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Local Solutions: Financing Climate Action through Land Value Capture

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Abstract

The urgent need to address climate change has prompted subnational governments worldwide to explore innovative financing mechanisms to fund climate investments. This paper examines land value capture (LVC) as a potential source of financing for local climate action, reviewing instruments and implications associated with their implementation. It demonstrates how public climate interventions, including low-carbon transportation and green infrastructure, can positively impact land values and how subnational governments can recover those increments through LVC for additional public benefit. The paper examines common LVC instruments and their rationale, exploring how these mechanisms have been employed in different jurisdictions to fund climate mitigation and adaptation efforts. The paper underscores the potential of LVC as a viable financing mechanism for subnational climate action, offering insights into its practical implementation.

Keywords: climate change, land value capture, land use, municipal finance

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Introduction

The impacts of climate change, compounded by current patterns of urbanization and inequalities, require fiscally healthy local governments that can act boldly. Subnational governments must be enabled and aware of the opportunities to access financial instruments to provide services and address the current climate crisis.[1] Climate change presents an enormous and impending threat that all levels of government must commit resources towards to avoid cascading and crippling damages. The investments needed to decarbonize the economy and adapt to the mounting impacts of climate change total in the trillions of dollars. Unfortunately, global financial systems and current municipal revenues are wholly inadequate to respond to the crisis as currently operating. A small fraction of the trillions of dollars needed for climate action are being met through existing finance flows, and subnational governments often cannot access what funding there is due to institutional and legal constraints.

Yet, the climate crisis cannot be solved with money alone. Forward thinking planning and a reconfiguration of existing land uses will be needed to move people and assets out of harm's way, protect valuable natural lands that are carbon sinks and buffers to climate impacts, and site new infrastructure to support a decarbonized economy. Such changes in land use must be carefully navigated so as not to further exacerbate inequalities compounded by climate change. It is not difficult to imagine an era of climate-driven land speculation as competing demands for land for safe habitat, renewable energy, agriculture, habitat, and more stack up. In fact, it is already happening (McCarthy 2022, Keenan et al. 2018). Cities must be equipped with not just the finances, but also the political will and the tools to equitably distribute the benefits of climate resilience across the population.

As cities confront these challenges, they should embrace a largely untapped, yet universal resource sitting under their feet – land. The value of this resource is enormous and exceeds the value of all global equities, securities, and gold combined (Coomes et al. 2018). In the United States alone, studies have estimated that the value of urban land (just the land, not the buildings or improvements on top of the land) is nearly double the nation's GDP (Florida 2017). Increasing demand for a finite resource, more intense uses, and service and infrastructure improvements have all contributed to the continued increase in land values. At the same time, climate change, and mitigation and adaptation investments in response to climate change, are also impacting land values, further increasing the potential of this untapped resource. While climate change will make some land uninhabitable, decreasing its value as a place to live, it will also increase land values elsewhere in more resilient places. To whom should those land value increments belong? Likewise, investments in new infrastructure and new land use regulations in response to climate change will raise the value of land. Developers and property owners should share a portion of that increment to help local governments recover costs of the infrastructure or help fund investments in other public benefits, including additional climate resiliency.

Land value capture (LVC) provides the mechanisms that link public interventions on climate to increases in land value and offers opportunities to sustainably finance and encourage urban climate action. When utilized, LVC can improve the fiscal health of cities and help close the global climate finance gap, enabling local governments to respond to urgent local needs exacerbated by climate change. Beyond the potential of LVC to generate much needed revenue, it also represents a formidable tool to improve the functioning of urban land markets, improve overall fiscal health, and advance equity goals beyond just climate action. By integrating urban planning with municipal finance instruments, LVC can create a more favorable enabling environment for public climate interventions, especially in urban and urbanizing areas. The magnitude of the climate crisis and response needed present an opportunity to look beyond the economic and financial systems that have been complicit in fueling current challenges. As Dunning and Lord (2020) suggest, LVC can be much more than another revenue stream for municipalities but can be leveraged to foster the type of inclusive, climate resilient development necessary in an era of climate change.

