LINCOLN INSTITUTE
OF LAND POLICY

Willingness to Pay for Climate Adaptation: International Case Studies on Private Developers' Preparedness to Contribute to Urban Climate Adaptation

Working Paper WP23EK1

Erwin van der Krabben
Radboud University

Alexander Lord
University of Liverpool

James H. Spencer
Louisiana State University

Stephen Buckman
Clemson University

August 2023

Abstract

There is increasing global awareness that, despite efforts to reduce greenhouse gas emissions, adaptation to climate change is necessary. Additional stresses related to climate change, including rises in sea level, river flooding, urban heat islands, and extreme rainfall and drought, present an emerging challenge for public urban infrastructure. Local governments are required to facilitate additional investments in climate-proof public infrastructure strategies, such as permeable pavements, separation of storm water and sewage, strategic application of greenspace and trees, water storage and retention, and improved draining and grading plans. In times of fiscal stress, however, any new infrastructural investment poses a substantial financial challenge for municipalities. Though there is quite some evidence of the positive impact of climate change adaptation on property values, which undoubtedly benefits real estate developers' business cases, not much is known yet about real estate developers' willingness to contribute to these public infrastructure investments. This study aims to fill that gap, by a comparative case study of three cities that are, through their location in coastal zones, vulnerable to climate risk and in need of climate adaptation measures, respectively the contiguous cities of Charleston, North Charleston, and Mount Pleasant (South Carolina, Unites States), the Liverpool City Region (United Kingdom) and the City of Rotterdam (the Netherlands). The case studies analyze both the current role of land value capture (LVC) and real estate developer contributions in inclusive urban climate adaptation strategies, and the prospective role LVC may play, if favorable conditions for developers to contribute can be established.

About the Authors

Professor Erwin van der Krabben is Professor of Planning and Property Development at Radboud University in the Netherlands. His research interests include land management policies, land value capture, and the financing of public infrastructure.

Radboud University
Postbus 9108
6500 HK Nijmegen
The Netherlands

Tel: +31 24 3611254
erwin.vanderkrabben@ru.nl

Professor Alexander Lord is Lever Chair in Urban Planning at the University of Liverpool's School of Environmental Science. His research interests relate primarily to real estate development and land value capture.

The Roxby Building
University of Liverpool
Liverpool
UK
L69 7ZQ

Tel: +44 151 794 3110
mailto:a.d.lord@liverpool.ac.uk

Professor James H. Spencer is Vice Provost and Dean of the Graduate School at Louisiana State University. He also serves as Professor of Urban & Regional Planning and as an Adjunct Senior Fellow at the East West Center. His scholarship focuses on international urbanization and planning issues, with a particular focus on water supplies, infrastructure, and inequality.

Louisiana State University
LSU Graduate School
119 West David Boyd Hall
Baton Rouge
Louisiana, United States

Tel: +1 225-578-3885
jhs@lsu.edu

Professor Stephen Buckman is Associate Professor at the University of Clemson's College of Architecture, Art and Construction. His work centers on the confluence of resiliency in economic and real estate development. He is particularly interested in issues of equity and built form.

Clemson University
College of Architecture, Art and Construction
1 North Main Street
Greenville, SC 29601

Tel: +1 864-656-2874
stbuckm@clemson.edu

Acknowledgements

We would like to thank the research participants who made themselves available to support the small program of semi-structured interviews conducted as part of this research. We would also like to place on record our thanks to the staff of the Lincoln Institute for their support.

Table of Contents

Chapter 1. Introduction **1**

Research questions 2

Chapter 2. Policy context: Urban Climate Adaptation Finance **4**

Climate risks and the costs and benefits of urban adaptation 4

Climate adaptation finance 5

Chapter 3. The relationship between climate and land value **8**

What determines land values? 8

What role should land value capture play in financing climate adaptation? 9

Private developers' willingness to contribute 11

Corporate social responsibility 11

Land value capture tools 14

Chapter 4. Case studies **18**

Case study selection 18

Case study design and data collection 18

Land value capture and private real estate development – The case of the Charleston, SC Lowcountry region 19

Willingness to pay for climate adaptation – Evidence from the Liverpool City Region 32

Rotterdam's climate adaptation strategy – Private developers' readiness to contribute 40

Chapter 5. Discussion and lessons learned **51**

Sense of urgency 51

What drives private developers? 51

What role can land-based finance play in funding climate adaptation measures? 52

What can go wrong? Risks of market-based finance 52

Are the LVC instruments fit for purpose? 52

"Free money in land". But how much exactly? 53

Chapter 6. Conclusions **54**

Willingness to Pay for Climate Adaptation:

International Case Studies on Private Developers' Preparedness to Contribute to Urban Climate Adaptation

Chapter 1. Introduction

There is an urgent need to change the way we plan and construct our cities in the changing climate, claims a recent report by the European Environment Agency (EEA, 2019). There is increasing global awareness that, despite efforts to reduce greenhouse gas emissions, adaptation to climate change is necessary. Additional stresses related to climate change, including rises in sea level, coastal and river flooding, urban heat islands, and extreme rainfall and drought, present an emerging challenge for public urban infrastructure (Root, Van der Krabben & Spit, 2015a). Local governments are required to facilitate additional investments in climate-proof public infrastructure strategies, for example, to mitigate possible flooding or deluge incidents (Root et al., 2015b; Bobylev et al., 2013). In times of fiscal stress, however, any new infrastructural investment poses a substantial financial challenge for municipalities. In Europe, insufficient financial resources are consistently mentioned as the key barrier to urban climate adaptation by local authorities (EEA, 2019). While many cities have begun enacting policies and programs to build resilience towards climate hazards, there are numerous barriers to financing urban adaptation activities, and little is known about how and where finance for those activities is flowing (Alliance, 2021).

As one of the potential financing methods for climate-proof urban infrastructure investments, land-based financing is often proposed as a potentially attractive source of funding. In a recent viewpoint, Dunning and Lord (2020) posit that cities need to rediscover financial models that direct land use to prepare for climate change. However, though there is increasing evidence of the relation between climate change adaptation and land and property values (Kiel, 2021), little is known about the actual use of land-based finance for urban climate adaptation investments. So far, only a few studies have analyzed how land-based finance can provide additional funding for climate change resilience. Notable exceptions include Hartmann & Spit (2014); Root et al. (2015a, b; 2016); Keskitalo et al. (2016); Bisaro & Hinkel (2018); and Storbjörk et al. (2019). The amount and impact of land-based finance available for climate adaptation can possibly be increased by an integrated climate adaptation and urban planning approach, by extending the "land value capture toolbox" available to local governments and by optimizing the use of land-based finance as a leverage to attract private or public finance for climate adaptation investments. However, little is known yet about the position of the real estate development industry and their ability and willingness to contribute to climate adaptation investments, via any kind of developer contribution to climate-proof public infrastructure. While in most countries real estate developers might see contributions to public infrastructure as "business as usual", this might not be the case yet for additional climate investments, for instance because these are considered as public responsibility or because there is still uncertainty about their benefits from these investments (in terms of increased housing prices). It is to be expected that considerations

about the financial viability of their projects play a major role in this (increased costs of climate-proof public infrastructure strategies versus potential higher income from selling their newly-built properties). However, other considerations, including *corporate social responsibility* (CSR), may play a role as well. Local governments, when considering land-based finance as a funding source, may have to make a trade-off between using land-based finance for climate adaptation and alternative societal goals, including affordable housing and public transport. A better understanding of real estate developers' willingness to pay (WTP) is particularly relevant, since in most jurisdictions land value capture (LVC) - in the form of a developer contribution - is to a larger or lesser extent *negotiable* (Muñoz-Gielen & Van der Krabben, 2019).

To support the claim that LVC can play a role in financing urban climate adaptation investments, additional research is needed to identify how land values are changing in light of climate change, how urban climate adaptation measures may cause an uplift of land and property values, and how land-based finance can better support cities at risk. Though there is quite some evidence of the positive impact of climate change adaptation on property values, which undoubtedly benefits real estate developers' business cases, not much is known yet about real estate developers' willingness to contribute to these public infrastructure investments. This study aims to fill that gap, by a comparative case study of three cities that are, through their location in coastal zones, vulnerable to climate risk and in need of climate adaptation measures, respectively Rotterdam (the Netherlands), the contiguous cities of Charleston, North Charleston, and Mount Pleasant (South Carolina, Unites States), and the Liverpool City Region (United Kingdom). We analyze how land-based finance is currently used as a funding source for urban climate adaptation, to what extent, and under which conditions developer contributions to public climate adaptation investments can be negotiated. Additionally, we aim to contribute effective *negotiable* and/or *non-negotiable* land-based finance mechanisms for urban climate adaptation investments to the local government LVC toolbox.

Our broader goal in this study is to analyze and explore how cities that are vulnerable to climate risk and aim for climate adaptation measures can unlock the potential of land-based finance for the (co-)funding of climate-proof public infrastructures. Within this context, we aim to understand how real estate developers and investors decide on contributing to the costs of climate-proof public infrastructures and what would be favorable conditions for them to contribute. By doing this, we hope to provide evidence and best practices of effective LVC mechanisms for this purpose, that may have potential in other cities as well.

Research questions

1) What is the current role of LVC and developer contributions in inclusive urban climate adaptation strategies, in South Carolina, England and the Netherlands?
2) Under which conditions would private developers be willing to contribute to inclusive urban climate adaptation strategies?
3) What would be effective *negotiable* or *non-negotiable* land-based finance mechanisms to fund particular investments in urban climate adaptation?

We conduct a comparative, international study of LVC for climate adaptation in three cities / city regions, in three different countries, Rotterdam (the Netherlands), the contiguous cities of

Charleston, North Charleston, and Mount Pleasant (South Carolina, Unites States), and the Liverpool City Region (United Kingdom). This helps to understand how planning culture, the use of particular LVC instruments, real estate valuation practices, market volatility, climate change awareness, and the role of CSR in the real estate industry, next to the particular aspects of individual business cases, affects how much real estate developers and investors are willing to contribute to climate-proof urban infrastructures.

Chapter 2. Policy context: Urban Climate Adaptation Finance

Climate risks and the costs and benefits of urban adaptation

Climate change is a global phenomenon and its mitigation through reduced greenhouse gas emissions requires a global effort. The impacts of the changing climate, however, are more localized and require urgent action at a local scale (EEA, 2019). Key climate risks for cities include temperature change, precipitation change, sea level rise, flooding and inundation, ecosystem change, and disasters and extreme risk events (figure 2.1). Urban climate adaptation policies should aim at mitigating these climate risks for cities. Climate adaptation can take place at different levels: 1) (inter)national; 2) water system level; 3) city or neighborhood level; 4) location level (public spaces); and 5) property or plot level.

(Inter)national climate adaptation measures particularly concern investments in water safety and the prevention of flooding due to sea level rise or river basin flash floods at either national or international scale.

Water system climate adaptation measures particularly concern investments in the prevention of both flooding and drought at regional level in relation to a river basin or a system of rivers (e.g., Colorado river in the US; Delta program in the Netherlands).

City or neighborhood climate adaptation measures may involve investments in different types of off-site green and blue infrastructures (e.g., sea walls, water retention areas) that can be expected to have an (indirect) impact on climate safety of various real estate development projects.

Location level climate adaptation measures is about on-site investments in climate-proof public infrastructures, such as permeable pavements, separation of storm water and sewage, strategic application of green space and trees, water storage and retention, and improved draining and grading plans that have direct impact on climate safety of particular development projects.

Property or plot level climate adaptation measures, finally, refer to investments at the building level, like green roofs, water retention in private gardens, and alternative building design.

Figure 2.1: A Selection of Key Climate Impacts and Potential Risks for Cities

IMPACT	DESCRIPTION OF IMPACT	POTENTIAL URBAN RISKS
Temperature change	Temperatures are rising in cities around the world. Mean annual temperatures in cities around the world are projected to increase by 0.7 to 1.5°C by the 2020s, 1.3 to 3.0°C by the 2050s, and 1.7 to 4.9°C by the 2080s.	In the short term, above-normal temperatures lead to heat waves (which exacerbate urban heat island effects) and below-normal temperatures lead to cold waves in cities. Poorly constructed shelters are at risk from heat stress, which can be compounded by indoor air pollution, scarcity of drinking water, increased prevalence of diseases, etc. In the long term, the combination of rapid urbanization, climate change, and population growth will increase stress on energy systems. Warming will intensify demand for cooling, which will pose threats to urban energy supply.
Precipitation change	Mean annual precipitation in cities around the world is projected to change by -7% to +10% by the 2020s, -9% to +15% by the 2050s, and -11% to +21% by the 2080s.	Increasing potential for urban flooding and inundation, particularly for coastal and low-lying cities. Some cities will also experience more severe droughts.
Sea level rise	Climate change and sea level rise will exacerbate hazards such as storm surges, erosion, and saltwater intrusion. Sea level in coastal cities is projected to rise 4 to 19 cm by the 2020s, 15 to 60 cm by the 2050s, and 22 to 124 cm by the 2080s.	In the long term, coastal cities, urban aquifers, the built environment, transportation, and marine ecosystems will be severely affected.
Flooding and inundation	Flooding and inundation will exert additional pressure on existing urban water systems due to competition and demand for limited water resources. This will lead to negative impacts in health, economy, and environment.	Varies by location, depending on water stress. Large volumes of storm water runoff, rising sea level, changes in surface water and groundwater. For example, farmers in the urban periphery, housing in low-lying areas, and populations with little or no access to piped water will suffer most. Urban dwellers without tenure security, migrants, informal dwellers in risk-prone areas will also be affected.
Ecosystem change	Climate change and urbanization are likely to increase the vulnerability of biodiversity hotspots, urban species, and critical ecosystem services.	Ecosystem degradation can lead to the loss of biodiversity, open space, or green infrastructure that may serve as barriers to extreme climate risks. Clean air and water are also necessary for healthy cities. Nature-based solutions can present opportunities for green economies, social equity, and better health and quality of life.
Disasters and extreme risk events	Climate change will increase the risks of morbidity, mortality, and mental illness in urban areas due to greater frequency of weather extremes. Climate-related disasters will disrupt movement of people and goods and have economy-wide impacts. Extreme impacts will also destroy existing physical infrastructure, such as melting asphalt and buckling railway tracks.	Extreme events will pose both short- and long-term risks to children, the elderly, the sick, and the poor disproportionately. Some chronic disabilities and health conditions (e.g. respiratory and heat-related illnesses) will be exacerbated by climate change. The experience of extreme impacts also induces mental stress and trauma. Interdependencies between transportation and other economic, social, and environmental sectors can lead to citywide impacts.

Source: Chu et al., 2019

Climate adaptation finance

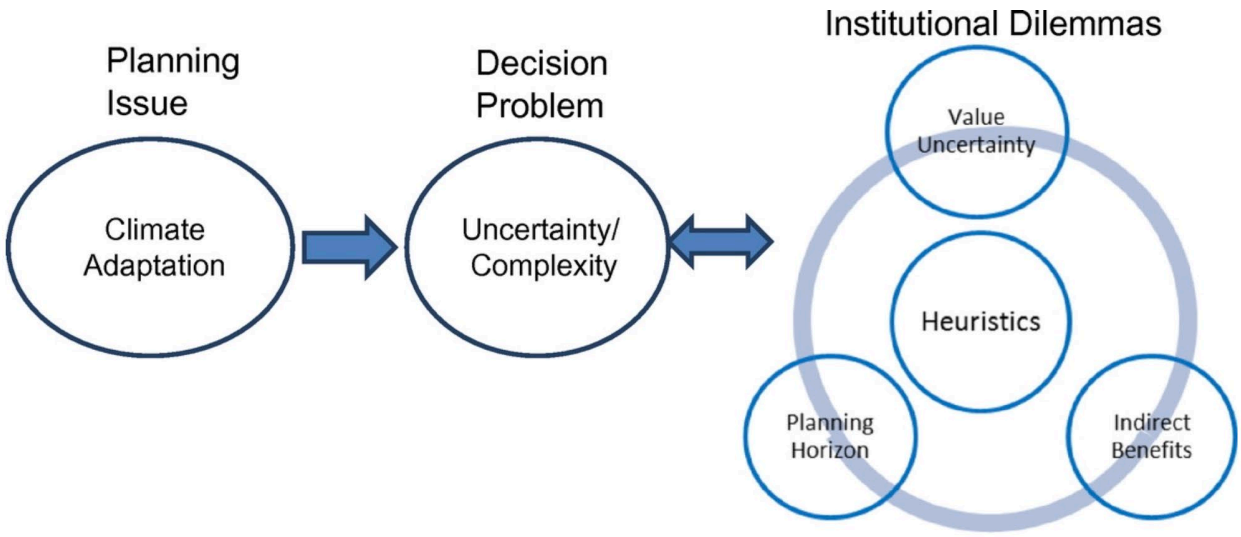
To adapt cities to climate risks, the World Bank estimates that between USD 11 and 20 billion will be needed by 2050 on an annual basis to protect global urban infrastructure from climate risks. The Cities Climate Finance Leadership Alliance (Alliance, 2021) finds, however, that globally less than USD 4 billion was invested annually in 2017-2018 in urban adaptation finance projects. Urban adaptation finance can be defined as ‘resources directed to activities aiming to address climate-related risks faced by cities thereby contributing to urban resilience’ (Alliance, 2021, p. 6). According to the Cities Climate Finance Leadership Alliance, financial flows qualify as urban adaptation finance when the activity financed targets an urban climate risk and 1) affects the city and urban communities directly and/or 2) occurs within the city boundary.

