The Positive, Negative and Neutral Outcomes of Designed Adaptation in the Built Environment

Los Resultados Positivos, Negativos y Neutrales de la Adaptación Diseñada en el Entorno Construido

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Abstract

This article posits that design of climate adaptation interventions is co-aligned in process with the social diffusion of innovation. As such, innovation is fundamentally a differentiation to the status quo through trial-and-error that is designed to fail and circumvent, as much as it is designed to insulate and transform. Through cycles of creation and failure, social, financial and ecological capital are reorganized within an adaptive cycle—a process that simultaneously offers the promise of both a subjectively more equitable and more exploitive set of potential outcomes. Adaptation has long been regarded as neither good nor bad—it is merely a social process of learning and trade-offs from which some may benefit and others may bear the burden. This article challenges the rhetoric that resilience and adaptation activities universally yield positive outcomes for society and ecology. To the contrary, only in an optimal scenario would such activities yield a net positive result of a more equitable and just future. In some cases, designed adaptations may be failures for some and successes for others.

Keywords

Adaptation; Adaptive Capacity; Resilience; Innovation; Design; Climate Change.

Resumen

Este artículo postula que el diseño de intervenciones de adaptación climática está alineado en proceso con la difusión social de la innovación. Como tal, la innovación es fundamentalmente una diferenciación del status quo a través de prueba y error que está diseñada para fallar y eludir, tanto como está diseñada para aislar y transformar. Mediante ciclos de creación y fracaso, el capital social, financiero y ecológico se reorganiza dentro de un ciclo adaptativo, como un proceso que simultáneamente ofrece la promesa de un conjunto de resultados potenciales subjetivamente más equitativo y más explotador. Durante mucho tiempo, la adaptación no se ha considerado ni buena ni mala; es simplemente un proceso social de aprendizaje y compensaciones del que algunos pueden beneficiarse y otros pueden soportar la carga Este artículo cuestiona la retórica de que las actividades de resiliencia y adaptación producen universalmente resultados positivos para la sociedad y ecología. Por el contrario, solo en un escenario óptimo tales actividades producirían un resultado neto positivo de un futuro más equitativo y justo. En algunos casos, las adaptaciones diseñadas pueden ser fracasos para algunos y éxitos para otros.

Palabras clave

Adaptación; Capacidad de Adaptación; Resiliencia; Innovación; Diseño; Cambio Climático.

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Introduction

This article posits that design of climate adaptation interventions is co-aligned in process with the social diffusion of innovation. As such, innovation is fundamentally a differentiation to the status quo through trial-and-error that is designed to fail and circumvent, as much as it is designed to insulate and transform. Through cycles of creation and failure, social, financial and ecological capital are reorganized within an adaptive cycle—a process that simultaneously offers the promise of both a subjectively more equitable and a more exploitive set of potential outcomes.[1] To this end, adaptation has long been regarded as neither good nor bad—it is merely a social process of learning and trade-offs from which some may benefit and others may bear the burden.[2] This article challenges the rhetoric that resilience and adaptation activities universally yield positive outcomes for society and ecology. To that contrary, only in an optimal scenario would such activities yield a net positive result of a more equitable and just future. In some cases, designed adaptations may be failures (i.e., maladaptations) for some and successes for others. This potential phenomena is a fundamental axiom of climate justice in that maladaptive outcomes often disproportionately impact historically marginalized communities.[3] Understanding the positive, negative and neutral potential outcomes of adaptation and resilience interventions are central to a critical analysis of everything from the redesign of buildings and cities to the legislation of rules and institutions that seek to address environmental change and degradation.

By the very nature of their concentration of population, cities are highly vulnerable to physical climate change impacts, such as urban flooding and heat stress.[4] The literature on climate adaptation has largely focused on the mechanisms of public sector adaptation often to the exclusion of a broader range of stakeholders.[5] These urban governance activities can be viewed through the lens of two institutional approaches—(i) a 'dedicated' approach that casts the adaptations as positivist exercises, often within a neoliberal political domain (e.g., disaster capitalism); or, (ii) a 'mainstreaming' approach that casts the adaptations as urban metabolic processes.[6]

Much scholarly debate has focused on implementation—that is, how governance institutions can actually design and execute projects advanced in the name of resilience or adaptation. Until recently, research on design and implementation has had a strong focus on public sector activities that have uncritically failed to ask the questions: how, why and who bears the costs, consequences and benefits of adaptation activities?[7] Although a public sector focus is consistent with broader ambitions for advancing public safety and social welfare, the answers to these questions requires a critical engagement with a wide range of agents who collectively operate in a complex urban ecology. This article aims to open a dialogue on the nature of innovation and its positive, negative and neutral implications in the adaptation of the built environment. Through this analytical lens, such interventions can be critically evaluated in terms of their impact on socio-ecological agents and processes.

