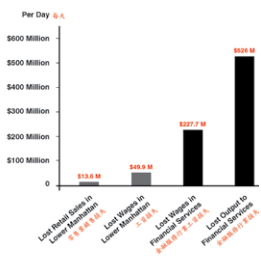




**How is Lower Manhattan Impacted? 曼哈顿下城受影响**

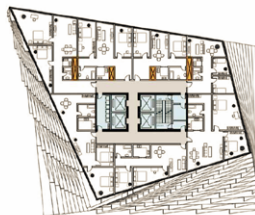
**What is the Impact for NYSE Euronext? 对纽约证券交易所的影响**

**Who in Lower Manhattan is Impacted? 曼哈顿下城谁受影响**

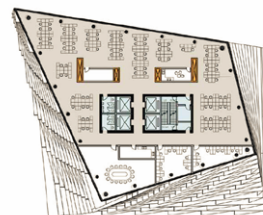


## 7. Adaptive Design + Development Research

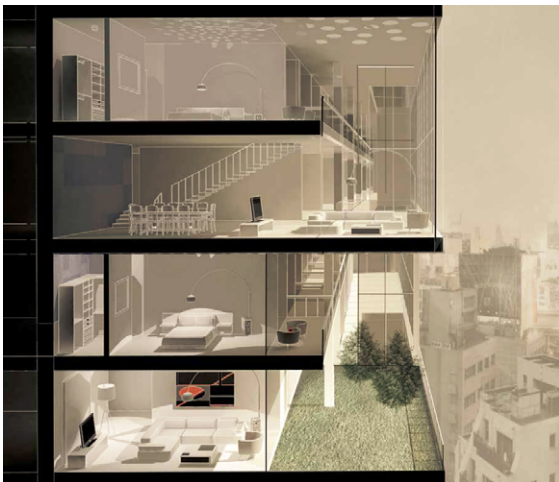
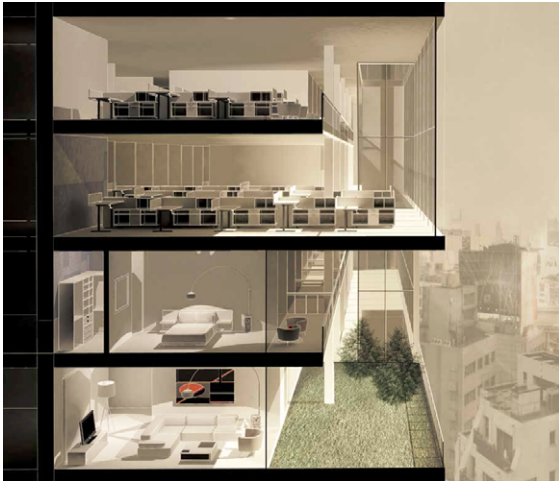
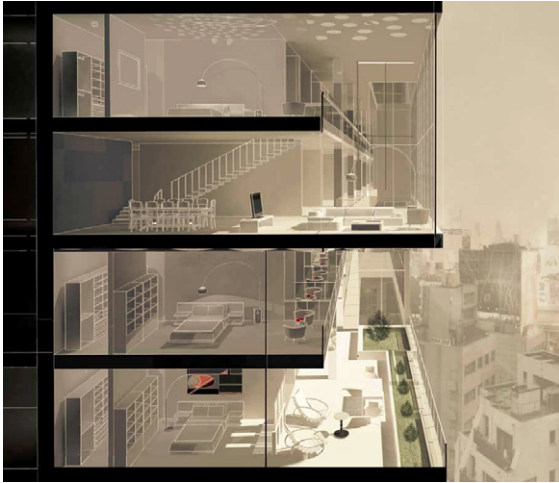
Beginning in 2012, the author formed a research team under the auspices of the Center for Urban Real Estate (CURE.) at Columbia University, in partnership with the Japanese real estate firm Hulic, Co., Ltd., to study the design and development of adaptive buildings. Given the tremendous anticipated change with an aging and declining population, real estate firms have begun to prepare long-term strategies to adapt. In macro-economic terms, the decline in productivity and economic output, together with a significant public debt burden, have been modeled to have a deleterious impact on commercial real estate demand in Japan. However, while most cities are shrinking in terms of population and economic productivity, Tokyo is growing and is projected to continue to grow in the future. The implications for this concentration of capital and an increase in population density are numerous. One of the principal findings of the empirical research is that residential product types will diversify as household composition and preferences diversify. Likewise, labor and corporate real estate trends suggest a long-term trend in favor of what are presently deemed alternative horizontal workplace models. With the need to accommodate new products and services in the real estate market, there is also several economic pressures on the performance of real estate assets themselves. First, given the illiquidity of the land markets and low rates of leveraged return, firms must amortize returns over longer periods. Longer return periods suggest a longer useful life for buildings that are additionally challenged by unprecedented long-term forecasts for labor and construction costs. The second external factor is the very high cost of energy and the increasing burden of longer periods of extremely hot and humid climactic conditions. Therefore, buildings will need to be able to be designed with the capacity to adapt to not only programmatic changes but also environmental conditions, as well. This research has developed analytical models that bridge multi-dimensional aspects of real estate analytics, architectural design and mechanical and structural engineering. In addition, significant organizational research has been undertaken to provide an optimal utilization of these models for decision making and execution. The outcome of this research is a prototype building to be constructed in Shibuya, Tokyo in 2017.