[1] The term "subnational governments" refers broadly to local, or municipal and regional, entities.

This chapter explores LVC for climate action and argues that local governments can and should leverage the largely untapped resource of land to sustainably finance all or part of their climate investments.

Importance of Subnational Climate Action

Subnational governments are critical to both climate mitigation and adaptation efforts. An increasing share of global greenhouse gas emissions stem from urban areas and, as mentioned in a previous chapter, around 40 percent of emissions are a result of activities under the purview of subnational governments (IPCC 2022a; Martinez-Vazquez 2021). In addition to their emissions contributions, urban areas also represent areas of consolidated vulnerability to the impacts of climate change, to which local governments are often responsible for responding. More acutely aware of the local impacts of climate change, subnational governments have an opportunity to fill the gap left by national governments and international frameworks.[2] Indeed, recent international conferences and agreements have finally acknowledged the importance of multilevel and subnational action on climate change, recognizing the shortcomings of national action and current global climate finance flows.[3] Administrative, technical, and financial capacity at the subnational level is critical to ensure decisions are made to fairly direct resources towards more climate friendly and resilient communities.

While legal frameworks vary depending on the context, subnational governments generally have control over many investment and policy decisions that relate to climate mitigation, including land use regulations, building codes, parks and greenspace, transportation, and urban form.[4] These are the same responsibilities and tools that make subnational governments significant actors in the processes that generate land values. When considering the mitigation potential and strategies available to subnational governments, it is also important to consider the region's level of development and state of urbanization. To achieve deep emission reductions, established cities will need to focus on improving energy efficiency and retrofitting buildings; limiting sprawling, greenfield development; and improving low-carbon mobility options, such as public transportation, walking, and biking. On the other hand, rapidly urbanizing, emerging regions have the opportunity to leapfrog carbon intensive infrastructure and development patterns, but also risk making poor decisions that will lock-in emissions for decades. Compact and walkable urban form combined with high-quality public transportation, green space, and energy efficient buildings can ensure low carbon development and a high quality of life in emerging cities (IPCC 2022a). In both scenarios, public action, and investments in land and how land is used to address climate change, are positively affecting land values, most often the value of privately held property. Acknowledging this point is central for understanding and justifying the use of land value capture, as described in later sections.

[2] International frameworks refer to the multiple international conventions and multilateral agreements that relate to climate change and sustainable development financing. The UN Framework Convention on Climate Change (UNFCCC), founded in 1994, is the primary body that establishes the basic legal framework and instruments for international cooperation related to climate change, including the 1997 Kyoto Protocol and the 2015 Paris Agreement. The UNFCC also includes financial mechanisms, including the Global Environment Facility, the Green Climate Fund, and the Adaptation Fund. The Sustainable Development Goals, the Sendai Framework for Disaster Risk Reduction, and the New Urban Agenda also contribute to this framework.

[3] The Glasgow Climate Pact, the resulting agreement from the 26th Conference of the Parties (COP) in 2021, makes explicit reference to the "urgent need for multilevel and cooperative action" and notes the importance of local and subnational financing mechanisms. COP21 also established the Marrakech Partnership for Global Climate Action facilitates collaboration between national governments and cities, regions, businesses, and others, to help implement the Paris Agreement.

[4] The examples of subnational climate action listed here are not comprehensive, but rather highlight a few of the actions that will be discussed throughout the chapter in relation to land values and land value capture instruments. See Smoke and Cook's previous chapter, "Administrative Decentralization and Climate Change: Concepts, Experience, and Action," for a more complete overview of subnational climate mitigation and adaptation actions.