Innovation and Adaptation

Anthropocentric Bias in Socio-ecological Design

Given the chaotic complexity of urban ecology and the stochastic performance of engineered systems, how can cities ever be 'designed' to adapt (in a biological sense) to climate change? Adaptation interventions are not neutral and objective activities defined by science, rather they are patent and latent conduits of social values. It is social values that carry the weight of the diffusion of innovation.[8] As

1 Giacomo Fedele, et.al., "Limited use of transformative adaptation in response to social-ecological shifts driven by climate change", *Ecology and Society* 25, 1 (2020): Art. 25. doi:10.5751/ES-11381-250125

2 Susannah Fisher and David Dodman, "Urban climate change adaptation as social learning: Exploring the process and politics", *Environmental Policy and Governance* 29, 3 (2019): 235-247. doi: 10.1002/eet.1851

3 Kwame N. Owusu-Daaku, "(Mal) Adaptation opportunism: when other interests take overstated or intended climate change adaptation objectives (and their unintended effects)", *Local Environment* 23, 9 (2018): 934-951. doi:10.1080/13549839.2018.1505836

4 Kelly Maxwell, et.al., "Built Environment, Urban Systems, and Cities", in *Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment*, volume II (Washington, D.C.: U.S. Global Change Research Program, 2018). doi:10.7930/NCA4.2018.CH10

5 Anaj Wejs, et. al., "Legitimacy Building in Weak Institutional Settings: Climate Change Adaptation at Local Level in Denmark and Norway", *Environmental Politics* 23, 3 (2014): 490-508. doi: 10.1080/09644016.2013.854967; Caroline Uittenbroek, et. al., "Mainstreaming climate adaptation into urban planning: overcoming barriers, seizing opportunities and evaluating the results in two Dutch case studies", *Regional Environmental Change* 13, 2 (2014): 399-411. doi: 10.1007/s10113-012-0348-8

6 Hens Runhaar, et al., "Mainstreaming climate adaptation: taking stock about "what works" from empirical research worldwide", *Regional Environmental Change* 18, 4 (2018): 1201-1210. doi:10.1007/s10113-017-1259-5

7 Andrea Sarzynski, "Public participation, civic capacity, and climate change adaptation in cities", *Urban Climate* 14 (2015): 52-67. doi: 10.1016/j.uclim.2015.08.002

8 Ingolfur Blühdorn, "An offer one might prefer to refuse: The systems theoretical legacy of Niklas Luhmann", *European Journal of Social Theory* 3, 3 (2000): 339-354.

such, we define human systems as communication systems in the vein of Niklas Luhmann, in that they are distinct from their interaction with biological systems that are incapable of such communications.[9] In recognizing that all adaptation activities impose some measure of costs and utilization of capital, including natural capital, a designer's fundamental aim should be to minimize costs and maximize social and environmental benefits—a maxim of sustainability. Given the non-communication between human and ecological systems, this will always be a unidirectional extraction of natural capital no matter how "sustainable" the practices of design are.

Design within urban ecologies cannot fully account for trade-offs between social and environmental welfare because human and biological systems do not communicate with one another. *Therefore, design will almost always bias anthropogenic ends, and are often framed as "ecosystem services."* As a consequence, design tends to focus on 'value-added' innovations to off-set the social and environmental costs of adaptation itself—despite the fact that a complete off-set of environmental costs is dubious, given the anthropogenic bias. Yet, this does mean that one should not attempt such an accounting.

Designed adaptation is fundamentally an outcome of the diffusion of innovation—a uniquely human process of multilateral communication. A fundamental mechanism of innovation is experimentation. Experimentation and the complementary methodological processes of design are necessary to learn from the failures and barriers that thwart the diffusion of innovation. By extension, design experimentation may be examined and contextualized at multiple scales within a range of multi-scalar relationships, including human and environmental trade-offs within urban ecologies. However, if anthropocentric adaptation is a function of social communication, it must always be external to the adaptation of complex biological systems. Any designs or interventions that promise full socio-ecological integration may be well intended, but they are more likely an outcome associated with 'greenwashing.'