While adaptation policies require huge (public) investments, financial benefits – apart from obvious societal impact – most likely occur as well. Successful adaptation investments, including blue and green infrastructures, investments that prevent (parts of) cities from flooding, and 'climate-proof' buildings can result in higher property values and (related) higher land values. Moreover, smart investments in climate-proof public infrastructure may lead to a structural reduction of public infrastructure-related costs, both in terms of investments (e.g., reduced sewage system costs), reduced maintenance costs of public infrastructures, and prevented damage costs. Land-based finance particularly can play a role in capturing part of these financial benefits that may occur, at least in two different ways. First, effective LVC strategies can generate income for cities to invest in climate adaptation. Second, income from LVC strategies for cities can act as a leverage to negotiate more attractive private or public loans for funding of future urban climate adaptation investments. We assume that land-based finance of urban climate adaptation can be particularly relevant with regard to investments at city or neighborhood level, location level, and property or plot level.

Institutional dilemmas: clustering uncertainty and reducing complexity

Uncertainty about the speed in which climate change takes place, the size of climate impact and potential risks at local scale, and the effect of urban climate adaptation investment adds to the complexity of decision-making processes regarding investing in climate-adaptive public infrastructures. Narratives can reduce the problem of complexity by clustering knowledge and positions, which function as heuristics (Matthews, 2013). Gigerenzer and Gaissmaier (2011) define heuristics as: 'a strategy that ignores part of the information, with the goal of making decisions more quickly, frugally, and/or accurately than more complex methods' (p. 454). Root et al. (2016) argue that 'in that sense, clustering knowledge into bite-sized pieces functions as a heuristic to simplify multifaceted problems and to act as shortcuts for organizational decision-making' (p. 252). So, how do policymakers and practitioners make sense of the complexity associated with climate adaptation? What 'short-cuts' and rationales do they use to overcome complex problems? Root et al. identify three institutional dilemmas for local governments when trying to make decisions about climate adaptation investments: value uncertainty, planning horizon problems, and indirect benefits. Figure 2.2 conceptually illustrates how investments in climate adaptation 'connects' three spheres: 1) climate adaptation as a planning issue; (2) uncertainty and complexity as a decision problem; and 3) the decisions problems bundled into thematic clusters of institutional dilemmas. First, decision-making may be further complicated by uncertainty regarding the lack of agreement about how current generations value climate adaptation, let alone future generations. A second dilemma to adapting to climate change is that the planning horizon is substantially out-of-sync with conventional planning approaches. A third dilemma for adaptation investments is the degree to which clear benefits can be established and whether these benefits are direct (benefiting for instance property owners or private developers' business cases) or indirect (including positive long-term impact for society).

Figure 2.2: Institutional dilemmas in planning for climate change: value uncertainty, planning horizon, and indirect benefits



Source: Root et al., 2016

Chapter 3. The relationship between climate and land value

The uplift in land values resulting from the award of planning consent constitutes the 'unearned increment'. This value, attributable solely to the statutory permission to develop, in turn provides the fundamental case for LVC. In many contexts the use of diverse LVC mechanisms to recover this value traditionally provides funding for a host of public goods – infrastructure, greenspace, schools and medical facilities, affordable housing - while increasingly new types of public goods are funded with land values as well, including climate adaptation measures, clean energy investments, cultural heritage projects, and urban transformation investments. But how much value exists in a site is a function of the specific development for which consent has been given, and without a clearly codified understanding of the expected costs and potential profits to the developer, the maximum sum available to be captured remains the great unknown.

What determines land values?

What determines land values? Lord et al. (2022) state that from the classical economists, Malthus, Riccardo, Mill, and James, we inherit the insight that the answer to this question depends upon what the land is used to produce, but that in the modern era the interactions of planning policies, urban design, market forces, and both statutory and private investment this question is a great deal more complex than it might superficially seem. Over decades, academic investigation has made significant progress in addressing some aspects of the question particularly regarding the built environment, that asset class that depends on land for its production. Particularly, hedonic models provided insights into the attributes of dwellings that confer value and the neighborhood effects of amenities such as public parks and greenspace. Indeed, many climate adaptation studies make use of hedonic modeling techniques (see Kiel, 2021 for an overview). However, whilst there is a clear logic to understanding the value of land in relation to its productive capacity there are three main challenges to this approach (as explained more extensively in Lord et al., 2022).[1] Firstly, the economic value of land is not solely determined by the hypothetical nature of the various developments that it might accommodate. Next to *endogenous* influences, *exogenous* influences that exist independently also have a bearing upon the value of proposed development and ultimately, therefore, on the value of the land itself. Climate risks are one example of such exogenous influences. Secondly, property markets are volatile. Any assessment of land values provides only an instant snapshot of the market at a particular moment in time. But property development is a slow business. Land and property investments that had been considered profitable at the start of the project may no longer be considered economically viable later in the development process. And thirdly, in any context where the built environment is delivered by a private development industry under the incentive of a profit motive the issue of commercial confidentiality means that the economic costs and revenues of development are rarely transparent. Without this information it becomes difficult to arrive at even a rudimentary calculation whereby the costs of development subtracted

[1] These challenges relate to the institutional dilemmas for climate adaptation investments discussed in Chapter 2.

from the expected proceeds reveal the value of the land itself and, crucially, the right to develop it.

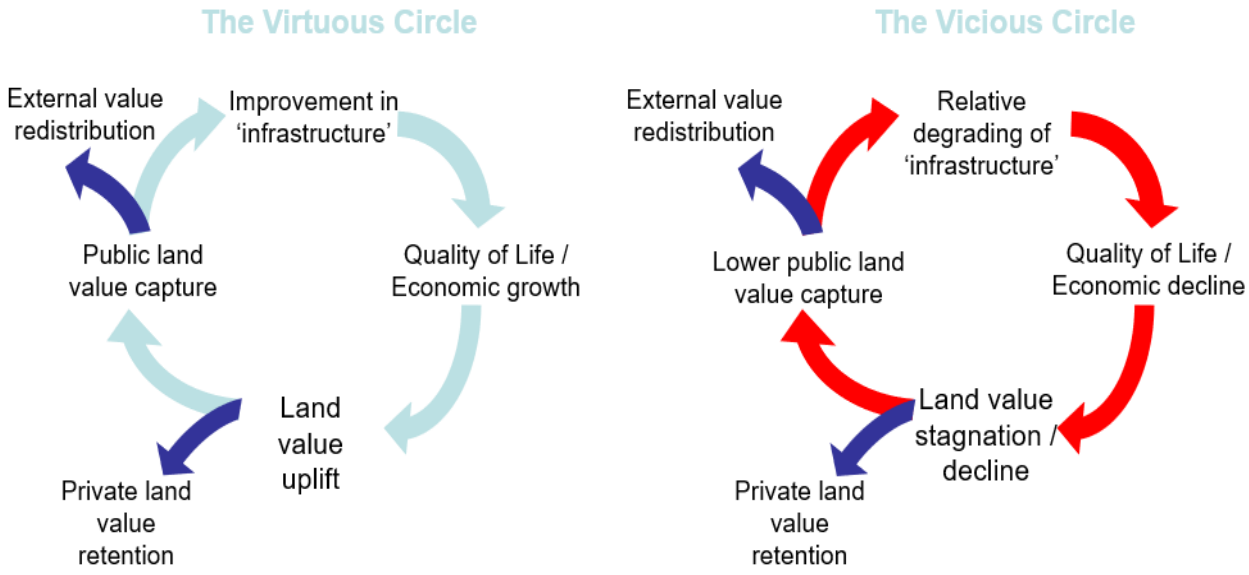
In this study we seek to address these three inter-related problems of understanding the value of land that has been made available for development. Next to hedonic studies of climate change and climate adaptation impact on real estate value, a better understanding is needed of how much of the uplift in land values caused by climate adaptation investment is captured by local governments and how private developers make decisions when negotiating a developer contribution to climate adaptation (and other public amenities) in their development projects.

What role should land value capture play in financing climate adaptation?

Studies that link climate change with land and property values can be divided into studies that have analyzed the negative impact of climate risks on land and property values and studies that have looked at the positive impact of climate adaptation investments on land and property values. Nicholls (2019) provides a review of the hedonic pricing literature on the negative impact of climate risk. Kiel (2021) reviews recent studies that have analyzed the positive impact of climate change adaptation on residential property values.

While these studies can play an important role in informing policy makers about the increment land values that may result from public investments in climate adaptation, additional information is still required to define how much land value can be captured from the 'developing landowner' in a specific case. Theoretically, it can be argued that the long-term development viability of a development project depends critically on the starting point. If at the start of the project the viability is above the critical level, a 'virtuous circle' may appear, with economic growth leading to land value uplift, public land value capture, and additional investments in 'infrastructure', which may then be repeated over time. In contrast, if at the start of the project the viability is below the critical level, a 'vicious circle' may appear, with economic decline leading to land value stagnation, lower public land value capture, and relative degrading of 'infrastructure', which may then be repeated over time (figure 3.1).

Figure 3.1: Virtuous and vicious development cycles



Source: Lord et al., 2019

These 'circles' suggest a strong path dependency in the built environment and, alongside, in developer contributions to all kinds of public amenities. From a planning perspective, it would be interesting to know whether local planning policies can challenge path dependence in built environment and help to change a 'vicious circle' into a 'virtuous circle'. As one of few studies we are aware of, University of Reading et al. (2014) and Lord et al. (2019) have presented empirical evidence of the amount of developer contributions in England. By combining survey data on developer contributions with qualitative data (based on interviews) on negotiation practices, Lord et al. provide insight in the behavioral features of the process by which developer contributions were established: delay in the process by which planning consent was agreed, an increased propensity amongst developers for re-negotiation following agreement, and generally bargaining developer contributions downwards through 'the viability charade'. These features begin to elucidate some behavioral insights into the inner workings of the process and the impact of planning policy on these circles.

Lord et al. (2022), in another Lincoln Institute Working Paper, have presented evidence based on case studies in China of how much increment land value can be generated potentially, if cities decide to invest in clean air: improving air quality has a positive impact on property values, and increased property values will lead to higher land values. While China's cities have the advantage that they own all development land and will be able to "cash" the air quality premium on land value by leasing out developing land against higher prices, in most other countries' cities the air quality premium or a similar premium that is the result of public investments in climate-adaptive public infrastructures will go to the private landowners. It depends on the effectiveness of available land value capture instruments and – as we will argue below – the willingness of private developers / landowners to contribute - to what extent cities are able to capture (part of) that premium to "shape" optimal conditions for a virtuous value cycle.

In the context of this proposal, we are particularly interested in the extent to which 'planning' has been able to challenge some aspects of this path dependence. For instance, have cities started to spend developer contributions to climate-adaptive public infrastructures, at the expense of traditional infrastructure or affordable housing, and what are possible behavioral explanations for these changes (if any)?

Private developers' willingness to contribute

The "willingness to pay" concept indicates that public goods are not direct objects of utility but rather derivatives of their attributes and characteristics from which utility is derived (Lancaster, 1966; McIntosh et al., 2014). The willingness to pay for such goods is influenced by the utility that it gives. This means that parties are willing to contribute as long as their perceived utility exceeds current utility (McIntosh et al., 2014). The concept assumes that actors make a rational choice when deciding to contribute to the costs of public goods.

To understand developers' willingness to contribute to climate adaptive public infrastructures, it is useful to start with the logic employed by the development industry in their computation of 'development viability' (Crosby, 2019; McAllister, 2019) - the business case for real estate development in the first place. The most commonly employed approach by the development industry in virtually all international contexts is the "residual method" which effectively seeks to separate the costs of development from its hypothetical proceeds in order to leave a residual balance which reflects the value of the land required for the development to take place. However, this approach is wholly *endogenous* – the value of the development is understood purely in its own terms - without any adjustment for *exogenous* factors, attributes external to the development itself that may influence its value. Climate change is precisely one of these exogenous factors.

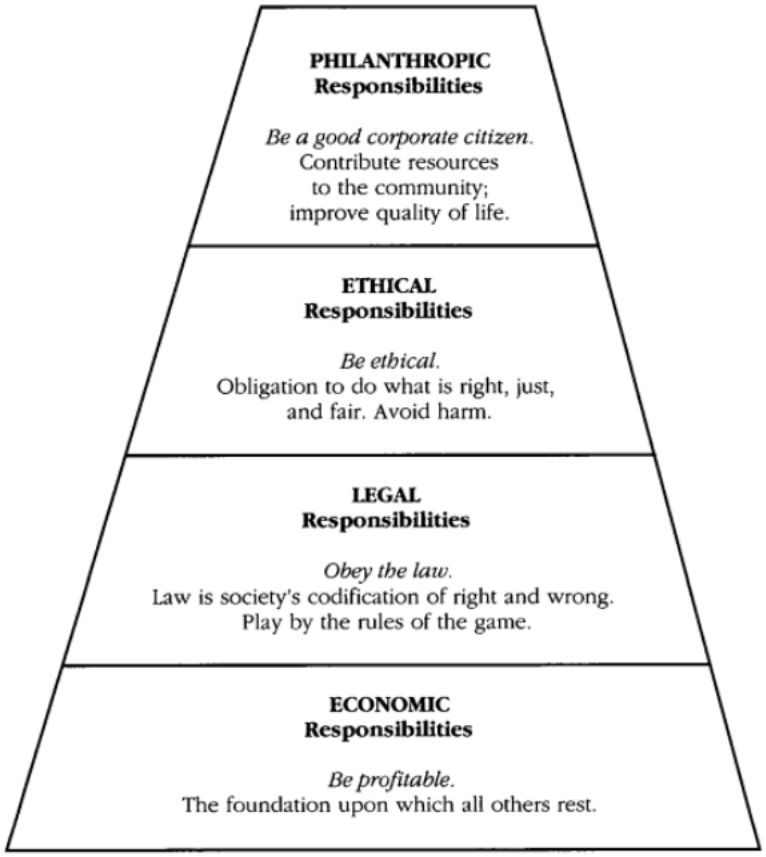
As we have argued above, at present, private developers and local governments may have some information on the impact of climate change, on how investments in climate adaptive public infrastructures may potentially reduce that impact, and on how that may affect land and property values, but that information is likely to be incomplete. What we can derive from the willingness to pay literature is that this will influence private developers' decisions to contribute voluntarily to climate adaptive public infrastructures. Koppenjan & Enserink (2009) argue that in such situations the responsible government bodies can influence private developers' willingness to contribute by 1) creating prospects for return on investment (public infrastructure should generate positive cash flows); 2) managing scope and externalities (combining climate investments with profitable real estate development); 3) managing risk perceptions of private parties (by offering financial guarantees with regard to operation and currency risks, granting tax exemptions, providing soft loans, formulating supportive regulations); and 4) reducing political uncertainty (by offering a clear legal institutional framework, by reducing the number of government organizations involved). In this study, we aim to explore whether such conditions might influence private developers' willingness to contribute to climate-adaptive public infrastructures.

Corporate social responsibility

Many economists, however, question the rational assumption behind the willingness-to-pay concept. Behavioral economics, that is about the psychology behind the economy, looks behind the motivations of firms and individuals, why certain choices are made and not always the "best" choice, from a rational perspective. What we are particularly interested in here is whether private developers include some kind of corporate social responsibility (CSR) for mitigating and adapting to climate change into their decisions to contribute (voluntarily) to climate adaptive public infrastructures. CSR has been defined as "policies and operating practices that enhance the competitiveness of a company while simultaneously advancing the economic and social conditions in the communities in which it operates. Shared value creation focuses on identifying and expanding the connections between societal and economic progress" (Porter and Kramer 2011, p. 2). According to these authors, CSR may be taken as a holistic framework based on social responsibility principles that integrates the concepts of sustainability, shared value, and the notion that corporations reframe their mission to do what is best for the common good. Carroll (1991) distinguishes four types of responsibilities companies may consider with respect to their impact on society, environment, and economy (figure 3.2):

- Economic responsibilities (required)
- Legal responsibilities (demanded)
- Ethical responsibilities (expected)
- Philanthropic responsibilities (desired)

Figure 3.2: The Pyramid of Corporate Social Responsibility



Source: Carroll, 1991

What we aim for in this study is to understand better the business economics of the development industry, how they calculate the maximum amount of money they want to contribute to climate adaptation investments, and to what extent they take CSR regarding climate change into account in their investment decisions. We hypothesize that they will at least take the following into consideration:

- Business case: value of the development purely understood in its own terms;
- Real estate valuation practices: user value versus exchange (investor) value;
- Possible impact of climate change, as an exogenous factor, on their business case; depends on risk assessment (change; impact);
- Market volatility and possible impact on their business case;
- Institutional context for LVC: LVC regulation and practices (negotiable versus non-negotiable);
- Institutional context for climate adaptation: who is responsible (state or individual);

Climate change concern: Corporate Social Responsibility; trust in other stakeholders' cooperation; Land value capture tools

The land value capture literature usually distinguishes macro-level instruments, direct LVC instruments, and indirect LVC instruments (Alterman, 2012; Muñoz-Gielen & Van der Krabben, 2019) (figure 3.3). Broadly speaking, land value capture instruments are based on two rationales: a direct and an indirect rationale (Alterman, 2012). Direct instruments (including property tax, betterment tax, and land value added tax) endeavor to capture value increases on the basis of the rationale that land value increases belong to the public, but not the developers or landowners (Alterman, 2012). To make them effective, they often need explicit and rigorous legislative support. For that reason, they are also referred to as non-negotiable developer obligations (N-NDOs). The indirect rationale assumes that developers or landowners should internalize the impacts from their land or real estate development (Muñoz-Gielen & Van der Krabben, 2019). Compared with direct instruments, indirect instruments are more local and pragmatic and are usually not regulated in legislation. Consequently, the amount of land value that can be captured is often negotiable and they are referred to as negotiable developer obligations (NDOs). Macro-level instruments, including mainly strategic land management, public land leasing, and land readjustment, concern a third category of land value capture instruments. The particular land management model enables local governments to capture the difference between the costs of developing the land and the profits of selling the building land. Some of these macro-level instruments are based on legislation and thus non-negotiable (particularly land readjustment models and public land leasing in countries where land is state-owned), while other land management models are based on common practices in a particular country (like the public land management model in the Netherlands).