The impacts of climate change, despite mitigation efforts, are projected to increase in the coming decades (IPCC 2022b). Subnational governments play an essential role in adapting to these impacts and protecting vulnerable populations. Reducing future vulnerability to climate change will depend, at least partially, on the capacity of subnational governments to safeguard populations and critical infrastructure, including sanitation, water, health, transport, communications, and energy. Nature-based solutions in urban settings, such as increased tree canopy, increased greenspace for stormwater control and flood protection, and coastal wetlands, offer adaptation benefits while also contributing to mitigation efforts. Marginalized populations in informal settlements are particularly vulnerable to the impacts of climate change. Investments to improve services and living standards are essential to increase the adaptive capacity of these populations and provide many co-benefits, including positive impacts to land values. Like the mitigation responses mentioned before, different levels of development and urbanization are important to consider for adaptation action also. Emerging and rapidly urbanizing areas present an opportunity for inclusive, climate resilient development to be incorporated into urban form from the start, rather than having to undertake costly retrofitting that is necessary in many established cities.

Strengthening municipal fiscal health through own-source revenue streams, such as LVC, will be critical to achieve the levels of funding required to meet the scale of the climate crisis. Local governments are already acting on climate through a range of interventions and investments, including changes to land use regulations and building codes, investments to change gray infrastructure to green infrastructure, and investments in low-carbon mobility systems. However, more ambitious action is needed which will require additional financing. Cities that promote more compact development or the densification of under-utilized areas are using land use regulations in ways that not only help reduce consumption of land, but also increase the value of property, especially as the greater densities help meet growing demands for housing. The next section will explore how these examples of climate action can be a source of revenue if linked to appropriate LVC instruments.

Land Value Capture: An Overview

Public action should generate public benefit. This is the basic tenet of land value capture, which is based on the idea that increases in private land values resulting from government actions should be – at least partially – recovered by the public, as the private landowners did nothing to earn the increment other than being in the right place at the right time. Government actions that generally increase land values include investments in physical infrastructure, such as sewer systems and roads, or administrative actions, such as allowing greater density in a particular area.

To demonstrate this, imagine a single plot of land on the periphery of a small city (Figure 1). The plot of land is not serviced by any infrastructure, such as roads or potable water and therefore, its land value is low, as it cannot accommodate many uses. However, as the nearby city grows, the city builds a road adjacent to the plot of land and extends water and sewer infrastructure to properties along the new road. Responding to the new demand created from the infrastructure investments, the city changes its land use regulations to convert the previously rural plot of land to allow for commercial and multi-family residential development. Each of these actions by the city increased the value of the plot of land and generated a windfall for the property owner, despite the property owner taking no action. In fact, studies have found that the urban multiplier – the increase in land value associated with the conversion of rural land to urban uses – typically ranges from 400 to 600 percent (Smolka 2013). The principles of LVC argue that the positive increments in land values caused by public action should be recovered by the public to help defray costs.