Value-Added Innovation as Motivation for Change

Innovation can be defined as "an idea, practice or object which is perceived as new by an individual or unit of adoption."[10] A multidisciplinary survey of the definition of innovation found over 60 different scholarly definitions, most of which implied new or improved products, services and processes.[11] Innovation is rarely more than differentiation through a process of trial and error, wherein one is just as likely to fail and create negative value than one is to succeed and create a new positive value (i.e., 'value-added'). Very often when people speak in popular terms of innovation, they are referencing value-added innovation without acknowledging that much innovation is destructive or regressive.

By extension, innovation can be simplified to a process of differentiation by which one is likely to fail many more times than they will succeed in creating a value-added benefit. This axiom often defines the parameters of iterative design. Although, it should be acknowledged that design may also formally involve the disciplined methods associated with experimentation and scientific inquiry. In that sense, design is not exclusively a reactionary process of differentiation. Design is both proactive and reactive to parameters both known and unknown. But, the design of adaptation can be argued to be largely a function of differentiation to an unsustainable status quo and is therefore more fundamentally at least as reactive as it is proactive.

Designed adaptation and innovation in the built environment may fall within two categories—engineered systems (e.g., buildings) and rules (e.g., institutions). Given climate change's widespread impacts, effective adaptation must address both

9 Lennart Olsson, et al., "Why resilience is unappealing to social science: Theoretical and empirical investigations of the scientific use of resilience", *Science Advances* 1, 4 (2015): e1400217. doi: 10.1126/sciadv.1400217.

10 Everett Rogers, *Diffusion of Innovations* (New York: Simon and Schuster, 2010).

11 Anihita Baregheh, et. al, "Towards a Multidisciplinary Definition of Innovation", *Management Decision* 47, 8 (2009): 1323-1339. DOI: 10.1108/00251740910984578

categories, as each are co-dependent. Whether one views institutions through the lens of 'rational choice institutionalism,' as rules of the game exogenously derived,[12] or 'sociological institutionalism,' as rules endogenously derived from the playing of the game,[13] the rules are in place to provide the stability of members of an institution through an efficiency derived from the minimization of transaction costs.[14] This stability function of institutions is analogous the reversionary performance of engineering and ecological resilience.[15]

When one changes the rules (i.e., differentiating innovation), there are transaction costs that may or may not be equally borne by the members of the institution—or by society as a whole. Unequal distribution of such costs may lead to inequitable and unjust outcomes, even though the innovative adaptation itself may advance the interests of most institutional members. Uncompensated private costs to change may prevent institutional members from advancing change—by extension, a small group of agents may limit adaptation that would have otherwise benefited a broader urban constituency. Value-added innovation may serve to offset these private costs and ease the transition for the collective internalization of change within the members of the institution of the now regularized or increasingly regularized transaction costs (e.g., increasing insurance costs associated with sea level rise and storm surge). This is built on the assumption that the members within the institution are seeking benefit maximization and are bound by some form of a paradox of collective rationality.

Therefore, the greater the value-add in the innovation—and the more distributed that benefit is—then the more likely it is that members will be motivated to change the rules or the play of the game because the additional value from innovation outweighs the transaction costs of a new adapted institutional exchange. An example of this relates to broader calls for increasing the performance standards associated with building codes. Uncompensated private costs in increased construction costs to homebuilders motivated the homebuilders to heavily lobby against the adaptation of building codes to include parameters associated with changing environmental ranges (e.g., larger gutters for increased rainfall events). These anti-adaptation preferences were only recently reversed in light of the value-added benefits of risk reduction associated with increased insurance coverage and reduced insurance premiums.

As previously noted, innovation can lead to failure in its execution and application and is in itself not an absolute good. Innovation is only the process mechanism by which value can be generated and diffused. Therefore, innovation is merely the mechanism by which one form of change is effectuated, and may lead to either or both adaptation and maladaptation. For example, consider the case of coastal geographies increasingly at risk from climate change. Buildings may be designed with any number of resilience innovations to withstand those impacts. But, those same engineered designs may be maladaptive in that they breed a false sense of confidence of the buildings' capacity to withstand sea level rise—a condition that undermines supporting infrastructure that is outside of the scope of engineering resilience designs at the building scale. For some short- to mid-term building owners and occupants, resilience design may be adaptive, for instances in areas not subject to future permanent inundation, but are otherwise subject to increased flood risks.