Figure 3.3: Types of LVC instruments

Source: IHS, 2021, adapted from OECD/LILP, 2020 and Alterman, 2012

This categorization in three types of LVC instruments is useful with regard to a discussion of potential land-based finance instruments or strategies for urban climate adaptation as well. However, land-based finance for urban climate adaptation may not only concern capturing (part of the) increment value of land and property that is due to investments in climate-adaptive public infrastructures but may also concern a structural reduction of maintenance costs or contributions by insurance companies (based on prevented climate damage). Based on Deloitte (2020) and our own research, we have identified ten different types of (potential) land-based finance instruments / strategies (table 3.1). Additionally, table 3.1 links these instruments to both the level of climate adaptation investments and the potential adaptation impact, the financial impact, in terms of both benefits and costs, and an indication of the potential amount of land-based finance that can be 'earned' with applying the instrument/strategy.

Table 3.1: Selection of land-based finance instruments for climate adaptation

Type of financial instrument	How it works	Relation with climate risks	Level of climate adaptation impact	Expected financial impact	Expected impact for developers / home owners
1. *Public land development*	Municipality acquires land, services the land and sells building plots to developers. (Part of the) net income from buying and selling used for 'climate-proof' financing green and blue infrastructures.	Heavy rainfall, urban heat islands, biodiversity loss.	Green and blue infrastructures can contribute to local water storage, mitigate urban heat island impacts, and increase biodiversity.	Positive: higher property prices; higher residual land values, as a result of higher housing prices; Negative: reduction of net land available for housing, higher public infrastructure costs.	Developers expected to pay premium on building plots; Reduced funding for other public amenities (if additional costs exceed additional income plot sales).
2. *Urban Land Readjustment (ULR)*	ULR assembles and reparcels land by possible swapping of land positions among landowners (no transactions involved), so that part of the land will go to the public sector and can be used for green and blue infrastructures.	Heavy rainfall, urban heat islands, biodiversity loss.	Green and blue infrastructures can contribute to local water storage, mitigate urban heat island impacts, and increase biodiversity.	Positive: higher property prices; higher development value for landowners; Negative: reduction of net land available for housing, higher public infrastructure costs.	Landowners share both extra costs and extra development value.
3. *Tax Increment Financing (TIF)*	Designed to earmark related increment of property tax in a proclaimed area, premised on the idea that provision of 'climate-proof' red, green, and blue infrastructures will increase property values.[2]	Heavy rainfall, urban heat islands, biodiversity loss.	Green and blue infrastructures can contribute to local water storage, mitigate urban heat island impacts, and increase biodiversity.	Positive: higher property prices; higher revenues from property tax. Negative: reduction of net land available for housing, higher public infrastructure costs.	Property taxes for homeowners will increase; Developers bear investment risks (in case of developer-funded TIF).
4. *Property tax*	Homeowners' 'green' investments in their own houses lead to higher housing prices; revenues from property taxes will increase and can be reinvested in additional public	Heavy rainfall, urban heat islands, biodiversity loss.	Both green and blue public infrastructures and 'green' investments in houses can contribute to local water storage, mitigate urban	Positive: higher housing prices, increased tax revenues; Negative: additional costs for homeowners	Homeowners pay higher property taxes; market value of their homes will increase.

[2] 'Red infrastructure' refers to road and public transport infrastructure; 'green and blue infrastructure' refers to green areas and (recreational) water.

Type of financial instrument	How it works	Relation with climate risks	Level of climate adaptation impact	Expected financial impact	Expected impact for developers / home owners
	green and blue infrastructures and/or subsidies to homeowners.		heat island impacts, and increase biodiversity.	(both investments and maintenance costs).	Subsidies can be made available to homeowners for 'green' investments.
5. *Sewage charges and water tax*	Users pay (regular) charges for use of sewage system and / or taxes for water safety and clean water (annual charge or tax). Part of the revenues put in a regional climate adaptation fund; amount based on 'prevented (maintenance) costs'.	Heavy rainfall, flooding, droughts.	Climate adaptation investments can contribute to local storage and drainage, reducing sewage and water system costs.	Positive: fund provides subsidies to local climate adaptation measures, either by developers or homeowners.	No extra charges or taxes; developers or homeowners can receive subsidies for climate adaptation investments.
6. *Developer exactions, obligations or impact fees for both on- and off-site infrastructure*	Developer either builds or pays for on-site green-blue infrastructure (one-time, up-front charge), to mitigate the climate impact of their development on the community.	Heavy rainfall, urban heat islands, biodiversity loss.	Both on- and off-site green and blue infrastructures can contribute to local water storage, mitigate urban heat island impacts and increase biodiversity.	Positive: higher housing prices; Negative: reduction of net land available for housing (larger land surface to green / blue infrastructures), increased public infrastructure costs.	Housing prices will increase, improving developers' business case; Possibly, reduced developer contributions to other public amenities.
7. *Reduction of maintenance costs of public space*	Climate adaptation measures can in some cases reduce maintenance costs for municipalities.	Urban heat islands, heavy rainfall.	More robust red, green, and blue infrastructures, resistant to extreme weather.	Positive: reduced maintenance costs for red, green and blue infrastructures; Negative: increased construction costs.	No impact on developers and / or homeowners.
8. *Contributions by insurance companies*	Insurance companies implement a fund meant for subsidizing climate adaptation investments by real estate owners; amount based on 'net value of prevented future damage payments'.	Heavy rainfall, flooding.	Additional investments in new buildings to protect them for heavy rainfall and flooding.	Positive: less damage payments for insurance companies; subsidies to real estate owners; Negative: additional costs of climate adaptation investments.	Insurance costs remain at same level for real estate owners; Subsidies cover (part of the) climate adaptation investment costs.

Source: Deloitte, 2020 and authors' work

Chapter 4. Case studies

Case study selection

We conducted a comparative, international case study of LVC for climate adaptation in three cities / city regions, in three different countries, respectively Rotterdam (the Netherlands), the contiguous cities of Charleston, North Charleston, and Mount Pleasant (South Carolina, Unites States), and the Liverpool City Region (United Kingdom).

Motivation for the selection of these three city regions:

- *Vulnerable to climate change*: due to their geographical location in coastal zones, these cities are all vulnerable to climate change, particularly because of risks related to flooding, while other climate risks, including urban heat islands and drought, play a role as well.

- *Implementation, actions, and financial aspects:* while all three cities have begun to implement their climate adaptation strategy and investments in climate-proof urban infrastructures have been initiated, there are budget gaps, and the city governments are searching for alternative funding sources. Though there is some reference to land-based finance (e.g., the use of Tax Increment Financing in Charleston), detailed information on opportunities for LVC is absent yet.

- *Climate adaptation strategy*: in all three cities, awareness has increased with regard to the potential impact of climate change at the local level and the need to act. This has resulted in local climate adaptation strategies, supported by various policy documents:

    - **Charleston:** 2019 *Flooding and Sea level rise Strategy;* 2017-2018 *Charleston Regional Hazard Mitigation Plan;*
    - **Liverpool City Region:** 2021 Liverpool City Region: *Year One Climate Action Plan 2021-2022;*
    - **Rotterdam**: Rotterdam Climate Initiative (no date)*: Rotterdam Adaptation Strategy*; 2020-2022 *Climate Adaptation Implementation Program.*

Case study design and data collection

The case studies aim to fill in this gap with regard to the role land-based finance can play. Through, respectively, a survey among the real estate development community (Charleston case), semi-structured interviews with public and private stakeholders (Liverpool and Rotterdam cases), and simulation gaming (Rotterdam case) data have been collected particularly with regard to the willingness of private developers to contribute to public climate adaptation investments considering both exogenous and endogenous conditions that might impact their readiness to contribute.

All three cases pay attention to:

1. Local climate adaptation strategy
    - Local climate risks and sense of urgency
    - Local government policies and investment strategies for climate-proof public infrastructures
    - Available funding and potential funding gaps

2. LVC policies
    - Instruments and tools
    - How much land value is captured?
    - For which purposes is LVC used?
    - Prioritization of different social goals, when using LVC?

3. LVC and alternative financing mechanisms for climate-proof public infrastructures
    - Use of land-based finance; size of developer contributions
    - How much land-based finance available; prioritization
    - State of the art and best practices

4. Private developers' considerations to contribute
    - Business case: value of the development purely understood in its own terms
    - Real estate valuation practices: user value versus exchange (investor) value;
    - Possible impact of climate change, as an exogenous factor, on their business case; depends on risk assessment (change; impact);
    - Market volatility and possible impact on their business case;
    - Institutional context for climate adaptation: who is responsible (state or individual);
    - Climate change concern: Corporate Social Responsibility; trust in other stakeholders' cooperation.

Land value capture and private real estate development – The case of the Charleston, SC Lowcountry region

Key Points:

- Currently, Charleston has 180 days of nuisance flooding each year on average, with a record 89 days of flooding that breached the 7-foot seawall in 2019 (Mills, 2021). In the 1970s, this number averaged two days annually (Riley, 2015).
- "Flooding and preparedness for hurricanes, but we have always done that unrelated to climate change." The overall sentiment was that climate change was not a grave concern, despite 50% of the community believing it is an issue.
- "In general, it appears that developers believe that the minimalist approach is enough to make financial partners and governmental entities happy."
- LVC approaches in the environmental, economic, and political context of South Carolina – and many other parts of the United States – require a clear consensus on climate change value loss in order to socialize the economic costs of sea level rise into universal developer incentives as opposed to project-based approaches.

- LVC policy design must address the particularities of the US infrastructure finance conventions in which small-scale private investors drive public works development, and will likely play an outsized role in infrastructure mitigating sea level rise.

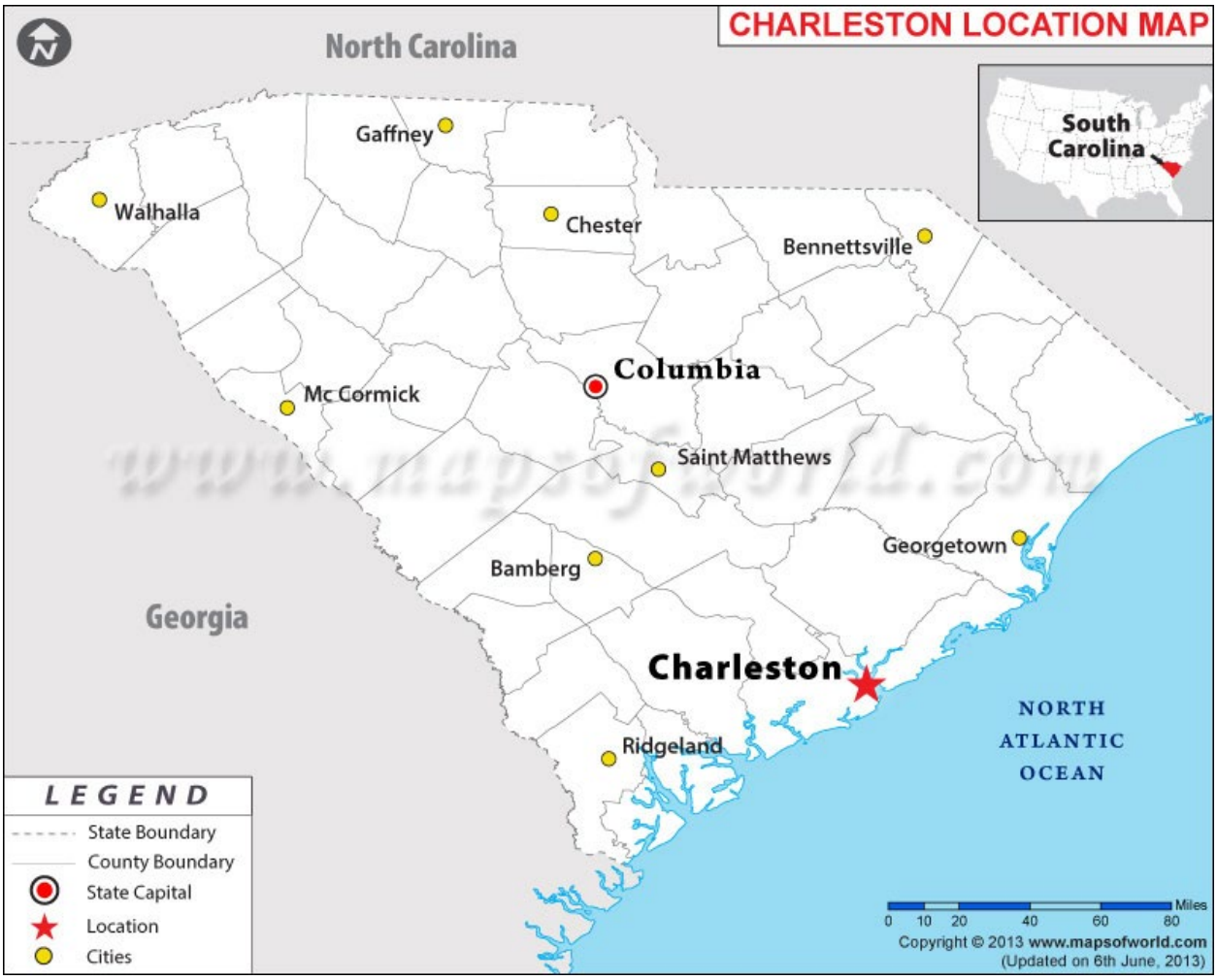
Context: Charleston, SC, and climate change

The city of Charleston, SC, has become one of the jewels of the US Southeast. Over the last decade, the city has experienced a rapid rise in development and, in turn, has seen itself ranked highly in numerous travel and leisure magazines, ranking it as the 7th best designation for jobs and a top destination for tourists, with *Travel and Leisure* magazine ranking it as the number one city in the world (World Travel and Leisure, 2022). With these rankings extolling the virtues of Charleston, there has been an explosion of real estate development from hotels to multi-family to office space. One cannot build fast enough to sate the demand. But with this rapid growth in the lower peninsula, the main tourist and commerce area of the city, there are some downsides.

One of the challenges on the horizon for the city is increased flooding and increased storm intensity exacerbated by climate change. Being just a few feet above sea level at its highest point, the city has always been prone to nuisance flooding, with King Tides causing an acceptable havoc on the city. Yet with climate change and only a moderate rise in sea level, the nuisance flooding that Charlestonians have decided to live with will go from an occasional inconvenience to a chronic one. Presently, the city experiences an average of 180 days of nuisance flooding a year, with a record 89 days of flooding breaching the 7 ft mark in 2019 (Mills, 2021). According to NOAA (2022), the city's threshold of nuisance flooding is 7.0 feet Mean Lower Low Water (MLLW),[3] with its major flooding threshold being 8.0 ft. While nuisance flooding might just be that, a nuisance, it does have financial ramifications, and costs the city roughly $124 million each year (Cains, 2021).

[3] The National Oceanic and Atmospheric Administration (NOAA) defines the MLLW as the average of the lower low water height of each tidal day observed over the National Tidal Datum Epoch (https://tidesandcurrents.noaa.gov/datum_options.html#:~:text=MLLW*,the%20National%20Tidal%20Datum%20Epoch).

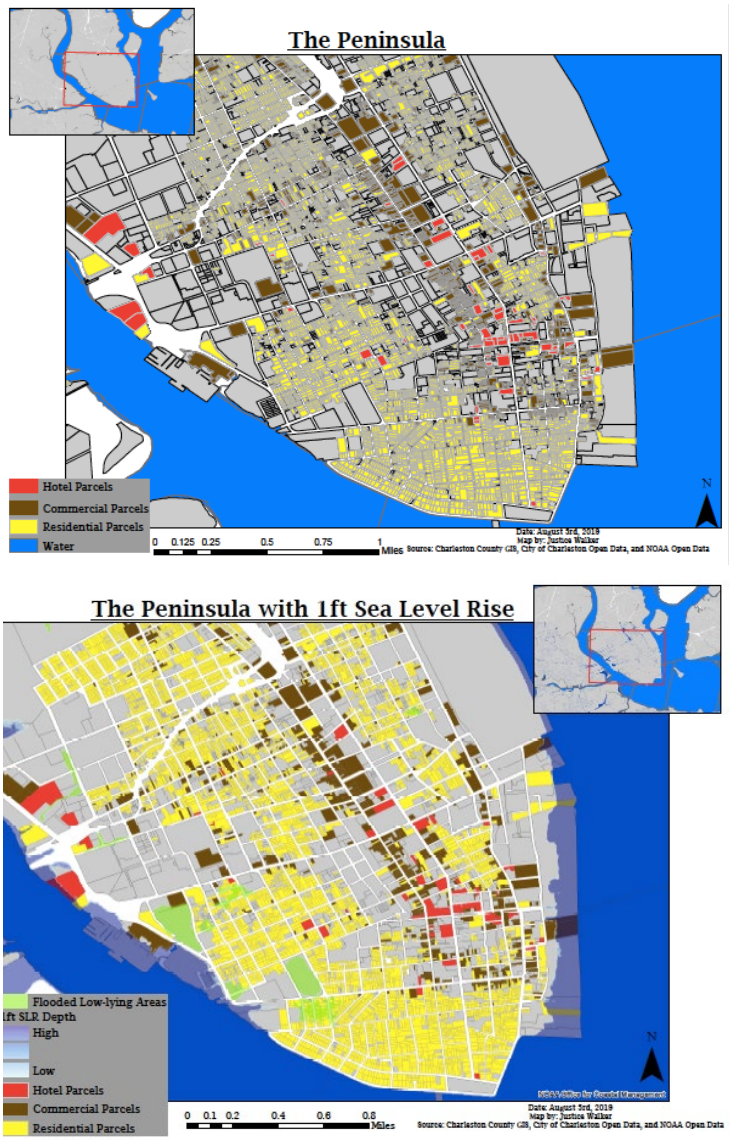
Figure 4.1: Map of South Carolina and Charleston