Multi-family Residential Rental  
Residential Condo



Office





# ABOUT THE AUTHOR

Jesse M. Keenan is the Research Director for the Center for Urban Real Estate (CURE.), Adjunct Professor of Real Estate Development at the Graduate School of Architecture, Planning and Preservation, and is affiliated faculty for Extreme Weather and Climate Change at Columbia University. Keenan has previously advised on matters concerning real estate and housing for agencies of the U.S. Government, 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's 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 conducts climate adaptation research with various cities around the globe including Amsterdam, Rotterdam, Tokyo, Miami, Stockholm, Rio de Janeiro and Sao Paulo. Keenan previously served as 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. Presently, Keenan serves on the Climate Change Working Group for the 4th Regional Plan for the tri-state New York metropolitan area and the Habitat Restoration Advisory Committee under the auspices of the Regional Plan Association. Keenan also serves as a climate change advisor to the national organization of the American Institute for Architects (AIA) and is co-chair for the 2016 North American Symposium on Climate Change Adaptation. Keenan has advised the Rebuild By Design and the National Disaster Resilience Competitions of the U.S. Government. Keenan serves as an Associate Editor of the International Journal of Climate Change Strategies and Management (Emerald) and as Vice-Chair of the Community Resilience Panel for Buildings and Infrastructure under the White House's Climate Action Plan supported by the National Institute of Standards and Technology (NIST).

Keenan's work bridging the art and science of the built environment includes contributions to exhibitions at the Museum of Modern Art, New York, Hong Kong Biennale, MAK (Austrian Museum of Applied Arts / Contemporary Art) 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; public resilience by the Rockefeller Foundation; adaptive capacity research with Goldman Sachs; adaptive building design research in Tokyo sponsored by

Hulic Co., Ltd.; international housing finance research sponsored by the Open Society Foundation; and, urban systems research in NYC for the Audi Urban Future Initiative.

Keenan is the co-author of "NYC 2040: Housing the Next One Million New Yorkers" (Columbia University Press) and is the co-editor of the forthcoming book, "Blue Dunes: Climate Change by Design" (Columbia University Press). Keenan has had works published by the Wharton Real Estate Review, the Cornell Real Estate Review, Projections: MIT Journal of Urban Planning, Building Research & Information, Journal of the American Planning Association, Journal of Water and Climate Change, Journal of Affordable Housing & Community Development Law, Journal of Environmental Policy & Planning, Enquiry: Journal of Architectural Research, Social Research: an International Quarterly, Harvard University, Journal of Southern Legal History, Pace Environmental Law Review, the American Bar Association, GSAPP Books, Columbia University Press, Cambridge University Press, MoMA.org, Reuters, John Wiley & Sons and has been cited as a housing and real estate authority by national and international media, including on-air on PBS, Reuters TV, Bloomberg TV and CNBC. Keenan serves on the Advisory Board of the Mori Foundation's Global City Power Index, on the Advisory Committee of the Design First initiative of The Municipal Art Society, on the Advisory Committee of Columbia University's Extreme Weather and Climate Change Initiative, as a juror for Architizer's A+ Awards 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 and began his research career working for the late Professor Charles Haar of Harvard Law School. Presently, Keenan serves as Of Counsel to the law firm Hinshaw & Culbertson, LLP and as principal of Keenan Climate Consulting. Keenan is a Fellow of the Forum + Institute for Urban Design and was previously a Pension Real Estate Association (PREA) Scholar. Keenan is a graduate of the University of Georgia (Bachelor of Arts, Political Science), Columbia University (Masters of Science, Real Estate Development), the University of Miami (Master of Law, Real Property Development Law) and Georgia State University (Doctorate of Law). Keenan was born in Albany, Georgia (U.S.A.) in 1979.