Yet, for others, such as long-term building owners and occupants, it may be maladaptive as frequently as it is adaptive. For instance, consider the design intervention of raising the elevation of house. This may offer short-term risk reduction, but the process of elevating the structure often reduces the material lifecycle of the house because of increased exposure to water and moisture from which the house

12 Kenneth Shepsle, "Rational Choice Institutionalism ", in *The Oxford Handbook of Political Institutions* (Oxford Handbooks Online, 2008). doi: 10.1093/oxfordhb/9780199548460.003.0002

13 Eric Brousseau, et. al., "Institutional Changes: Alternative Theories and Consequences for Institutional Design", *Journal of Economic Behavior & Organization* 79, 1 (2011): 3-19. doi: 10.1016/j.jebo.2011.01.024

14 Anthony Giddens, *The Constitution of Society: Outline of the Theory of Structuration* (Berkeley: University of California Press, 1984).

15 Julie Davidson, et al., "Interrogating resilience: toward a typology to improve its operationalization", *Ecology and Society* 21, 2 (2016): Art 27. doi:10.5751/ES-08450-210227

was not originally designed to withstand. Indeed, for low-income renters, new resilience-driven building codes may impose additional costs that disproportionately burden the costs of housing with little expected-value upside because they do not bear the benefits of risk reduction to the building assets that they do not own. In this case, designed adaptation and innovation in the corresponding institutions may be yield positive, negative and neutral outcomes depending on who bears the costs and burdens. Here, renters disproportionately bear the cost-burden, while owners yield most of the benefit. Over the long-run, however, renters may yield the benefits from reduced risks from uninsured losses to household contents, while building owners may bear the burden of a false confidence in economic devaluation associated with owning a building in an increasingly high-risk geography. This case highlights that adaptation and maladaptation may manifested to different parties over different time horizons. These scenarios and outcomes are almost always outside of the scope of the immediacy and unidimensional differentiation of reactive designed adaptation.

Diffusion and Experimentation

If adaptation and innovation are closely linked as social processes, then adaptation may well follow a similar pattern as the socialization and diffusion of innovative knowledge.[16] Zilberman, Zhao and Heiman (2012) argue that the processes of adaptation could follow the five stages first identified by Everett M. Roger in his now classic 1962 work, *Diffusion of Innovations* (2010).[17] The five stages of diffusion of innovation are knowledge, persuasion, decision, implementation and confirmation. These stages were drawn from thousands of empirical studies and have been shown to fit consistently within an 'S-Curve.' In this case, the S-Curve is a measure of how many members of a potential class adopt innovation at any given stage (e.g., early versus late adopters). By extension, adaptation may also follow a similar 'S-Curve.' As interpreted by Frederickson et al., in *The Adapted City* (2004), this S-Curve entails a series of eras of experimentation in which institutions design and test innovations through trial and error, in the same way that design is often iteratively experimental.[18] The ups and downs—the cycles of use and production—are common to both design and innovation.