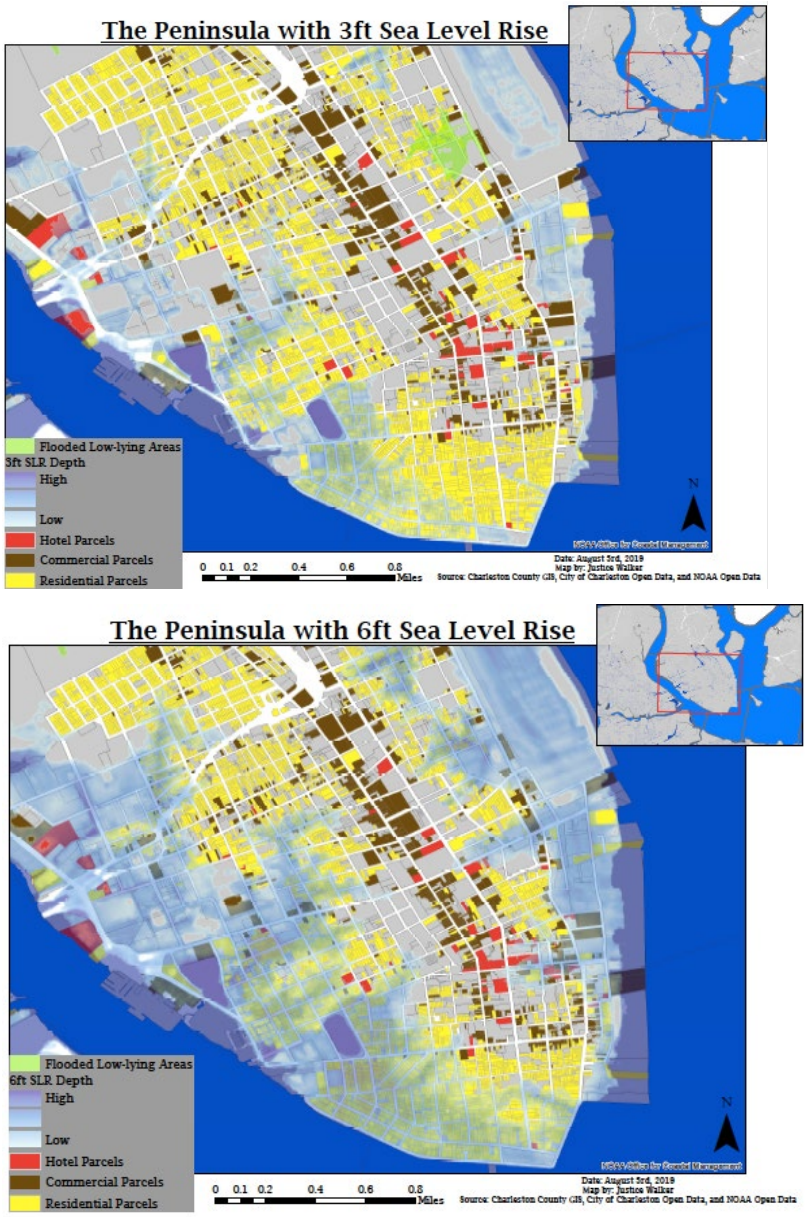


Source: Maps of the World Website: mapsofworld.com

The fear with climate change is that nuisance flooding will become more common, and the 8.0 ft threshold will be reached much more frequently. This is a grave fear for a city where 800 square miles of the city's coastal area lies just 4 ft above the high-tide line (Runkle et al, 2018). Furthermore, conservative estimates show that sea level will rise 3-4 ft by 2100 (Tibbetts & Mooney, 2018) with more drastic, maybe more realistic, predictions showing a 6 ft sea level rise by 2100 (Runkle et al. 2018). Some research has pointed out that while there are 180 days of nuisance flooding a year, by 2045 there could be 180 days of major flooding a year, in turn making almost 86% of Charleston's properties inaccessible to vehicular traffic (Mills, 2021). By looking at figure 4.2, one can better understand the actual impacts of sea level rise on the lower peninsula. The maps in figure 4.2 show the present state of the peninsula, a one-foot rise, a three-foot rise, and a six-foot rise in sea levels.

Figure 4.2: Charleston Peninsula and Sea Level Rise





Source: Buckman and Sobhaninia, 2022

These future climate projections have not been lost to many of the city's government and community members. For instance, in 2019 the city engaged two flooding-oriented reports: *Flooding and Sea level Rise Strategy* (City of Charleston, 2019) and *The Dutch Dialogues Charleston* (Waggoner & Ball, 2019a). Both reports outlined various ways to combat climate change from hardening shorelines to retreat, as well as less extreme sustainable design measures such as green buffers and bioswales. But beyond small scale measures, a more drastic approach has been proposed by the Army Corps of Engineers (ACE), in a cost-sharing partnership with the city, to construct a $1.7 billion sea wall to protect the lower peninsula, the heart of Charleston's commerce and tourism (US Army Corps of Engineers, 2021).

Perceptions of the importance of climate change to the Charleston real estate community[4]

While the Charleston public sector and community members are raising the red flags of climate change, answering the question of how the Charleston real estate development community feels about climate change is essential, because it will be the private sector, particularly the real estate development community, that will shape the city's built environment of the future. In a 2022 paper in the *Journal of Sustainable Real Estate*, Buckman and Sohaninia (2022) attempted to get a better understanding of the views of the development community.

In their study, Buckman and Sobhaninia surveyed 350 members of the Urban Land Institute Charleston's real estate development community, with a response rate of 55%.[5] The respondents included architects, brokers, developers, investment community, bankers, city government, and consultants. The survey, both Likert and open ended, asked broad demographic questions as well as general views of climate change in Charleston and how the development community is tackling it. It also included more specific questions on what they and their company are doing, if anything.

The results of the survey showed a development community that was at best apathetic towards climate change in the city. Most of the respondents, while understanding that climate change was a factor, were taking a business-as-usual approach with only a minimal increase in sustainability efforts in their day-to-day activities. This minimalist approach to the matter was seen by many of the respondents as being enough to appease investors, financial partners, and governmental entities. While the survey did show that developers themselves think they should be doing more, in an open-ended survey question, about 10% of respondents specified very pro-active steps that government should take to protect the city and support developers in building it out (Buckman & Sobhaninia, 2022).

More specifically, 50% of the respondents saw climate change as being a major concern for the city (rating of 5 on 1 – 5 scale). Yet at the same time, its impact on the real estate community specifically was of minimal concern, with 50% rating it only a 3 on a 1 – 5 scale. Yet 82% felt developers were shying away from areas subject to flooding, but at the same time, in an almost contradictory fashion, 62% responded "no" when asked if development patterns were shifting to different locations because of climate change. Furthermore, 80% of the respondents noted that the changes they were making were self-imposed and not insurance or government imposed (Buckman and Sobhaninia, 2022).

Even with the understanding that climate change is an issue for the Charleston community, the respondents still saw no slowdown in development in the city. The big takeaway was that as long as it was still profitable to build, even though climate change will force smaller less well financed developers to higher ground, development will continue. It will only be when people stop paying a premium to be in the flood prone lower peninsula of the city and when the profit margins for developers become less agreeable – either due to underwriters demanding more,

[4] Based on an original survey of n=55 senior members of the Urban Land Institute in South Carolina.

[5] Appendix 1 provides details on the survey questions.

increased cost of entitlements, or the taste of the buying public changes – will they abandon the area or radically change their development patterns (Buckman & Sobhaninia, 2022).

Lowcountry South Carolina as an Illustration of the Challenge of Infrastructure Provision to Mitigate Sea Level Rise (data as of 2016)

Our description of sea level rise futures in the Charleston, SC, region above illustrates a number of issues with broader relevance. Two broader trends define the real estate market context that are particularly relevant to Charleston as a Learning Laboratory: coastal risk amidst increasing storm and other hazards in the context of an unprecedented global move to cities. First, coastal development in the face of the drastic increases in flooding and storm frequency and magnitude described in the first section are not unique to South Carolina. Nor is the need to build infrastructure for a more resilient real estate development future. In 2010, for example, 39% of the United States population lived in a coastal county, a number that was – most likely accurately – anticipated to increase by at least 8% by 2020 (NOAA, 2014). Similarly, in 2010, 44% of global population lived within 150 km of the sea (United Nations), a number that most likely has also increased over the past decade.

erms of hazards and climate-related disasters, coastal hazards, and property damage – beyond the human costs – are widely accepted to be one of the major challenges of the 21st century. Super Storm Sandy, Hurricane Katrina, and the Indonesian and Japanese Tsunamis all illustrate how vulnerable coastal communities are to natural hazards and disasters. Sea level rise, as a long-term hazard, unlike these other coastal disasters, requires a policy approach that can be implemented over longer periods and is more systemic. Since the risk is not related to rare events, but rather to a changed normal set of assumptions, unlike fast-moving disasters, sea level rise is a gradual hazard more consistent with a planning and policy approach that emphasizes realistic and gradual adaptation.

Related to this principle of sea level rise being an evolving disaster, it is also a risk related to a "transition" from one steady state to another relatively steady state, rather than a risk related to a spike event, after which a known "normal" returns. This principle behind how one must approach sea level rise mirrors what has been shown related to the second long-term trend relevant to the South Carolina context: urbanization.

Global urbanization has been an ongoing trend for over one hundred years, and by 2007, the world had become 50% urbanized. Moreover, it is anticipated that urban residents are expected to comprise at least 66% of the global population by 2050 – in just 27 years. Coastal South Carolina is an excellent learning lab for examining these dynamics between coastal communities and urbanization. Between Myrtle Beach, the most popular beach destination on the US east coast; the metropolitan region of Charleston, at almost 1 million residents; and the fast-growing resort communities of Hilton Head Island and surrounding islands, South Carolina is one of the fastest-developing coastal regions in the country. Environmentally, South Carolina has 2,876 miles of coastal shoreline – the 11th longest in US – and one of the densest, given that the distance from the Georgia/South Carolina coastal border to the South Carolina/North Carolina one is only 187 miles. As a reference point, a "crow flying" from New York City to Los Angeles only has to travel 2,446 miles!

Beyond this extreme context of a very dense network of coastal areas subject to rapid increases in sea level rise-related flooding, and the rapid urbanization of the region driven by rapid increases in the real estate market, there are institutional characteristics of governance that have broader relevance. Specifically, as a state with a very market-oriented philosophy, South Carolina relies on market-driven solutions to policy questions, generally, which makes investment in expensive infrastructure to mitigate sea level rise difficult if there is no clear and compelling market rationale. The few exceptions to this challenge are where sea level rise demonstrably threatens a unique, high-value, and spatially concentrated asset, as is the case with the downtown Charleston ACE infrastructure project described in the first section above. While South Carolina's market-driven approach makes it difficult to take big steps to mitigate sea level rise, it also better reflects the large portions of the world where sea level rise is either not a policy priority, or where public funds are simply not available, as is the case in many developing nations where urbanization is rapidly accelerating in coastal areas. In either of these institutional contexts – low governmental capacities or preferences for "market" solutions – innovative solutions that use land markets and other assets to drive adaptation are particularly relevant. Thus, solving land value capture challenges in the South Carolina Low Country may have much wider implications for a global challenge.

Land Value Capture in the Lowcountry of Charleston, South Carolina?

The description of survey evidence above shows that private sector real estate developers see the importance of the issue but are not incentivized to take any actions to adapt to increased threats of flooding. Without such market incentives, adaptation and mitigation measures default to large infrastructure projects like that described above. Such projects can help clarify the nature of LVC, and what is needed to make it work to address the challenge of sea level rise.

A clear example of LVC in action is the previously mentioned $1.7 billion seawall that is being proposed by the city and the Army Corps of Engineers. While the wall is in the preliminary stages of discussion and development, it presents a radical infrastructure measure, a massive technological fix, to combat sea level rise. The original proposed seawall was projected to cost $1.7 billion and has wavered from that number to $1.1 billion and back again. The proposed wall would encircle the lower peninsula and utilize a lock system to allow water to flow freely while at the same time controlling its inundation to the city. It would be a joint venture, with the Army Corps taking $775 million and the city taking $325 million of the costs (US Army Corps of Engineers 2021). Yet while many are singing the praises of what the proposed wall would bring, ironically, William Cogswell, a Republican developer famous for the iconic Cigar Factory and the redevelopment of the Charleston Navy Yards, has made his opposition to the wall a key part of his platform as he runs for Charleston mayor (election will be in November 2023).

The proposed ACE project has not yet been funded, but whatever the final decision, debates in the planning stages illustrate two key points. First, the tax-paying public in the municipality of Charleston will likely bear some of the financial costs, along with the federal tax-paying public, even though the immediate benefits are geographically limited to very specific and geographically limited areas of the municipality. This rationale is driven by the reasonable argument that downtown Charleston is a regional public good that benefits everyone since it is a major tourist destination, and a large component of the regional labor market is supported by

tourists. The second point illustrated by Charleston's ACE project is that the intended benefits to the broader municipal tax-paying residents will eventually "trickle down" to the general public through business and tourism viability. While this projection is also not unreasonable, what about the parts of the economy not directly tied to the tourism economy? Such residents may benefit on a third-degree order through the subsidy of other public goods like schools and parks. In sum, the ACE approach prioritizes business sustainability, and in a fiscally tight municipal finance environment, funds directed to big infrastructure investment for SLR may also detract from other needed services.

Most importantly though, Charleston's ACE big infrastructure project solves an engineering problem, but does not *create true value*; rather, it is geared towards *preserving value*. As a mitigation strategy to rising sea levels, its intention is not to develop the Charleston economy so much as it is to preserve its position in the tourism market. In other words, the infrastructure is geared towards preserving the value of $1 million homes, *not* towards developing homes that have that value. Thus, there is no opportunity to capture *new* value, only the opportunity to *preserve* existing value. In such a project like the ACE one in Charleston, it is only once the land value is in decline that the state, or public agency, can really claim any of the financial benefits. In other words, it is difficult for the municipal and federal investors to claim that sea level rise would have decreased any given downtown home's value by 25% (for example), and then increase property taxes in those specific areas to cover these *projected* losses. For this kind of big infrastructure model to work as a LVC strategy, one must secure consensus that land values are currently in decline, and more specifically in decline *because of* sea level rise. Such consensus would not only depend on strong multivariate statistical models, but also on public confidence that such outcomes were strong and predictable enough to rationalize current self-taxation of a narrow group of affected residents.

This thorny challenge to LVC in the case of Charleston's Big Infrastructure project (See Spencer 2019 for a description of Big Infrastructure as opposed to Small Infrastructure) is driven by at least two factors:

1. The project is being implemented even as residential land values in downtown Charleston are fast rising;
2. There is no documented loss of land value in Charleston – i.e., the market does not recognize SLR (i.e., we are only looking at value preservation rather than value creation).

These questions result in a fundamental problem: 1) project-based SLR adaptation like the above Big Infrastructure project is more driven by politics and interest groups than by long-term sustainability concerns; 2) project-based approaches like this need an *iconic* asset to leverage up-front capital; and 3) LVC policies tend to emphasize governmental regulations and policies related to land and projects (i.e., the "capture" component of the design) more so than the underlying dynamics of land values independent of policy interventions (i.e., the "value" component of the design). This distinction between projects and policies as opposed to underlying trends is accentuated when they are implemented in a context like South Carolina, where land regulation is very difficult. This last point (3) brings up the question of residential property valuation as a LVC tool. Without addressing the valuation trends and subsequent methods to estimate value, we are left at the mercy of the dropping market value of land/property using existing appraisal methods, which can take a while, and maybe might be too late. In this

case, the only solution is the Big Infrastructure project described above that is about *preserving value, not capturing new value*. It is the public entity defending a revenue stream because it is unwilling to "sacrifice" areas to SLR. The cost of this "defense," however, is borne by those outside the flooded areas.

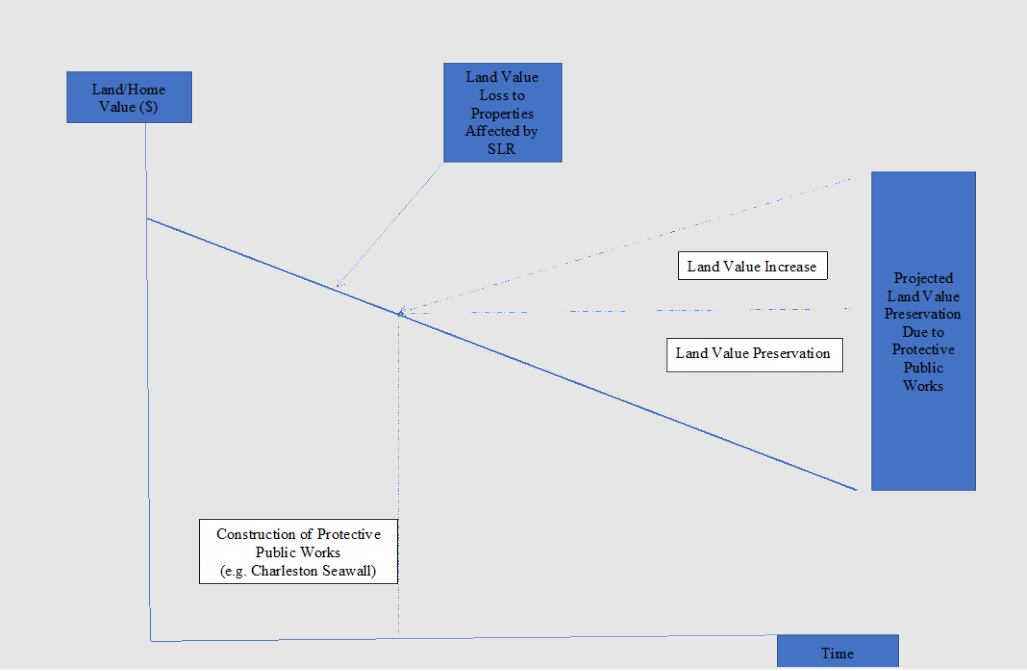
In sum, thinking about LVC in the context of a gradual sea level rise trend that requires a transition from an unprotected coast without infrastructure to a protected one with infrastructure, requires attention to three issues: 1) willingness to pay with respect to new products versus eliminating risks; 2) infrastructure in low-regulation states is generally financed by private capital markets leveraged by long-term repayment schedules financed by user fees; and 3) small scale investors are a very large share of the capital that covers up-front costs of new infrastructure in the United States.