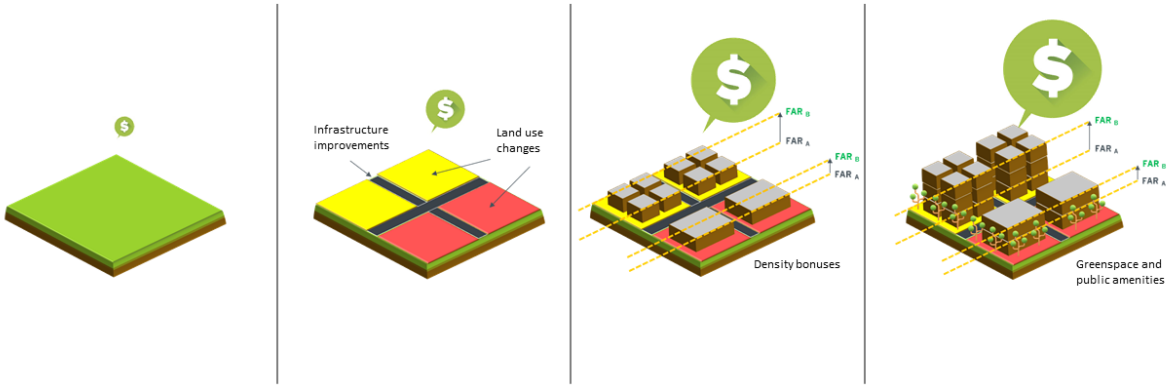

Figure 1. Illustration of public actions and their impacts on land values. Public investments in infrastructure improvements, such as a new road, park, or subway line, and government actions, like a change of land use or density allowances, are examples of public actions that generate land value increases. The positive increments in land values caused by public action should be recovered by the public for public benefit. Source: Lincoln Institute of Land Policy.

Today, LVC instruments are used across the globe, in both mature and developing economies, to finance various types of infrastructure and public goods, from light rail to affordable housing. There is a rich body of research documenting the positive impacts of public investment on land values and how that value can be recovered by the public for additional infrastructure, affordable housing, and other public goods (Smolka 2013; Walters 2013; Vetter and Vetter 2016; McAllister et al. 2018; Hu et al. 2019; Kim 2020).

A recent survey of 60 countries found that LVC is used in all countries, at least occasionally (OECD/Lincoln Institute of Land Policy, 2022). Generally, higher income countries employ a slightly more diverse set of instruments (2.5 types of instruments versus 2, respectively), but this does not always hold true. Chile, Egypt, India, and Turkey use five different types of value capture instruments on a regular basis (OECD/Lincoln Institute of Land Policy, 2022). Importantly, the same survey found that the large majority of countries designate subnational governments responsible for implementing LVC instruments. While it is difficult to quantify the current or potential scale of revenues from LVC instruments, we can look to specific countries for evidence. In England, developer contributions (the primary LVC tool available) generated £7 billion for local governments between 2018-2019, a 16% increase from the prior year (Lord, et al., 2020). While this may seem like a small figure compared to the global finance gap, these funds are often essential for local projects. Developer contributions and other LVC mechanisms were a significant source of funding for the London Crossrail project, one of the UK's largest urban infrastructure project (Buck, 2017).

LVC instruments are versatile and have been applied through a diverse set of techniques that share a common goal: to recover all or part of the positive increment in private land value caused by public action and return it in the form of public benefits. Common examples of LVC instruments include special assessments, betterment levies, the property tax, transfer of development rights, land readjustment, and charges for development rights (Germán and Bernstein 2020). Despite the diversity of instruments, the process of LVC can be represented in three interrelated components:

1. Value generation: The LVC process depends on public action that increases land values. As mentioned previously, this can include investments in infrastructure and regulatory and administrative action. Subnational governments are responsible for a wide range of actions that may generate value, including direct investments in infrastructure, land use changes, granting of building rights, and fee waivers.
2. Value appropriation: The second step in the process involves the recovery of land value increases. There are many LVC instruments that could be utilized depending on the local context, including the

legal framework, type of action, and administrative capacity. Often, the choice of LVC instrument depends on how the proceeds will be utilized, in addition to the type of action that generates the value. For example, betterment contributions are often used to only recover the cost of an infrastructure investments that has increased the value of land for specific property owners. Despite the variety of instruments, the premise remains the same: public action should generate public benefit.

3. Value utilization: The final step in the LVC process is the use of the recovered increment. This step is fundamental to the public perception and success of the instrument. The funds recovered should be used in a way that promotes equity and generates a demonstratable public benefit.

Common Land Value Capture Instruments

A variety of LVC instruments exist and terminologies vary across countries and legal contexts. However, the Lincoln Institute and OECD provide a useful taxonomy of LVC instruments in their 2022 *Global Compendium of Land Value Capture Policies* (OECD/Lincoln Institute of Land Policy). This taxonomy includes five different categories of LVC instruments, detailed below.