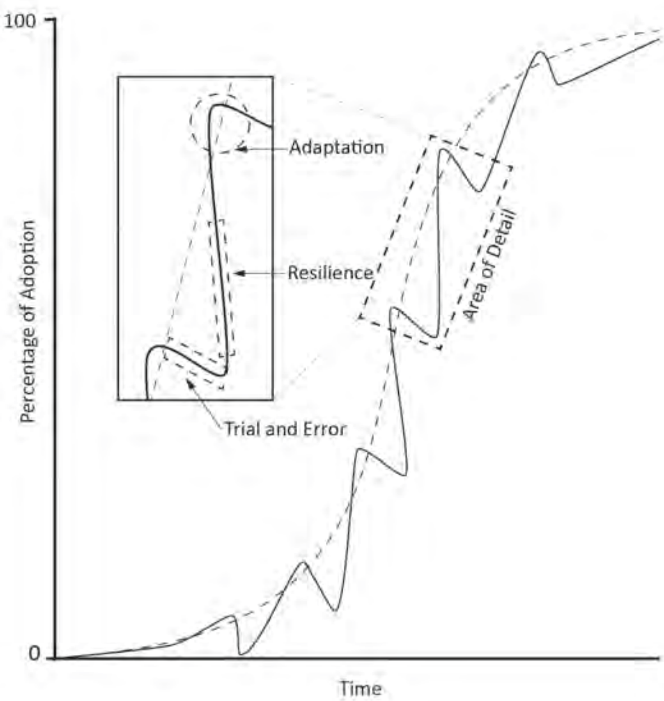
As represented in Figures 1 and 2, this is conceptually consistent with the process of adaptation relative to climate change. For a time, adaptation may lead to periods of stability, only to be followed by tumult. This alters the trajectory of adaptation, until a new innovation is developed (through emergent and cumulative learning and communication) and communicated, at which point another period of stability prevails. As such, adaptation and maladaptation can be conceptualized as processes along of trajectory of periodic moments of resilience, wherein stability (a relative anthropocentric concept) is periodically maintained in response to various shocks and stresses stemming from the economic, social and environmental impacts. As these responses to shocks and stresses are diffused through communication, a stage of resilience and stability is reached until such point as the shocks and stresses exceed the threshold of that particular state of resilience. In this sense, the trajectory is not necessarily as linear as is represented, but rather it is dynamic across multiple axes wherein the same intervention may have both progressive and regressive impacts depending on the intersubjective nature of the analysis.

People are biased to seek the status quo, but these brief periods of stability must be contextualized on a broader trajectory of either adaptation or maladaptation. This trajectory may vary significantly for any given object (e.g., building) or subject (e.g., institutional rules) of design intent. Of course, one never knows whether the sum of one's actions or intents may ultimately lead toward adaptation or maladaptation; only

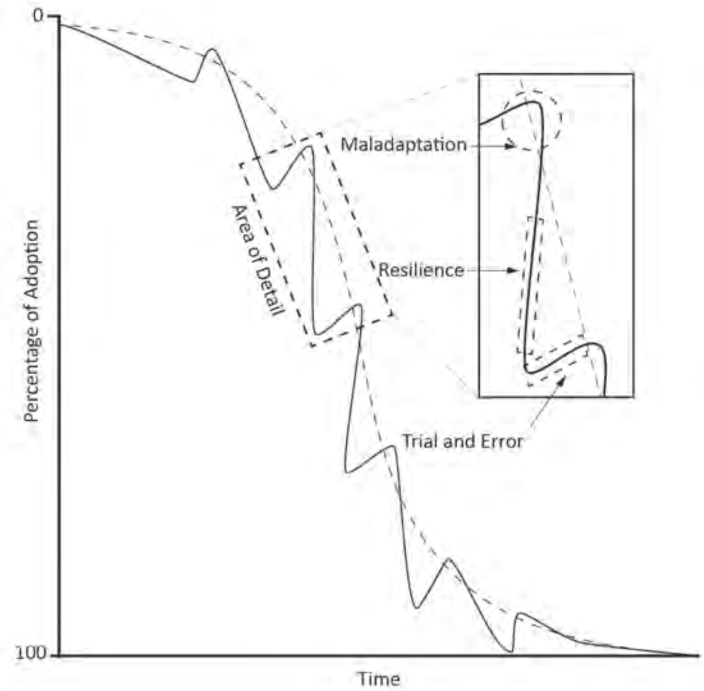
16 David Zilberman, et. al., "Adoption versus adaptation, with emphasis on climate change", *Annual Review of Resource Economics* 4, 1 (2012): 27-53. doi: 10.1146/annurev-resource-083110-115954

17 In the last year of Roger's life he co-wrote a posthumously published paper which drew the connection between is S-Curve for the diffusion of innovation and adaptation of complex systems. Everett Rogers, et al., "Complex Adaptive Systems and the Diffusion of Innovations", *The Innovation Journal: The Public Sector Innovation Journal* 10, 3 (2005): Art. 29. doi: 10.1.1.130.8047

18 George Frederickson, et. al., *The Adapted City* (Armonk, NY: ME Sharp, 2004).



[Fig. 1] Adaptation as Diffusion of Innovation. (Positive Net Value Innovation) Adapted from Rogers, 2010; Gersonius, 2012.