Moreover, in discussing these three issues below, we attempt to clarify two unique aspects of SLR and of infrastructure finance in the US because any LVC policy in South Carolina must fit within these concepts to be effective in the short- and medium-term. The second unique aspect of LVC policy in the US has to do with the specifics of how major public works investments are financed in the American political economy.

1. Land Value Capture or Land Value Preservation? Willingness to Pay for Products Versus Risk Mitigation

The first unique aspect is how to understand LVC in a context where land value is actually being lost due to SLR; in this case, LVC is more precisely "land value preservation." Climate-proofing communities against sea level rise is the production of a new public good, very similar in terms of concept and governance to other transitions to new infrastructures like water supplies. However, SLR is more akin to sanitation, since it is an infrastructure removing a risk rather than providing a product. This is why water and sanitation are generally linked public services, combining the sale of the product with the removal of that product's externality. If a LVC follows this well-trodden rationale for the provision of a new infrastructure, it will need to match the risk reduction component – mitigating SLR – with the development component. What is the new collective product that residents are willingly paying for that is systematically linked to the removal of the flooding risk?

Figure 4.3: Hypothesized Land/Home Value and SLR Protective Public Works



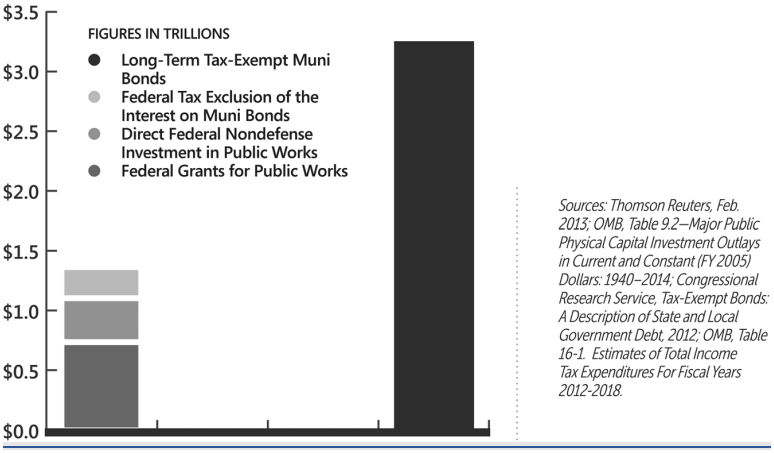
Source: Authors

2. LVC Public Works in the American Political Economy: The Importance of Private Investment Capital from Small-scale Investors

Although real estate developers appear not to build SLR calculations into their projects, small scale real estate investors can have an extremely important role to play in financing SLR public works in the US through LVC. Perhaps one of the most important policy principles in the United States is that the federal government is a relatively small contributor, as is local government. Rather, it is the private market that provides most up-front capital to invest in new public works, either as direct investor or as part of lender capital pools.

Figure 4.4 below indicates how much this is the case. Between 1940 and 2014, tax-exempt municipal bonds financed well over twice the amount of direct investment by the Federal government. Thus, state and local funds contributed to proposed SLR-mitigation projects such as that proposed for Charleston described above need to establish the associated long-term revenue stream that can make such private investment in municipal bonds and other financial arrangements viable projections of value creation that can cover the up-front costs.

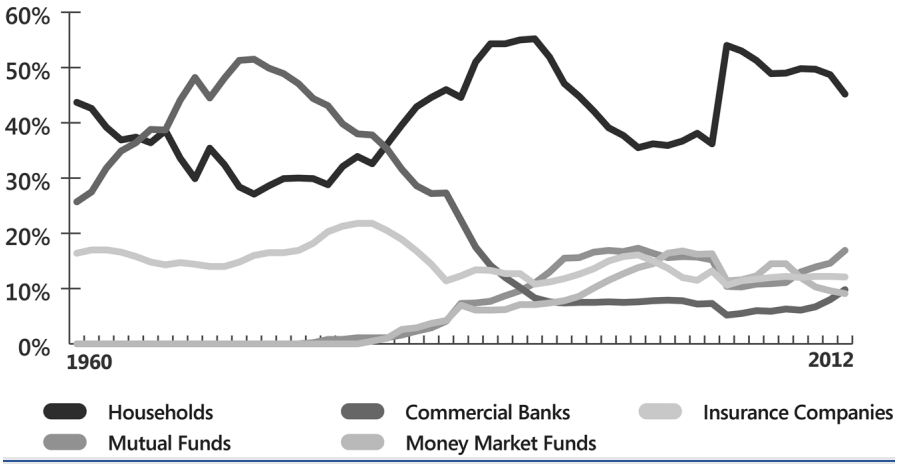
Figure 4.4: Municipal bond issuances and federal government support for infrastructure



Source: Reproduced with permission from Istrate, 2013 in Spencer, 2022

In addition to the need to establish viable revenue streams associated with SLR public works investments, it is important to understand the decentralized nature of such investment pools. Contrary to decades earlier, today's investment in public works generally is driven by households, as shown in figure 4.5 below. In 2012, for example, about 50% of municipal bonds were purchased by households, as opposed to banks, insurance companies, and other centralized investment funds, all of which are below 20%. Because of this decentralized nature of infrastructure provision in the United States, any effective LVC policy will need to demonstrate sufficient investment returns to "households" making highly diverse decisions about their personal portfolios, retirement funds, and other financial decisions that directly affect their quality of life. For this reason, an effective LVC policy in the US political economy will need to establish that land value loss is quantified and socialized in ways that go well beyond iconic projects such as that described for Charleston.

Figure 4.5: Top five holders of municipal bonds, share of municipal bonds outstanding, 1960–2012



Source: Reproduced with permission from Istrate, 2013 in Spencer, 2022

Concluding Thoughts on Future Research: Is There a Viable Way to Get Around Private Sector Inaction?

LVC approaches to SLR in the context of South Carolina, to be implemented systematically rather than through a single iconic project, would need to establish that value is decreasing in the face of SLR, all other factors equal. A LVC planning and policy future separating out asset and rental values as the precursor to LVC policy development might follow studies that use online real estate data and machine learning to assess value to examine neighborhood-level differences in the face of gentrification (Spencer, conditionally accepted).

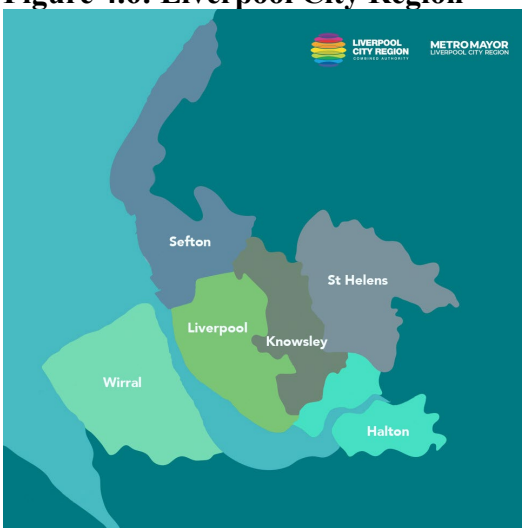
What are the informal and quasi-formal ways in which Small Infrastructure (Spencer, 2019) is currently being created before the economic fundamentals of Big Infrastructure projects become viable? Do communities in South Carolina and elsewhere build local seawalls? Are they coming up with local, demand-sensitive-priced projects and solutions that residents are willing to invest in? Spencer (2022) has shown that communities often create new, land-based value before the economic fundamentals of Big Infrastructure projects make sense. Such models take different forms, but each involves local communities pooling money, land, and other resources to provide a shared good that they willingly pay for and manage. We need to clarify what developers and homeowners – especially those that intend to own their properties for the long term – are actually paying for if we are to have an adequately socialized LVC planning and policy practice.

Willingness to pay for climate adaptation – Evidence from the Liverpool City Region

Context

The Liverpool City Region is a metropolitan-scale 'combined authority' located in England's north west. The expression 'combined authority' refers to a specific governance arrangement that exists in some English city regions (others include the West of England centered on Bristol and the West Midlands covering the Birmingham metropolitan city region) whereby a number of formal local authorities (in this case, Liverpool, Halton, Knowsley, Sefton, St. Helens, and Wirral) have a combined mayoralty that provides a higher tier of city-regional governance. The combined authority provides a strategic-scale focus on issues such as economic development, transport, housing, and physical infrastructure. As a result of their wider scale of operation, English city region combine authorities cover a broader territory and serve a larger population than traditional local authorities. In the case of the Liverpool City Region Combine Authority the full metropolitan area extends to 279 square miles (723 km²) serving a population of approximately 1.5 million.

Figure 4.6: Liverpool City Region



Source: Liverpool City Region

Figure 4.7: Liverpool City Region in Context

Source: British American Trade and Investment

Like many coastal settlements around the world, the Liverpool City Region faces a complex mix of threats from climate change including the enhanced frequency of extreme weather events, urban heat island effects, and the prospect of sea level rise. A range of sea level rise scenarios have been modelled which show that many of the city-region's coastal and coastal-adjacent neighborhoods are at risk of significant flood events in the near future (see, for example, Plater, 2017). These coastal communities are not only home to tens of thousands of residents, they are also some of the highest value real estate markets in the city region.

It is this context that prompted the Liverpool City Region Combined Authority to become the first in the country to declare a Climate Emergency, committing to become net zero carbon by 2040 – 10 years ahead of the UK target.

Figure 4.8: Land projected to fall below annual flood level in 2050[6]

Source: Climate Central

[6] Available at: https://coastal.climatecentral.org/map/9/-1.6683/53.7242/?theme=sea_level_rise&map_type=year&basemap=roadmap&contiguous=true&elevation_model=best_available&forecast_year=2050&pathway=ssp3rcp70&percentile=p50&refresh=true&return_level=return_level_1&rl_model=gtsr&slr_model=ipcc_2021_med

However, meeting the specific local challenges of the climate emergency will require investment. We know through much of the modelling work discussed above the specific communities that are likely to be most severely affected under various scenarios of sea level rise. Ensuring that investments in the built and natural environments are of a sufficient scale to make these areas adaptable to the changing environment of the future will require a marriage of environmental science and the principal source of investment for developments of this kind in the UK – Land Value Capture.

Land Value Capture in Liverpool

England has a long history of what has come to be known internationally as 'Land Value Capture'. Many of the original, classical statements of the questions at the core of the LVC debate can be found in authors writing on experiences of urbanization in nineteenth century England, such as John Stuart Mill and Henry James. Subsequently, the principle that development should be subject to a charge or levy has been an aspect of English planning practice for many years dating back to the Town and Country Planning Act's Development Charge (1947), with moments of refinement, revision, and replacement following through the Land Commission Act (1967), the Community Land Act (1975), the Development Land Tax Act (1976), the Town and Country Planning Act (1990), and the Planning Act (2008).

Although the legal framework outlined above aims to recover some (or, ideally, all) of the uplift in land values resulting from the award of consent to develop the internationally-common expression, Land Value Capture is not commonly used in England. Instead, the language that is most frequently used to refer to this policy issue in the UK is 'developer contributions' as it is the developer's obligation to provide public goods, and in some cases cash contributions, to ensure their development is acceptable to the local planning authority and represents a sustainable and properly-serviced new development.

The current context within which developer contributions are determined is set by two pieces of legislation. Firstly, Local Planning Authorities (LPAs) have the right to negotiate obligatory contributions – hence 'planning obligations' – with developers on a case-by-case basis. This is provided for under section 106 of the 1990 Town and Country Planning Act. These negotiated agreements have consequently come to be known colloquially in the English development context as 'section 106 agreements' (henceforth, S106). Such agreements most commonly result in the provision of 'in-kind' contributions by the development industry such as public greenspace, access roads, other 'grey' infrastructure or a quota of housing that is required to be made available on an affordable tenure (such as shared ownership or a with a rent cap). Secondly, the Planning Act 2008 and subsequent Community Infrastructure Levy (henceforth, CIL) regulations from 2010 (amended in 2019) provide the legislative basis for the CIL. This is a locally determined fixed charge on development which usually takes a relative form, such as '£X/m² of new development'. Local planning authorities have the right, but not the obligation, to adopt CIL and can combine this cash-generating form of developer contribution with the right permitted under S106 agreements to negotiate in-kind contributions. At the time of writing, just over half of all English local authorities have adopted CIL, meaning that in these areas' development may be subject to what are in effect two instruments of land value capture: S106 agreements to secure in-kind contributions and CIL to recover cash contributions.

None of the six local authorities that comprise the Liverpool City Region Combined Authority have chosen to adopt the Community Infrastructure Levy. As a result, in this part of England policy makers have elected to rely solely on negotiated S106 agreements to provide for developer contributions.

This raises a number of questions with regard to the issue of how the Liverpool City Region will harness developer contributions to support the goal of securing development which will be sustainable in a future defined by the climate change emergency. Chief amongst these questions are those that pertain to the process by which S106 agreements are negotiated and agreed: what developer contributions are local authorities requesting, to what extent are such requests grounded in evidence on the specific character of future climate instability, to what extent are developers more or less willing to make contributions that are focused on climate adaptation relative to other categories of investment, and is the system by which developer contributions are exacted fit for this purpose?

In order to address these questions, a program of 14 semi-structured interviews were conducted with a range of participants in the development process: planning officers, planning consultants, and property developers. The following report of research findings is organized around the core questions identified above:

Do local authorities request developer contributions to support climate adaptation?

Research conducted for the Ministry for Housing, Communities and Local Government (2020) provides a national-scale account of the total raised through developer contributions and the types of public goods that they are used to finance. This data is reproduced in table 4.1.

Table 4.1 Detailed real terms value (in millions of British pounds) of agreed developer contributions between 2005/06 and 2018/19

Contribution Type	2005/06	2007/08	2011/12*	2016/17	2018/19
CIL	-	-	-	771	830
Mayoral CIL	-	-	-	174	200
Affordable Housing	2,000	2,614	2,300	4,047	4,675
Open Space & Environment	215	234	113	115	157
Transport & Travel	361	462	420	131	294
Community Works	75	192	159	146	62
Education	154	270	203	241	439
Land Contributions	960	900	300	330**	135
Other Obligations	149	183	30	50	187
England total	3,927	4,874	3,700	6,007	6,979

Source: Lord et al., 2020

Table 4.1 clearly shows that the most significant source of investment for developer contributions in England as a whole is affordable housing. In 2018/19, of the £6bn total raised

through S106 agreements (excluding CIL and the London-specific Mayoral CIL), £4.7bn (just under 80%) was used to fund affordable housing. This reflects the broader English policy context that, particularly in London and the South East, sustained house price inflation over several decades has resulted in median value dwellings being unaffordable for many citizens. The implication of table 4.1 is that local authorities across England have correspondingly sought developer contributions for this specific category of investment in response to this policy landscape.

Close scrutiny of table 4.1 also reveals that this was not always the case. In 2005/06 affordable housing contributions represented half of all S106 investment – a similar proportion as 2007/08 and 2011/12. It can also be seen that over the full timeframe represented by table 4.1 'open space and the environment' has seen a reduction in the scale of investment resulting from S106 contributions: the £215m that went into this category in 2005/06 had fallen to approximately three-quarters of this level by 2018/19 (£157m). This category would include any nature-based climate adaptation investment. So, why are we asking for less investment in the natural environment?

To answer this question in the specific case of the Liverpool City Region, research participants were asked to reflect on how investment priorities are identified in the process by which developer contributions are negotiated and agreed. For many participants the core determination of what results from negotiation was said to be the requirements of local planning policy:

> "We ask for what the policies in the local plan require us to ask for. In our case that is 30% affordable housing. That is our first request. In some cases the developer will try to bargain that down but, even if they don't, once that is agreed there is not generally a huge amount of room to make additional requests." (Participant J)

In this excerpt, Participant J refers to local planning policy which requires all new development to provide 30% of all dwellings to be made available on an affordable tenure. The developer's contribution is correspondingly the loss of this fraction of the development to a dwelling type/tenure that they are obliged not to sell at open market values but rather to make available as affordable housing. The vast majority of English local authorities have similar policies (and similar fractions) to ensure that the private development industry provide mixed developments of market and affordable housing. However, as can be seen from the testimony above, making affordable housing contributions the first and principal request potentially constrains local authorities to request additional investment by developers in the environment: affordable housing may be crowding out investment in climate adaptive infrastructure.

For other participants, market conditions were understood to be important in accounting for geographic variability in the scale of developer contributions that could be exacted:

> "The main issue is that you are in a stronger position to negotiate in areas where the market is hot. Developers will accept that they have to make contributions in these areas. Where the market is weaker we would generally have to accept we would get less." (Participant D)

The implication of this finding is that the strongest markets may be able to secure a greater value of developer contribution than weaker market areas. This has clear equity implications. The effects of climate change will be blind to land values but if our LVC policies are not it is conceivable that more affluent areas may obtain a greater degree of investment to support climate adaptation. However, on the question of what investment in this particular area would comprise, some participants pointed out that there is a lack of clear evidence to inform decision making:

> "We do sometimes ask for sustainable urban drainage systems. However, as for larger scale flood defences…that would need a huge amount of money. More than any single development could provide I would have thought. Plus, I don't think we have any evidence to say what we need or where we need it. I know there are climate change models but they aren't part of what we consider when we are negotiating section 106". (Participant A)

Building on this point another participant pointed out that decision making would ideally need to take a longer-term view than is currently the case.

> "We don't look at climate modelling. We're guided by the local plan. We try to get developer contributions that comply with that. There is a lot stuff in the plan about sustainability but there are no specifics. What would be required in order to make somewhere climate-proof over the next century? We just don't know." (Participant E)

Are developers willing to make contributions towards climate adaptation?