## SELECTED CLIMATE CHANGE AND EXTREME WEATHER PUBLICATIONS:

**Keenan, J.M.** & Weisz, C. (Eds.). (2016). *Blue Dunes: Climate Change By Design*. New York, NY.: GSAPP Books / Columbia University Press.

**Keenan, J.M.** (2016). Private Mainstreaming: Using Contract and Strategic Processes to Promote Organizational and Institutional Adaptation. *Projections: Journal of the MIT Department of Urban Studies and Planning*.

**Keenan, J.M.** (2015). Public Enabling of Adaptation of Private Real Estate in New York City. In Rosenzweig, C. & Solecki, W. (Eds.), *Climate Change and Cities*. Cambridge, UK.: Cambridge University Press.

Daamen, T. & **Keenan, J.M.** (2015). Rotterdam City Ports Case Study. In Rosenzweig, C. & Solecki, W. (Eds.), *Climate Change and Cities*. Cambridge, UK.: Cambridge University Press.

Weisz, C., Blumberg, A., & **Keenan, J.M.** (2015). Design Meets Science in a Changing Climate: A Case for Regional Thinking to Address Urban Coastal Resilience. *Social Research: An International Quarterly*, 82(3), 839-857.

**Keenan, J.M.** (2015). Real Estate and Property Rights. In Min Soo Chun, A & Brisson, I.E. (Eds.), *Ground Rules in Humanitarian Design* (pp. 59-70). New York, NY.: Wiley & Sons, Inc.

**Keenan, J.M.** (Ed.). (2014). *Southern Manhattan Coastal Protection Study: Evaluating the Feasibility of a Multi-Purpose Levee*. New York, NY.: New York City Economic Development Corporation

**Keenan, J.M.** (2014). Two Birds with One Stone: Adaptation and Economic Development. In Rowe, M. (Ed.), *New Ideas for New York's New Leadership* (pp. 50-54). New York, NY.: Municipal Arts Society.

**Keenan, J.M.** & Chakrabarti, V. (2013). *NYC 2040: Housing the New One Million New Yorkers*. New York, NY.: GSAPP Books / Columbia University Press.

**Keenan, J.M.** (2009). *A Survey of Issues Facing the Federal Coordination for the Housing and Redevelopment of the Gulf Coast, U.S.*, Joint Center for Housing Studies, W09-6. Cambridge, MA.: Harvard University.

**Keenan, J.M.** (2005). The Small Business Liability Relief and Brownfields Revitalization Act of 2002: Promoting A Multi-Jurisdictional Policy. *Pace Environmental Law Review*, 22(1), 39-51.

**Keenan, J.M.** (2003). Green Power Pricing Plans: A Real Power Alternative?. *National Association of Environmental Law Societies Reporter*, 14, 1-6.





With climate change well underway, cities worldwide are struggling to develop and apply knowledge that will help advance social, environmental and economic adaptation to extreme weather and changing ecologies. Nowhere is this need more pressing than in the design, development and management of the built environment in New York City. In particular, private sector actors are challenged with developing a capacity to adapt to both known and unknown manifestations of climate change in the future. This dissertation aims to contribute to a new conceptualization of the nature of adaptive capacity as it understood and applied across a variety of systematic scales, including the building, the real estate firm and the allied professionals operating within the built environment. This research sets the stage for designing and managing adaptive capacities that allow for the transformation of the real estate sector not just to accommodate climate change but also to address a variety of indirect consequences manifested from natural resource depletion, evolutionary markets and changing consumer demands.