[Fig. 2] Maladaptation as Diffusion of Innovation. (Equal or Negative Net Value Innovtion) Adapted from Rogers, 2010; Gersonius, 2012.

history will determine that. Yet, this conceptualization is important to understand the impacts of one's actions in year zero. This is precisely how and why the idea of path dependency has been so widely utilized in the climate adaptation academies.[19] Although Figures 1 and 2 suggest continuity and linearity of change, empirical evidence and history suggest otherwise. Rather, the diffusion of innovation (good and bad) over time looks something like a composite of Everett's original—now famous—S-Curve.

One has to leave open the door that adaptive design may be good or bad depending on which people benefit from the change. Change may lead to adaptation for one actor and maladaptation to another, or some other inequitable distribution. For instance, the luxury real estate industry uses resilience as a marketing pitch. The buildings they design have the technology of engineering resilience, but the buildings are located in high-risk geographies that yield collective maladaptive outcomes for everyone else. Some have argued that this partitioning of resources with even the best intentions may lead to a type of climate gentrification as an outcome to resilience investments.[20] In sum, there is nothing necessarily equitable or efficient about adaptation or resilience; current evidence suggests that those who can afford such interventions are the ones who benefit the most. *Designers must resist the temptation that turn resilience into yet another amenity.*

Of course, the exact trajectory and curvature of the S-curve will vary. As the nature of innovation is fundamentally unpredictable, the wave dimensions and amplitudes shown in Figures 1 and 2 would vary accordingly. It could be argued that, if an institution creates efficiencies that promote maladaptation, then it accelerates change within its own life cycle toward decreasing the risk of failure. In other words, if institutions (or even buildings) are on a course of maladaptation, then failure may not necessarily be a bad thing, as it may cut losses and prevent further reliance on bad rules and behaviours. Thus, a maladaptive trajectory could, in theory, lead to adaptation—but the costs of failure and the benefits of the reorganization of capital in favour of resilience and stability may be inequitably distributed. For instance, there are examples of coastal communities throughout the U.S. wherein the public and private sectors have made investments into buildings and infrastructure that

19 Jon Barnett, et al., "From barriers to limits to climate change adaptation: path dependency and the speed of change", *Ecology and Society* 20, 3 (2015). doi: 10.5751/ES-07698-20030

20 Jesse M. Keenan, Thomas Hill, and Gumber, Anurag, "Climate gentrification: from theory to empiricism in Miami-Dade County, Florida", *Environmental Research Letters* 13, 5 (2018): 054001. doi: 10.1088/1748-9326/aabb32/meta

are located in areas that are rapidly disappearing because of coastal erosion and subsidence.[21] These investments have delayed difficult decisions and have stimulated a reliance by local populations that is largely maladaptive. In some cases, major storms have caused large-scale failure of these built environment systems and the decision has been made to manage a relocation.[22] This is an example where maladaptation may have a threshold—beyond which either failure or adaptation are the only alternatives.

For instance, managed retreat from the coasts may be adaptive for governments and holders of financial capital, but it may be maladaptive for low-income populations with limited resources to relocate. Alternately, there may be superior social outcomes for vulnerable populations who have been steered away from such high-risk geographies. Indeed, one could argue that the coastal real estate industry is on a broader trajectory of maladaptation. Yet, when this sector fails in the face of flooding and sea level rise, it will lead to transformations with winners and losers. The losers will be banks and homeowners. The winners will likely be renters who benefit from the void of resident homeowners and future homeowners who were steered to less risky geographies. Ultimately, short-term benefits that may accrue to renters will ultimately manifest in unmitigated long-term risks wherein all parties are losers.

Evaluating Designed Adaptation

The notion of trial and error is critical to this theoretical association with designed adaptation. Gersonius identifies both static and dynamic modes of assessing adaptation (2012)[23], as represented in modified form in Figure 3. One could argue that, if errors are made in a dynamic process, then the time lost is less than under the alternative circumstance (that is, an error made under static conditions) because there is flexibility and room to correct the mistake. Conversely, if errors are made in static environments, then it takes more time to correct because of a lack of relative flexibility from which to correct the error. Likewise, correcting the error may only bring the system or institution back to the predicate state and not an optimal one—assuming optimality is even possible (generally, it is not). Herein lies the challenge of stationarity in the design of systems and institutions. The goal is to design for the adaptive capacity to accommodate both knowns and unknowns.[24]