Echoing some of the findings presented above, many developers were keen to point out that the principal demand on their contributions is affordable housing:

> "You know AH [*affordable housing*] is the main thing. Most local authorities that we operate in make requests for affordable housing first and foremost." (Participant B)

Whilst this account chimes with the findings presented above there remains the question of whether developers have preferences regarding the kinds of contribution they make. Whilst they may accept that a local policy to secure affordable housing is often a local authority's principal demand, it is conceivable that developers may be more willing to make some contributions than others. This point was given clear articulation by a planning consultant:

> "Most developers accept that they cannot just build houses – they also have to provide other infrastructure that makes a place work. I can't speak for all developers but I would expect that they are most willing to make contributions that return value to the site. So, if we are talking about greenspace or natural flood defenses then there are circumstances where that could add value to a development. You might find that they are happier to supply that than something which does not add value." (Participant L)

A developer made a similar point:

> "Having some certainty is important. If I know what the terms of the obligation are then we can usually work with it. So long as the development is viable, we're happy to provide what the council want. I'd personally prefer it if they wanted things that make the development better but I'm not a politician." (Participant G)

For a different developer, the main issue was not a willingness to pay but a perceived mismatch between what developer contributions could realistically achieve and the scale of the climate emergency.

> "If you look at what climate change could do…the investment required is going to be massive. We can't deal with that on a site-by-site basis. So, yes, I'm happy to include features that improve the development, but I think we are kidding ourselves if we think that we can deal with this one development at a time" (Participant N)

<u>Is the system by which developer contributions are exacted fit for this purpose?</u>

This last point speaks to the discretionary nature of the English planning system. Development proposals are assessed on a case-by-case basis with developer contributions equivalently determined on each individual proposal. The result is a micro-scale focus that should, theoretically, result in each development being sustainable in its own terms. However, this approach potentially grates with the macro characteristics of the climate emergency. If metropolitan areas such as the Liverpool City Region are to seek engineering solutions to mitigate the worst effects of climate change it will probably be necessary to think at a more strategic scale than each individual development. This point was made clearly by one participant:

> "It used to be the case that there were pooling restrictions. You didn't used to be able to pool developer contributions to pay for strategic infrastructure. Some of those restrictions were removed in the last few years but with all the other calls on S106 it would be really hard to imagine pooling enough to make a really sizeable investment." (Participant B)

A similar point was made by another participant from a local authority:

> "We don't charge CIL. For those authorities that do charge CIL, where the property market is strong, they can accumulate cash over time to pay for large scale infrastructure. You can see that with Crossrail in London. But we don't have that luxury up here." (Participant D)

The Crossrail development referred to in this testimony is the new 'Elizabeth Line' development in London which connects Heathrow airport with the east of London. A hugely significant infrastructure project, it was in part funded by developer contributions harvested through CIL.

From testimony of this kind, it is clear that the current system by which developer contributions are exacted in England means that some local authorities will be in a stronger position than others to recover the scale of investment required to invest in climate adaptation. For authorities in buoyant markets where S106 and CIL can be combined, it is possible to imagine developments that have some element of climate adaptation integrated into their specific character which could potentially be supplemented by more strategic infrastructure should local authorities choose to spend CIL receipts in this way. However, in weaker markets where CIL does not operate, of which the Liverpool City Region authorities are a good example, there may be less value to recover and a general tendency to focus developer contributions policies on making each individual development acceptable in its own terms.

Conclusions

The discussion presented above points to three main findings.

Firstly, the vast majority of the value exacted through developer contributions policies in England goes towards affordable housing as this is the principal and first 'ask' made by local authorities. This reflects a specific policy goal in the English context that may effectively 'crowd out' the possibility of securing developer contributions for other categories of investment.

Secondly, the development industry would not *per se* appear to be opposed to the principle that developer contributions could be used to fund measures to support adaptation to climate change. Indeed, where such investments conferred value to the site under development it is possible to imagine that this form of investment would be preferable to others that do not have as strong a commercial case.

Thirdly, the terms of the current system by which developer contributions are exacted in England means that some locations are in a stronger position to recover developer contributions than others. The most recent research commissioned by the Ministry for Housing Communities and Local Government shows that 53% of the value of developer contributions was secured in London and the South East; by contrast the North West, home to the Liverpool City Region, secured just 6% of this total (Lord et al., 2020: 47). The scale of investment that can be secured and the character of the instruments employed to exact contributions means that some locations may be able to marry site-specific climate mitigation measures with strategic-scale investments. For those authorities not in this position, the converse is true: developments may not secure the scale of climate-adaptive infrastructure required to make them sustainable over the longer term.

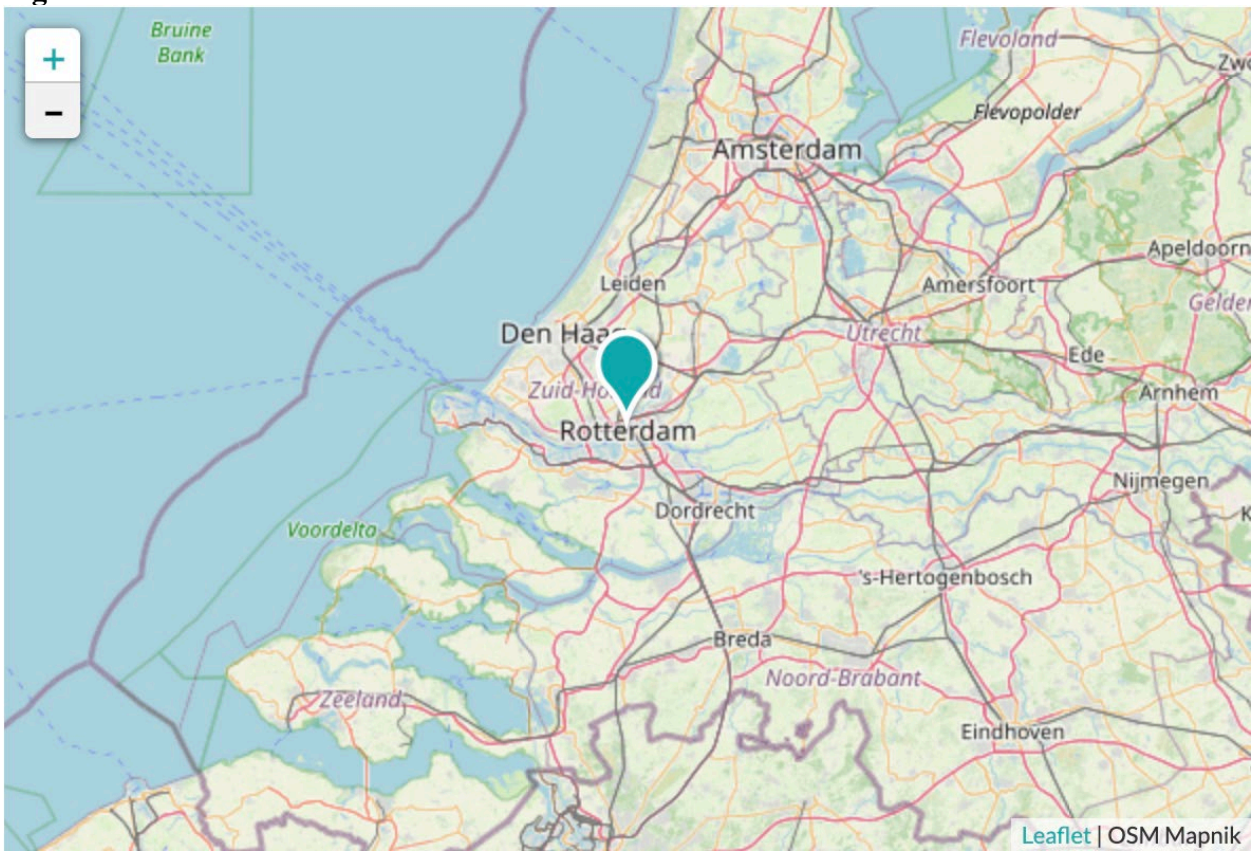
Partly in response to these systemic features of developer contributions policies in England, the UK government is currently consulting on a proposal to replace this system that combines negotiated S106 agreements and CIL with a single 'Infrastructure Levy'. This would see the end of negotiated S106 agreements and their replacement with a locally-determined levy on the sales proceeds from development – a conceptually distinct approach to the question of how the uplift in land value resulting from planning consent should be exacted. If this proposal is enacted, it could have a significant bearing on both the geography of developer contributions and their investment to support climate adaptation.

Rotterdam's climate adaptation strategy – Private developers' readiness to contribute

Context

The city of Rotterdam is particularly vulnerable to climate risks, due to its location at the North Sea coast in the lower reaches of the Rhine-Maas delta, (figure 4.9). If dykes and other flood defenses such as the Maeslantkering storm surge barrier do not 'grow along' with the average higher water levels, the risk of flooding of the land within the dykes increases. The same applies for the land outside the dykes, where 65,000 people live in the Rotterdam metropolitan region. Other climate risks for Rotterdam include increased salinity at collection points for fresh water and groundwater, higher seepage pressure due to rising sea levels, with negative consequences for the water quality, further decline in water quality, and an increase in harmful organisms such as blue-green algae, and urban heat islands causing heat stress and a decline in the city's livability (Rotterdam municipality, 2019).

Figure 4.9: Location of Rotterdam in Rhine-Maas delta



Source: Leaflet, Open Street Map

Table 4.2 summarizes the anticipated effects of climate change for Rotterdam by 2050, based on 2014 climate scenarios by the Royal Netherlands Meteorological Institute (KNMI).

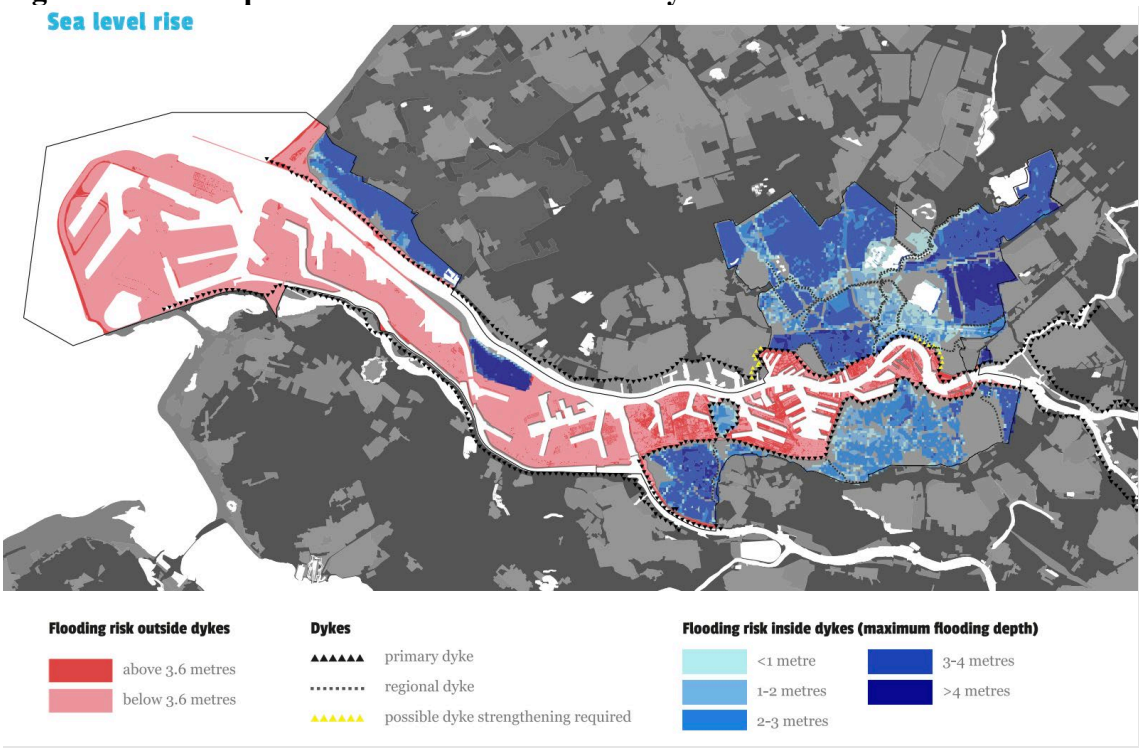
Table 4.2 Anticipated effects of climate change for Rotterdam by 2050

	Climate change	Anticipated climate impact 2050
	Temperature	• From 48 to 20 days of frost by 2050 • From 20 to 35 summery days by 2050
	Temperature	• >30°C from 1 day now to 5-12 days by 2050
	Temperature	• Average temperature rises from 22.1°C to 23.5°C by 2050 • Maximum daytime temperature rises from 36°C to 39°C
	Tropical nights	• From 7 nights of >20°C to around 3 weeks by 2050
	Drought	• Rainfall shortage increases from the current 230 mm to 41pprox.. 288 mm by 2050
	Rainfall	• Rainfall increases to 925 mm • Winters wetter and more extreme rainfall volumes
	Rainfall	• Maximum daily rainfall rises to 94 mm by 2050 • Number of days when rainfall >50 mm increases
	Rivers	• Flow increases in winter • However lower water levels in summer
	Sea level	• Sea level rise by 40 cm by 2050 and 100 cm by 2100 • This causes high-water levels to rise in Rotterdam

Source: Rotterdam municipality, 2019

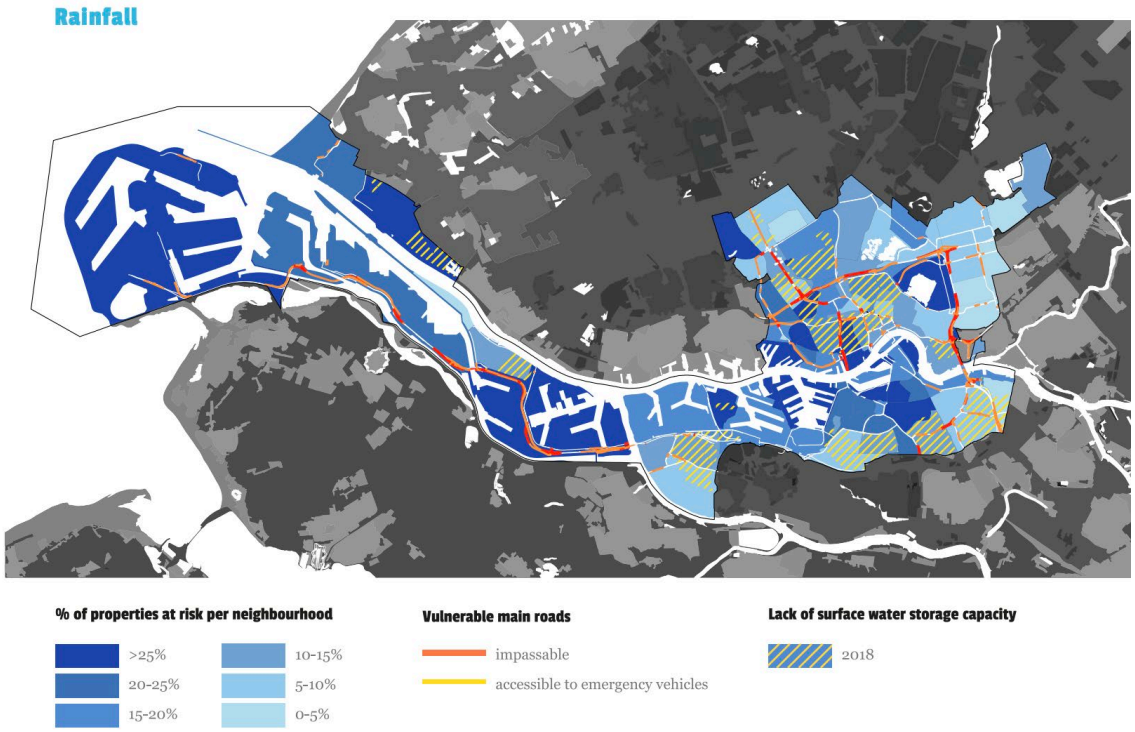
Figures 4.9 and 4.10 show some of the anticipated impacts for Rotterdam in detail.

Figure 4.9: Anticipated effects of sea level rises by 2050



Source: Rotterdam municipality, 2019

Figure 4.10: Anticipated effects of more (intense) rainfall by 2050



Source: Rotterdam municipality, 2019

Rotterdam's climate adaptation strategy

In the Netherlands, the national government launched a national climate adaptation program in 2007 (VROM, 2007). The Delta Program is responsible for the ongoing development of the program, the urban component of which is called the New Housing Development and Restructuring Program (Deltaprogramma, 2010). With the launch in 2009 of the climate adaptation program 'Rotterdam Climate Proof', the city of Rotterdam was one of the first cities in the Netherlands – and a frontrunner city globally as well (Stead and Tasan-Kok, 2013) – to develop its own local climate adaptation strategy. The 'Rotterdam Climate Proof' program resulted in the 2013 Rotterdam Adaptation Strategy (Rotterdam municipality, 2013). In 2019, the city updated its adaptation strategy in Rotterdam Weatherwise (Rotterdam municipality, 2019). Underlying this most recent strategy is the belief that climate change is not just a threat to the city; it also offers opportunities for developing attractive, multifunctional public spaces and green and blue infrastructure. The city now works on a multitude of new policies, actions, and investment projects to make Rotterdam climate proof (table 4.3).

While Rotterdam seems to be on the right track with its adaptation program, (part of) the budget needed for public investments in climate proofing the city has not yet been secured. So far, funding is available from a variety of sources. First, the city includes climate-proofing investments in its regular maintenance program for the sewage system, funded from local sewage levies. Second, municipalities, provinces, regional water authorities, and central government signed in 2018 the Climate Adaptation Administrative Agreement, allocating 600 million euro for local climate adaptation measures. Third, (limited) EU subsidies are available to cities for climate adaptation investments. Fourth, it is expected that Rotterdam's local water system will benefit from investments by regional water authorities – which have their own funding, based on an annual water tax to all Dutch residents and companies. And fifth, climate adaptation investments will be incorporated in Rotterdam's major transition programs, linking climate adaptation to intended investments in green and blue infrastructures, energy transition, and housing. However, a funding gap remains, and land-based financing can play an important role in closing that gap.

Table 4.3: Overview of Rotterdam climate adaptation policies, actions and investment projects (incomplete)

Rainfall	Heat	Drought	Sea level rise	Groundwater	Land subsidence
Policies • Capture and store rainfall locally • Reduce number of properties vulnerable to flooding; secure use of urban infrastructure	**Policies** • Sufficient cooling available in public buildings and private homes • Information campaign to residents	**Policies** • Secure drink water quality • Secure safety of peat dykes during drought periods	**Policies** • Strengthen dykes and flood defenses • Prepare (new) neighborhoods for flood risks	**Policies** • In some areas: solve problems due to low groundwater levels • In other areas: solve problems due to high groundwater levels	**Policies** • Prevent land subsidence due to low groundwater levels
What approach is required? • Improve urban water system • Water retention areas; retarding basins • Monitor health effects	**What approach is required?** • Increase green infrastructure, green roofs • Adjustments to building code	**What approach is required?** • Connect local water system to regional water system, to secure fresh water provision • Store and utilize fresh water to prepare for drought	**What approach is required?** • Connect Rotterdam's climate measures to national Delta Program and regional water authorities' investments	**What approach is required?** • Renovation of houses built on wooden pole foundations (to prevent pole rot) • Reduce risks of saline seepage (salt intrusion from the deep subsoil)	**What approach is required?** • Particularly peat soil vulnerable to land subsidence; awareness must be increase • Collaborate with regional water authorities in approaching the problem
What choices need to be made? • Design water-resilient public space • Water management integrated in early planning stage • Water retention and -retarding regulation for development projects	**What choices need to be made?** • Incentive scheme for property owners • Include heat stress regulation in building code • Include heat reduction investments in public space development	**What choices need to be made?** • Increase public awareness of drought problems • Prepare inhabitants for possible fresh water shortages in the future	**What choices need to be made?** • Regulation for minimum elevation levels for areas outside dykes • New developments near flood defenses must allow for future dyke strengthening	**What choices need to be made?** • Subsidy programs for homeowners that face foundation problems due to low groundwater level • Subsidy programs for homeowners that face problems due to excessive groundwater levels	**What choices need to be made?** • In some areas, existing infrastructures need renovation • Regulation for new development projects to prevent further land subsidence

Source: Rotterdam municipality, 2019, reworked by authors

Bridging the financial gap in climate adaptation through Tax Increment Financing in the Dutch planning context[7]

In a study of market-based financing of local climate adaptation investments in 2016, we asked whether Tax Increment Financing (TIF) as a local-level market-based mechanism would be applicable for facilitating investment in climate adaptation within the institutional context of Dutch land-use planning. TIF, widely used in most American states, also adopted in Canada and more recently in the UK (Squires & Lord, 2012), is a value capturing instrument designed to 'earmark the related increment of property tax in a proclaimed area to fund public investments' (Alexander, 2012). While the duration varies, a TIF is typically based on a 25-year-time span in a prescribed designated community improvement area. It is premised on the idea that the provision of new infrastructure in a designated area will increase property values. Though Dutch land-use planning in principle allows municipalities to apply TIF, it has almost never been used so far, except for by one or two cities. However, with the need for municipalities to raise additional funding for climate adaptation investments, TIF might be an attractive tool for cities to add to their LVC toolkit, particularly because the expected typically delayed – and uncertain at the start of the project – (in)direct benefits of climate adaptation investments in the long term might be captured much better within the typical 25-year-time span of TIF, compared to alternative LVC tools that capture increment land values only once at the start of the project.

We used a game-simulation approach to 'test drive' TIF for climate adaptation investments in Dutch cities. The participants in the games played different roles in which they assessed the possible use of TIF to raise additional funding for these investments.[8] We asked the participants two specific questions: 1) whether channeling the extra property tax earnings above the pre-investment tax base to climate adaptation investments in a specific area, rather than into the general city budget, was acceptable or not; and 2) whether utilizing an instrument that is premised on market growth is appropriate given Dutch municipalities were at the time of the game risk adverse in response to a stagnate planning and development sector. Additionally, we asked them to include in their assessment how the financial risks related to TIF should be divided between the public and private sectors, by offering them three funding options, respectively a *bond-funded*, *municipality-funded,* and *developer-funded* TIF.

The discussions among participants in the games concentrated on three dilemmas related to values: uncertainty, planning horizon, and indirect benefits. In the discussion about value uncertainty, it was not climate change itself that was questioned, but 1) the roles of public and private sectors in financing climate adaptation; 2) the risks of investing and the risks of not

[7] This section on testing TIF for climate adaptation investments is adopted from Root, Van der Krabben & Spit (2016).

[8] We played seven simulation game sessions with in total 59 experienced public and private-sector spatial planning practitioners and policymakers. The game concerned a fictional urban redevelopment project in a fictional city in the Netherlands in which climate adaptation investments are required to replace existing infrastructure due to current flooding problems and future projections that expect the flooding impacts to drastically increase due to climate change by 2050. To mitigate flood impacts a green and blue infrastructure investment plan has been introduced.

investing; and 3) who benefits from such investments and are such benefits fairly distributed? Participants generally argued that given that the answers to these questions remain unresolved, the government ought to play the lead role in facilitating investment in climate adaptation at the local level. Moreover, they were concerned whether channeling incremental property tax income into a specific area was 'fair' (those in economically disadvantaged neighborhoods would not likely enjoy attention from the market). Another consistent concern between participants as a whole was to rely for funding of climate adaptation measures – that were basically considered a public good by the participants – on the market-based speculative nature of TIF. The planning horizon dilemma was situated by the participants as a mismatch between two issues. Firstly, there was uncertainty about the investment phase and the degree to which the market would respond sufficiently to render projected value. Secondly, the strong prerogative was to cite the lack of political support to make explicit adaptation investments: climate adaptation has yet insufficient urgency to justify immediate action. Rather, the strategy to overcome such barriers is by incrementally integrating adaptation measures into planning and operational routines overtime. The indirect benefits dilemma discussion, finally, caused skepticism among participants about the impact of climate adaptation measures on property values. While participants recognize the indirect, "unpriced" benefits of climate adaptation measures, they doubt at the same time whether property values in a dedicated area after climate proofing will increase. Perhaps, climate proofing will prevent future decreases in property value, but that will not offer a solid business case for private developers to bear the risks of a *developer-funded* TIF.

Our analysis of the game outcomes points to the limited acceptance by most of the participants – at the time we played those games (2015) – that TIF, as a market-based financing instrument, should be applied to bridge the financial gap in climate adaptation. What might have played a role in the responses by the participants was that we played these games at a time that the Dutch real estate market was still recovering from the global financial and economic crisis, which made the participants more skeptical about market-based 'solutions'. The findings indicate that the practitioners' responses to TIF were largely shaped by climate adaptation dilemmas and not the characteristics of the instruments per se. Some participants argued that TIF might fit for financing 'regular' public infrastructure works in Dutch cities, but not for climate adaptation measures.

<u>Are developers willing to make contributions towards climate adaptation?</u>

In a more recent study, we asked private sector representatives how likely it is that land-based financing, based on private developer contributions, can play a role in the gap-funding of local climate adaptation measures in Dutch cities. In this study we did not focus on applying TIF– as Dutch cities have not adopted the tool and it is not likely that they will do so in the near future– but analyzed private developers' willingness to contribute to funding of climate adaptation measures within the context of current LVC practices in the Netherlands. For this purpose, 10

semi-structured interviews were held in Spring 2022 with representatives from Dutch private development companies.[9]

Regarding social responsibility and awareness. Participants all agree that the topic of climate change is an urgent matter and that not only actions must be taken to mitigate climate change, but to adapt to climate change as well. Moreover, they see a role for the development industry to act and take responsibility.

> "I think that sort of thing is more of a social responsibility that we have to be aware of, we too as private sector, not just the public sector, in order to do things better in the future" (Participant 5)

In their development plans they increasingly apply nature-inclusiveness principles and include climate adaptation measures in blue and green infrastructures.

> "Then another major flooding in Zuid-Limburg (NL) and the Eifel area (Germany), followed by periods of serious drought. Yes, that will be our new reality. (..) It already is actually". (Participant 7)

Regarding financial feasibility and willingness to contribute. All participants state that in the end their willingness to contribute to climate adaptation measures or any other kind of public goals depends on the financial feasibility of the projects. As long as a 'reasonable' profitability of their business cases can be secured, they are willing to contribute.

> "It's just very simple. If the project remains feasible, it doesn't matter what you spend your costs on. (…) It simply stands or falls with the feasibility."[10] (Participant 6)

> "I always consider (the financial feasibility) as conditional. If we don't make profit, we can't keep doing what we do". (Participant 1)

> "The long-term continuity of our company is always top priority for our management. In addition to commercial interests, of course". (Participant 4)

If the required contribution is expected to result in a financial loss, they will withdraw from the project. In that sense they expect municipalities to come up with 'smart' solutions. Including climate adaptation measures that do not add (commercial) value are not likely to result in higher developer contributions, given the problems they already face with regard to the financial feasibility of their plans.

---

[9] The interviews with private developers were conducted by Fenne Laarakkers, (former) student at Radboud University, as part of her master thesis research. The results of the study are used here with consent of the student. Full results of the study are published in Laarakkers (2022).

[10] Original quotes in Dutch; translated by the authors.

> "What are relatively 'easy' climate adaptation measures to implement that add (commercial) value, instead of adding only extra costs"? (Participant 6)

Regarding the impact of climate adaptation on property values. Participants mention that it is still hard for them to link climate adaptation measures to positive cashflows in their business cases. This obviously depends on the buyers of the houses they build and whether they want to pay more for a house in a climate-proof neighborhood. Most participants do not see evidence yet that this is the case. Moreover, they are concerned that climate adaptation measures will reduce the amount of issuable land in their development project, which will also affect the return on their investments.

> "We consider (climate adaptation) as a quality that indeed often adds social value, but whether that quality also results in higher property prices is another matter". (Participant 3)

Some of the participants argue that there is a trend that home buyers do pay more for a nature-inclusive, green neighborhood. So, integrating climate adaptation measures in green and blue infrastructures would be attractive. Participants also mention that the perspective for the buyers of the houses they build might change if they would see an effect of living in a climate-proof neighborhood on other costs, for example reduced sewage charges or water tax.

Regarding the prioritization of public goods. A potential barrier to the willingness of developers to contribute to climate adaptation measures is the piling of ambitions by municipalities in development projects. Participants argue that developers are expected to contribute to an increasing range of ambitions, including affordable housing, public transport infrastructure, parking, sustainability, circularity, and climate adaptation. They are concerned that including all these public goals in municipalities' development plans will jeopardize their business cases. Without transparency about the priorities set by the public sector, developers remain in the dark to which of these public goals they are expected to contribute, and development risks will increase.

<u>Is the system by which developer contributions are exacted fit for this purpose?</u>

Developer contributions may concern on-site public infrastructure in development projects (in kind or in cash), off-site public infrastructure required because of the development project (but benefitting other areas as well), and contributions to general (red, green, and blue) infrastructure investments that benefit the whole city. LVC regulation in the Netherlands provides municipalities with two mechanisms to exact developer contributions. As a first step, municipalities are obliged to try to negotiate a voluntary developer contribution before a building permit can be approved. Municipalities can choose to substantiate their claim, but do not have to do that. Particularly with regard to contributions for off-site public infrastructure and general infrastructure investments, municipalities usually charge a fixed sum per newly built house in the development project. Many municipalities, however, have published policy documents in which they substantiate the planned infrastructure investments. The revenues from the developer charges will be put in a fund and the municipality will use the fund to pay for these investments. As a second step, if a municipality and a private developer do not reach an agreement about the

size of the developer agreement, a so-called *exploitatieplan* must be drafted that substantiates the total public infrastructure costs in detail and defines the size of the developer contribution, according to detailed regulation regarding the type and size of public infrastructure costs. The size of the developer contribution that the municipality can charge is restricted based on the principle that the size of the contribution should not result in a financial project loss for the developer. In such cases, the municipality must seek additional funding (subsidies). If the developer is not willing to pay a contribution based on the *exploitatieplan*, a building permit will be withheld. Current practice is that in almost all development projects, the municipality and developers reach a voluntary agreement in the first step of this process. However, it is generally assumed – and so it was intended when the regulation was introduced – that the detailed regulation with respect to type and size of public infrastructure costs that can be charged to developers and that then defines developer contributions in the second phase of the process impacts the size of the negotiated contributions in the first stage.

Developer contributions to climate adaptation measures fit in this regulatory framework. Municipalities can charge developers both for on-site climate adaptation measures and for contributions to general public climate adaptation measures that benefit the city as a whole. However, whether this will generate sufficient revenues for cities to close the funding gap for climate adaptation measures is doubtful, at least in the short and medium term, since large urban transformation projects in many Dutch cities already face huge financial feasibility issues due to, among other things, substantial increases in building costs in recent years. Consequently, in many of those projects, municipalities can no longer fully recover their public infrastructure costs from developer contributions, offering not much room for additional climate adaptation measures to be included in public infrastructure costs.

Conclusions

Four conclusions can be drawn from the Dutch case study.

Firstly, planning practitioners see opportunities for land-based financing of the climate adaptation funding gap, particularly by integrating climate adaptation measures in already-planned red, blue, and green infrastructure investments.

Secondly, they are at the same time, quite understandably, concerned about exclusively relying on market-based financing for climate adaptation measures. The public sector needs to be in charge of financing urban climate adaptation.

Thirdly, the Dutch development industry is, similar to what we found in the UK, not opposed per se to contributing to climate adaptation measures, but they are still skeptical about the relation between these measures and real estate values. Consequently, they are reluctant to contribute more to climate-proof infrastructures, compared to ‘regular’ infrastructures.

And fourthly, in the short term, the financial feasibility of many of the current urban transformation projects in Dutch cities seems to put a cap on extending developer contributions to public infrastructure costs. Consequently, introducing charges to private developers for

climate adaptation measures might result in (negotiations regarding) decreased contributions for alternative public goods, including affordable housing.

Chapter 5. Discussion and lessons learned

Our case studies of Charleston, Liverpool, and Rotterdam show that for public sectors in these cities, climate adaptation is high on the agenda. The real estate development industry in these three metropolitan regions recognize – to a certain degree – the urgency to invest in climate adaptation, but believe (for various reasons) that climate action at the urban level primarily is a public sector responsibility. Land-based financing of climate actions is not common yet, but can play a role as gap funding, if certain conditions are met.

Sense of urgency

While the public sectors in Charleston, Liverpool, and Rotterdam, due to their vulnerable geographical positions as coastal cities, feel the urgency to protect themselves against climate risks and have developed policies to adapt the cities to climate changes, the actual implementation of sufficient local climate adaptation measures is still work in progress. Though different in detail, the climate policies and programs developed by the local (and regional) authorities in each of the three metropolitan regions demonstrate how serious they are to build resilience towards climate hazards. However, lack of sufficient revenue sources at the local level makes them dependent on federal/central government funding and still prevents them from a speedy implementation of the required climate adaptation measures. While land-based finance is recognized as a potential revenue source, effective use of this source is lacking so far and federal / national sources seem more promising for now.

What drives private developers?

Most, if not all private developers in our case studies share the public sector's sense of urgency to change the way cities are planned and developed in the changing climate. From this perspective, private developers in our cases claim that they are certainly willing to consider contributions to climate adaptation measures. However, at the same time, they demonstrate a wait and see attitude and point to various 'obstacles' to their financial contributions. First, while most developers probably see the necessity of big, public infrastructure projects that protect cities from flooding, not all developers are convinced yet that additional climate adaptation measures in their own development projects are required. What plays a role is that public sector policies and regulations with regard to these measures are not always transparent and consistent. Second, inconsistency also appears with regard to public and private sector responsibilities regarding climate investments. As long as the public sector fails to take a clear standpoint on this, quite understandably, private developers may be hesitant with their contributions. Third, investment decisions by private developers in the end depend on the profitability of their business case. Because convincing evidence that climate adaptation measures lead to increases in property values is lacking, they argue that their eventual contributions to these measures add to their costs, but are not likely to increase their revenues from selling properties. Finally, though not explicitly stated by participants in our case studies, private developers might actually rather prefer investments to mitigate climate change (e.g., 'green buildings', investments that support energy transition), instead of contributions to climate adaptation, since the climate benefits of mitigation investments are relatively easy to measure and refer to clear climate goals.

What role can land-based finance play in funding climate adaptation measures?

In all three cities, land-based finance has played a rather limited role in funding climate adaptation measures. We found a number of possible 'explanations' for the limited role of land-based finance thus far. Firstly, local government LVC policies regarding climate adaptation are not transparent and unclear. Consequently, the public sector often seems unable to present a properly motivated request for developer contributions to climate adaptation, weakening the public sector's position in negotiating these contributions. Secondly, convincing evidence that project-level climate adaptation measures increase property values is mostly lacking. As we argued above, this makes private developers skeptical about the extent to which they would benefit from climate actions. And thirdly, private developers are concerned about the profitability of their development projects in general, due to increased building costs and additional building requirements (e.g., energy transition and circular economy investments).

Nevertheless, based on our case studies, we argue that land-based finance can play a bigger role in the future, primarily as gap funding and in addition to bigger public climate investments. At project level, participants in our case studies have suggested that the integration of climate adaptation measures in "regular" infrastructure projects might reduce costs and improve the feasibility of their business cases. At local level, local authorities should consider installing a local climate fund and to require developer contributions to such a fund. Revenues from property taxes and/or dedicated tax income, from sewage levies and/or (regional) water taxes, can be combined with land-based revenues in such funds. Bankability of larger public climate adaptation investments may consequently improve.