It can be argued that because of the long useful life of buildings, the application of Net Present Value ("NPV") investment calculations based on "average or worst-case scenarios" are static decisions that set the stage for greater costs of time and resources in the event of error and/or failure.[25] In this regard, the design of buildings, particularly in flood zones, often revolves around statistical estimates of chance that revert to the mean potential range of outcomes in the advance of economic 'efficiency.' Likewise, even though more sophisticated methods exist within engineering practices, they are subverted to the economic performance of real estate and infrastructure and the conservative practice conventions of design and construction. Therefore, the temporal notion of Frederickson et al.'s eras and epochs would be consistent with the inevitable trial-and-error process of resilience measures along some curve of either adaptation or maladaptation for real estate and infrastructure. In other words, the life-cycle of buildings may or may not benefit from the diffusion of innovation in a broader adaptive trajectory that would otherwise ensure the stability and safety of a building. The risk of failure is significant.

The challenge is to design the adaptive capacity of a building (or infrastructural system) to account for dynamic and not static future operational parameters. Dynamic experiments could be conceptualized, at scale, as being components and systems of buildings that can be changed at relatively lower material, social and

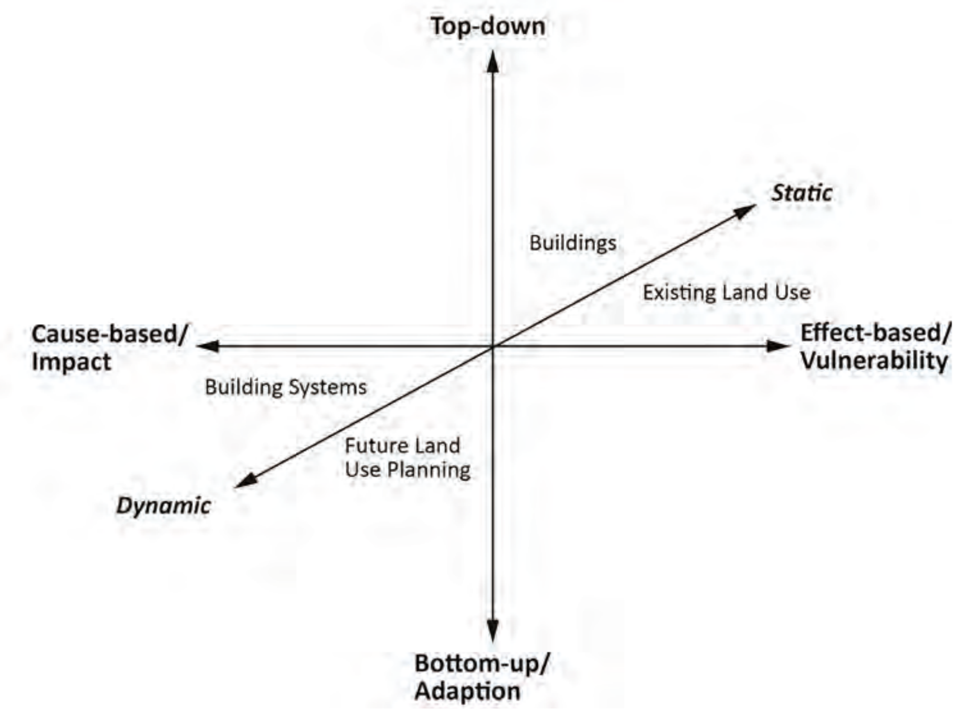
21 Katharine Mach, et al., "Managed retreat through voluntary buyouts of flood-prone properties", *Science Advances* 5, 10 (2019): eaax8995. doi: 10.1126/sciadv.aax8995

22 A. R. Siders, et. al., "The case for strategic and managed climate retreat", *Science* 365, 6455 (2019): 761-763. doi:10.1126/science.aax8346

23 Barry Gersonius, *The Resilience Approach to Climate Adaptation Applied for Flood Risk* (Rotterdam: CRC Press/Balkema, 2012).