What can go wrong? Risks of market-based finance

Participants in the cases have pointed to the risks of using market-based finance as a source for funding climate actions as well. In all three countries, protection against climate risks is considered primarily as a government responsibility, and sufficient protection cannot rely on (uncertain) market-based finance alone. Moreover, equity issues and gentrification dilemmas are likely to enter the discussion. The responses of the participants in our case studies show that, in the context of the limited financial feasibility of development projects, climate adaptation contributions may lead to negotiations about a *tradeoff* between different public goals. If local governments require climate adaptation contributions, other contributions – for example, to affordable housing or public transport – must come down, to secure the financial feasibility of the development project. Another equity issue refers to the fact that land-based finance often only targets new development projects, while climate risks are likely to threaten larger parts of a city.

Are the LVC instruments fit for purpose?

In none of the three cities have LVC instruments been implemented that are exclusively used for climate actions. And we didn't actually find any support for such an exclusively applied policy. Climate adaptation measures can be treated in the same way as traditional

red, green, and blue public infrastructure projects, when charging private developers for contributions to these projects. “Free money in land”. But how much exactly?

Land-based finance is based on the fact that changes in land use and public infrastructure investments create an increment value in land and that (part of) the “unearned increment” can be creamed off by the public sector, to reinvest in sustainable urban development. In our case studies, we find that the question of how much “unearned increment” - and, consequently, how much developers can be charged - often leads to dispute. This is of course not a new phenomenon and is due to characteristic asymmetric information problems in complex urban development projects. However, with the introduction of a relatively new public goal of climate adaptation, the information problems might be even bigger, since reliable information about costs and returns of these climate investments is in most cases missing and both public and private sector actors cannot count on reference projects from the past.

Chapter 6. Conclusions

Billions of dollars are needed to adapt cities globally to the impacts of climate change. While for many cities perhaps the sense of urgency to invest in climate adaptation measures is still absent, cities like Charleston, Liverpool, and Rotterdam simply have no choice to postpone climate action, due to their vulnerability to the immediate effect of sea level rise. For that reason, these cities are at the forefront of developing policies and taking action for climate adaptation measures. At the same time, however, funding gaps still exist with regard to the required investments in climate adaptation measures. Land-based finance can play a role in filling these gaps and act as a leverage to additional (public) climate investments. Private developers are not opposed per se to contributing to climate adaptation measures and are mostly aware of their social responsibility to play a role. However, uncertainties and a lack of transparency about both the urgency of local climate adaptation measures, the public sector requirements to develop climate-proof locations, and the (in)direct benefits of these measures, including their impact on property values, may still make the private sector hesitant to contribute. We would therefore recommend to local governments, as key elements of the introduction of a successful land-based finance strategy for climate adaptation: 1) to develop a clear climate adaptation strategy; 2) to increase the 'predictability' of required developer contributions to climate action; and 3) to provide evidence of successful climate adaptation measures and their impact on both the reduction of climate risks and their effect on property values.

Our study also points to private developers' concerns about the profitability of their business cases, if additional contributions to climate adaptation are required. This should raise concern for local governments as well, since private developers can be expected to withdraw from projects if the profitability is at risk. As a solution, the participants in our case studies suggest developing an integrated approach to urban development and climate adaptation policies. By integrating climate adaptation measures in 'regular' infrastructure projects, cost reductions may appear (and less developer contributions required). And by integrating climate measures into the design of an urban neighborhood, attractive places can be created that add to the viability of development projects.

Moreover, as we mentioned above, land-based finance often only targets new development projects, while climate risks are likely to threaten larger parts of a city. A possibility to prevent such unequal distribution of land-based finance is to install a local climate fund and to require developer contributions to such a fund, instead of using these contributions exclusively for financing of on-site climate-proof infrastructure. A potential, positive additional effect might be – particularly if revenues from developer contributions can be combined with other revenues, for instance from sewage levies or water taxes – that this will increase the attractiveness (bankability) of local climate adaptation investments by public and/or private sectors.

Research agenda

Finally, we recommend a research agenda, in order to prepare local governments and the private development industry for a much more *evidence-based* debate with respect to a land-based finance strategy for climate adaptation investments. Firstly, more research into the impact of both climate risks and climate adaptation measures on property values is needed, since private

developers' investment decisions in the end will always depend on that. Secondly, private developers' business cases often remain a black box for local governments, while at the same time local government LVC policies often are not transparent to private developers. Consequently, negotiations about developer contributions often struggle with information asymmetry problems. Research into business cases of development projects can be helpful to build a better case for land-based finance, by providing information on: 1) the impact of land use change on land values, and 2) how much of that increment land value is captured by local governments. Thirdly, we recommend further study of how land-based finance, by increasing bankability, can act as leverage to additional public and private sector financing of climate adaptation measures.

References

Alexander, E.R. 2012. "Institutional Design for Value Capture and a Case: The Tel-Aviv Metropolitan Park." *International Planning Studies* 17(2): 163-177. https://doi.org/10.1080/13563475.2012.673738.

Alterman, R. 2012. "Land Use Regulations and Property Values: The 'Windfalls Capture' Idea Revisited." In *The Oxford Handbook of Urban Economics and Planning* eds. Nancy Brooks, Kieran Donaghy, and Gerrit-Jan Knaap, 755-786. Oxford University Press.

Bisaro, A. and J. Hinkel. 2018. "Mobilizing private finance for coastal adaptation: A literature review." *WIREs Climate Change* 9(3). https://doi.org/10.1002/wcc.514.

Bobylev, N., D. Hunt, I. Jefferson, and C. Rogers. 2013. "Sustainable Infrastructure of Resilient Urban Environments." In *Advances in Underground Space Development*, edited by C.S. Zhou, 906-917. Singapore: Research Publishing.

Buckman, S. T. and S. Sobhaninia. 2022. "The impact of sea-level flooding on the real estate development community in Charleston, SC: Results of a ULI member Survey". *Journal of Sustainable Real Estate* Vol. 14(1): 4-20.

Cains, M.G. 2021. *Integrating climate change vulnerability risk, and resilience for placed based assessment of socio-ecological systems: Charleston harbor watershed* (Doctorial dissertation). Indiana University.

Carroll, A. 1991. "The Pyramid of Corporate Social Responsibility: Toward the Moral Management of Organizational Stakeholders." *Business Horizons* 34(4): 39-48. DOI: 10.1016/0007-6813(91)90005-G.

Chang, R. 2023. "This South Carolina Destination Was Just Named the No. 1 City in the U.S. by T+L Readers – Here's Why." *Travel + Leisure*. July 12. https://www.travelandleisure.com/trip-ideas/best-united-states-city-charleston-south-carolina.

Chu, E., A. Brown, K.M., J. Du, S. Lwasa, and A. Mahendra. 2019. "Unlocking the Potential for Transformative Climate Adaptation in Cities." Background Paper prepared for the Global Commission on Adaptation, Washington, DC and Rotterdam. Available online at ww.gca.org.

Cities Climate Finance Leadership Alliance. 2021. *2021 State of Cities Climate Finance Report*. (June). https://citiesclimatefinance.org/publications/2021-state-of-cities-climate-finance/.

City of Charleston. 2019. *Flooding and Sea Level Rise Strategy*. Accessed a https://www.charleston-sc.gov/DocumentCenter/View/20299/Flooding-and-Sea-Level-Rise-Strategy-2019-web-viewing?bidId=.

Crosby, N. 2019. "Development viability assessment and the provision of affordable housing. A game of 'pass the parcel'?" *Town Planning Review* 90(4): 407-428. DOI: https://doi.org/10.3828/tpr.2019.27.

Deloitte. 2020. *Financiële instrumenten klimaatadaptief bouwen*. The Hague: Province of South Holland (May).

Dunning, R. J., and A. Lord. 2020. "Viewpoint: Preparing for the Climate Crisis: What Role Should Land Value Capture Play?" *Land Use Policy* Volume 99. (December).

EEA (European Environment Agency). 2019. *The European environment – state and outlook 2020: Knowledge for transition to a sustainable Europe.* Luxembourg: Publications Office of the European Union. (December). https://www.eea.europa.eu/soer/publications/soer-2020.

Gigerenzer, G., and W. Gaissmaier. 2011. "Heuristic Decision Making." *Annual Review of Psychology* 62: 451-482.

Hartmann, T., and T. Spit. 2014. "Capacity Building for the Integration of Climate Adaptation into Urban Planning Processes: The Dutch Experience." *American Journal of Climate Change* 3(3): 245-252. http://dx.doi.org/10.4236/ajcc.2014.33023.

Keskitalo, E.C.H., S.K. Juhola, N. Baron, H. Fyhn, and J. Klein. 2016. "Implementing Local Climate Change Adaptation and Mitigation Actions: The Role of Various Policy Instruments in a Multi-Level Governance Context.: *Climate* 4(1). https://doi.org/10.3390/cli4010007.

Kiel, K. A. 2021. "Climate Change Adaptation and Property Values: A Survey of the Literature." Working paper. Cambridge, MA: Lincoln Institute of Land Policy (August).

Koppenjan, J.F.M, and Enserink, B. 2009. "Public-Private Partnerships in Urban Infrastructures: Reconciling Private Sector Participation and Sustainability." *Public Administration Review* 69(2): 284-296. https://doi.org/10.1111/j.1540-6210.2008.01974.x.

Lancaster, K.J. 1996. "A New Approach to Consumer Theory." *Journal of Political Economy* 74(2): 132-157. *http://www.jstor.org/stable/1828835*.

Laarakkers, F.P. 2022. "Developer obligations: the outcome for financing climate change adaptation." Master thesis, Radbound University, 2022. https://theses.ubn.ru.nl/bitstreams/b82fda14-e383-4d7c-8a55-b77c2c71b9aa/download.

Lord, A.D. et al. 2020. The incidence, value and delivery of planning obligation and the community infrastructure Levy in England, 2018/19. Ministry for Housing, Communities and Local Government: London. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/907203/The_Value_and_Incidence_of_Developer_Contributions_in_England_201819.pdf.

Lord, A.D., E. van der Krabben, and G. Dong. 2022. "Building the Breathable City: What Role Should Land Value Capture Play in China's Ambitions to Prepare for Climate Change?" Working paper. Cambridge, MA: Lincoln Institute of Land Policy (June).

Lord, A.D., G. Burgess, and R.J. Dunning. 2019. "Virtuous or vicious circles? Exploring the behavioural connections between developer contributions and path dependence: Evidence from England." *Geoforum* 106: 244-252.

Matthews, T. 2013. "Institutional perspectives on operationalising climate adaptation through planning." *Planning Theory and Practice* 14(2): 198-210. DOI: 10.1080/14649357.2013.781208.

McAllister, P. 2019. “The taxing problems of land value capture, planning obligations and viability tests: some reasonable models?” *Town Planning Review* 90(4): 429-451. DOI: 10.3828/tpr.2019.28.

McIntosh, J., R. Trubka, and P. Newman. 2014. “Can value capture work in a car dependent city? Willingness to pay for transit access in Perth, Western Australia.” *Transportation Research Part A: Policy and Practice* 67: 320-339.

Mills, G. 2021. *Sea level rise and coastal flooding in Charleston: A resilience and adaptation plan.* Retrieved from http://storymaps.arcgis.com/stories.

Muñoz Gielen, D., and E. van der Krabben. 2019. *Public Infrastructure, Private Finance: Developer Obligations and Responsibilities*. Milton Park: Routledge.

Nicholls, S. 2019. “Impacts of environmental disturbances on housing prices: A review of the hedonic pricing literature.” *J Environ Manage* 246: 1-10. DOI: 10.1016/j.jenvman.2019.05.144. Epub 2019 Jun 3. PMID: 31170618.

NOAA (National Oceanic and Atmospheric Administration). 2022. *Severe weather 101 – Floods.* National Severe Storms Laboratory.

Plater, A. J. 2017. ARCoES: Adaptation and Resilience of Coastal Energy Supply. Coastal flood risk map decision support tool. Available at: https://arcoes-dst.liverpool.ac.uk/.

Porter, M.E., and M.R. Kramer. 2011. “Creating shared value: How to reinvent capitalism -- and unleash a wave of innovation and growth.” *Harvard Business Review* (January/February): 62-77.

Riley, J.P. Jr. 2015. “Sea level rise strategy.” *City of Charleston, South Carolina* (December). Retrieved from https://www.charleston-sc.gov/DocumentCenter/View/10089 [Google Scholar].

Root, L., E. van der Krabben, and T. Spit. 2015a. “Bridging the financial gap in climate adaptation: Dutch planning and land development through a new institutional lens.” *Journal of Environmental Planning and Management* 58(4): 701-718. DOI: 10.1080/09640568.2014.885412.

Root et al. 2015b. “Between structures and norms: assessing tax increment financing for the Dutch spatial planning toolkit.” *The Town Planning Review* 86(3): 325-349. DOI: 10.3828/tpr.2015.20.

Root et al. 2016. “‘Test Driving’ a Financing Instrument for Climate Adaptation: Analyzing Institutional Dilemmas using Simulation Gaming.” *Planning Practice & Research* 31(3): 250-269. DOI: 10.1080/02697459.2016.1158073.

Rotterdam Municipality. 2013. “Rotterdam Climate Change Adaptation Strategy.” City of Rotterdam, Netherlands (October).

Rotterdam Municipality. 2019. “Preparing our city for a more extreme climate together.” City of Rotterdam, Netherlands: Rotterdam Weather Wise.

Runkle, J., Svendsen, E.R., Hamann, M., Kwok, R.K,., and Pearce, J. 2018. “Population health adaptation approached to the increasing severity and frequency of weather-related

disasters resulting from our changing climate: a literature review and application to Charleston South Carolina". *Current Environmental Health Reports.* Vol 5(4): 439-452.

Spencer, James H. 2019. "Small and Big Infrastructure: A Community Planning Theory of Increments, and Interoperability." *Journal of Economic Policy Reform*, DOI: 10.1080/17487870.2019.1616547.

Spencer, James Nguyen H. "Theorizing the Spatial Impact of Financial Valuation on Poor Communities: A critical discussion of empirical real estate appraisal." *(under review).*

Spencer, James Nguyen H. 2022. *Planning for Water Security in Southeast Asia: Community-Based Infrastructure During the Urban Transition*. London: Anthem Press. Release on September 13, 2022.

Squires, G., and Lord, A.D. 2012. "The transfer of Tax Increment Financing (TIF) as an urban policy for spatially targeted economic development." *Land Use Policy* 29(4): 817-826. http://dx.doi.org/10.1016/j.landusepol.2011.12.007.

Stead, D., and T. Tasan-Kok. 2013. "Urban resilience, climate change and land-use planning in Rotterdam." *Resilience Thinking in Urban Planning*: 211-228. DOI: 10.1007/978-94-007-5476-8_13.

Storbjörk, S., M. Hjerpe, and E. Glaas. 2019. "Using Public-Private Interplay to Climate-Proof Urban Planning? Critical Lessons from Developing a new Housing District in Karlstad, Sweden." *Journal of Environmental Planning and Management* 62(4): 568-585. DOI: 10.1080/09640568.2018.1434490.

Tibbetts, J. & Mooney, C. 2018. "Sea level rise eroding home clause and owners might not even know it." *Washington Post,* August 20.

University of Reading, Three Dragons, Hives Planning, David Lock Associates, and DLA Piper LLP. 2014. *Section 106 Planning Obligations in England 2011-12.* London: Department for Communities and Local Government (May).

US Army Corps of Engineers. 2021. *Charleston Peninsula Coastal Flood Risk Management Study.* Accessed at https://www.sac.usace.army.mil/Missions/Civil-Works/SupplementalFunding/Charleston-Peninsula-Study/.

Waggoner and Ball. 2019a. *Dutch Dialogues Charleston*. Charleston, SC. (September). Accessed at https://www.charleston-sc.gov/DocumentCenter/View/25055/Dutch-Dialogues-Charleston_Final-Report-September-2019.

Appendix

Appendix 1: Charleston ULI Survey

Charleston Questions

1. What is your primary business related to real estate?
    a. Real Estate Development
    b. Brokerage
    c. Architecture/Design/Engineering
    d. Investment
    e. Banking
    f. City Government
    g. Permitting/consulting
2. If you answered A, B, or C what area of real estate do you specialize in? (or check all that apply)
    a. Residential (single family)
    b. Residential (Multifamily)
    c. Hospitality
    d. Office
    e. Retail
    f. Industrial
    g. Mixed Use
3. What is your role in the company?
4. Do you see climate change as a major concern for the Charleston region? Rate 1-5 with 5 being a major concern and 1 not being a major concern.
5. Do you see concern for climate change in the real estate development community in Charleston? Rate 1-5 with 5 being a major concern and 1 not being a major concern.
6. What measures if any are you/your company taking in your developments to deal with climate change? Flooding, heat or resilience/preparedness for hurricanes etc?
7. If you or your company are making changes or planning to make any changes are they:
    a. Self-Imposed
    b. Government Imposed
    c. Imposed by underwriters (insurance or financing)
8. In regard to real estate development patterns where do see climate change having the greatest impact?
9. Are developers shying away from those areas subject to flooding?
    Yes No
10. In relation to the previous two questions do you see development patterns shifting to different locations because of climate change and if so where do you see development patterns shifting to?
    Yes No
11. In your opinion is the municipal government doing enough to combat climate change?
    Yes No

12. If you answered NO to the previous question, what should municipal government be doing? If you answered yes what are the best and worst thing it is doing or not doing?
13. What role if any does or should the development community have in combatting climate change?
14. Do you think cost is a main issue of climate change adaptation?
    Yes No
15. If you answered yes to the issue of cost what role is cost playing in the added effort of climate change adaptation?
16. Again, if yes. How are developers dealing with the cost of climate change adaptation and how would those costs be better dealt with in the future?
17. Who in the end should be dealing with the issue of cost(s) when it comes to climate change adaptation?
    a. Private Sector
    b. Public Sector
18. Is there anything you would like to add?
19. As this is an anonymous survey no identifying information will be obtained or shared. Yet if you wish to add furthermore nuance information and would be willing to be interviewed via zoom or in person please leave your name and email address.