24 Jesse M. Keenan, "Material and Social Construction: A Framework for the Adaptation of Buildings", *Enquiry: Journal of Architectural Research* 11, 1 (2014): 18-32. doi: 10.17831/enq:arcc.v11i1.271; Margaret Kurth, et al., "Defining Resilience for the Building Industry for the U.S.", *Building Research & Information* 47, 4 (2018): 480-492. doi: 10.1080/09613218.2018.145248

25 Barry Gersonius, *The Resilience Approach to Climate Adaptation Applied for Flood Risk*.



[Fig. 3] Evaluating Adaptation in the Built Environment. Source: Gersonius, 2012.

environmental costs than the alternative. In this case, innovation is synonymous with technology as envisioned by Rogers. Rogers defined a technology as a "design for instrumental action that reduces the uncertainty in the cause-effect relationship in achieving a desired outcome."[26] By definition, a technology then allows adaptation to move from static to dynamic as certainty in cause-effect reduces risk and creates more room for variable measures. As global efforts for the research, development and production of building system technologies are advanced and the economics of scale reduce unit costs, then overall institutional adaptation is advanced by virtue of accelerated pace of trial and error. It could also be argued that these lower costs to experimentation would increase positive robustness of the adaptation in terms of diversity and depth of experience in an evolutionary context. This may increase not only the pace of the long-term trajectory of change, but also the likelihood that the change is adaptive and not maladaptive.[27]

The practice of architecture and real estate is not simply about the design, construction and operations of buildings. It is also about the siting of those buildings across scales of time and space within larger socio-economic and physical parameters and cultural ethics. This is representative of the problem of scale endemic in the analysis of climate change and the notion of deliberate and systematic responsive planning thereto.[28] Because of the long useful life of infrastructure supported land, the implications for error should be contextualized within the rate of change associated with eras and epochs over multiple generations—this is the time scale of cities.

At least that was the old way of thinking about it. Climate change impacts—combined with ecological degradation—significantly challenge the time horizons of the fixity of land. If the fixity of land was at the origins of the bias to disregard the future, design practice can no longer look away. Critical analysis supporting the adaptation (and adaptive capacity) of buildings and infrastructure should include a broader set of variables in an ecosystem that includes people and the environment. While this makes things infinitely more complex in the consequences of failure, there is little alternative in light of a very dire assessment of the future the built environment in the face of climate change. While human design agency can never fully account for environmental trade-offs, the design ethos and utilize professional ethics to internalize these trade-offs in recognition of what it means to define the success or failure of any given innovation.

26 Everett Rogers, et al., "Complex Adaptive Systems and the Diffusion of Innovations".

27 Orion Lewis, and Sven Steinmo, "How Institutions Evolve: Evolutionary Theory and Institutional Change", *Polity* 44, 3 (2012): 314-339. doi: 10.1057/pol.2012.1

28 Neil Adger, et. al., "Successful Adaptation to Climate Change Across Scales", *Global Environmental Change* 15, 2 (2005): 77-86. DOI: 10.1016/j.gloenvcha.2004.12.005

Conclusion

This paper takes the position that adaptation and innovation are co-aligned in the diffusion of social innovation through social learning and communication. Innovation pushes forward as a process of differentiation, while adaptation—like design—may be both reactionary differentiation and proactive experimentation. The risk of failure and maladaptation is always on the horizon for both innovation and adaptation, respectively. Design has always been the exercise from which differentiation in culture and technology has advanced both human progress and environmental extraction. Examples of regenerative design (at-scale) are limited. As such, adaptation and resilience designs do not represent absolute goods. They are processes on a continuum of communication exchange that diffuses innovation—the good and the bad. They manifest in both successes and failures. The challenges for designers and the broader institutions of industry that support the production of the built environment is that time scales and economic interests are misaligned.

This is an old story; what's new is that climate change imposes new parameters and conditions on the design of rules, institutions and ultimately buildings, which in turn produces new horizons for getting it right or wrong. Stationarity in buildings and institutions is out. Dynamic performance that internalizes failure is in. The challenge is that as one internalizes more variables and responsibilities in adaptation, there is a greater risk of failure. The upside of failure is the opportunity to learn and to accelerate that learning in the translation of more distributively equitable ideas that benefit society and ecology.

In this sense, designers of buildings and institutions must embrace the possibility of failure, but they must do so with a critical reflection on who bears that burden of getting it wrong. The challenge ahead is to evaluate ostensibly adaptive and resilient interventions that are all too often agents of disaster capitalism. Such a critical appraisal must recognize the subjective nature of the outcomes—positive, negative, and neutral—and the likelihood that the affected parties will include both winners and losers. With these considerations in mind, these concepts may advance the design of interventions that advance collective measures of social and environmental welfare.

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