Infrastructure levies

Often known as special assessments or betterment contributions, infrastructure levies are fees landowners pay for public investments from which they benefit, such as a metro line, sewer system, or park. Depending on the type of investment, the government will designate a beneficiary area in which all landowners must pay the fee, which can be a one-time fee or assessed over a longer period. The amount of the fee should be proportionate to the land value increment incurred by the public investment.

Developer obligations

Developer obligations, also known as impact fees, exactions, or development charges, are cash or in-kind contributions developers pay as a condition of development approval or other permissions. They can be either negotiated or set by a fixed rate, and are intended to offset the costs of the additional infrastructure or level of service required by the new development. A key distinction from infrastructure levies is that developer obligations are initiated by developers or landowners. A common type of developer obligation is inclusionary housing, where developers are required to set aside or build a certain number of below market rate hosuing units, in order to preserve the supply of affordable housing.

Charges for development rights

This category of LVC instruments primarily relates to land value increments linked to regulatory changes that benefit landowners. At its core, charges for development rights are fees paid by developers in exchange for the right to build at a higher intensity beyond a set baseline. A prerequisite to implement charges for development rights is clear and predefined land use regulations that establish baseline and maximum development intensities (such as heights, setbacks, or floor area ratios). Charges for development rights, sometimes referred to as incentive zoning, can be in the form of cash or in-kind contribution, such as public space, infrastructure upgrades, or affordable housing units.

A related LVC instrument is the transfer of development rights (TDR). With TDRs, landowners in a designated area known as the sending zone (such as an environmentally or culturally sensitive area), can pay a fee to sell the development potential of their parcel (as established by local land use regulations) to another parcel in a designated area known as the receiving zone that is better suited for additional development. Not only do TDRs generate revenue for the local governments through the fee, but they also advance other planning objectives by limiting development in the sending areas and incentivizing more intense development in the receiving areas. Commonly, TDRs have been used to preserve farmland, wetlands, and historic buildings.

Land readjustment

Land readjustment refers to the pooling of privately-owned and fragmented parcels for joint development. Generally, landowners contribute a portion of their land for public infrastructure, such as roads, metro stations, utilities, or parks, which increase the value of the pooled parcels. Often, land readjustment is accompanied by land use regulations that allow greater development intensities, which further increases land values. Landowners are returned a smaller plot of land than they originally possessed, but it is more valuable due to the infrastructure investments and regulatory changes. Land readjustment has been used successfully to upgrade informal settlements and to build extensive rail networks.

Strategic land management

Strategic land management is a more direct form of LVC and refers to the government taking an active role in buying, developing, and selling or leasing land. Government-owned land, or land acquired by the government at pre-development costs, is developed and rezoned, and then sold or leased. In this sense, the government directly recovers the land value increments caused by public action.

Outside of these five categories of LVC instruments, the property tax and land value tax are two other types of LVC instruments. In both instances, jurisdictions with a well-functioning tax system should capture a portion of land value increments due to public investment so long as the assessed values are accurate.

Despite the wide use of these various LVC instruments, only recently has research started to examine the relationship between public investments in climate change adaptation and mitigation and land values. Increasingly, governments are exploring the use of LVC instruments as a source of financing for investments in climate action. The following section examines a few of the ways climate interventions impact land values and then revisits the three components of LVC in the context of climate change to demonstrate the connections between climate change, public actions, and changes in land value.

Climate Change, Land Values, and Land Value Capture

The impacts of climate change on land values are complex and disparate. Already, climate change is shifting areas deemed safe and habitable and where agricultural commodities can be cultivated (Marandi and Main 2021; Potapov et al. 2022). Public intervention to protect areas from the extreme impacts of climate change, such as coastal flood protection, will prevent a loss of property values, and depending on market forces, increase property values. However, other adaptation strategies, such as relocation, may cause the value of the land left behind to collapse. The impacts of climate change will not be felt evenly across geographies or populations within the same region. There will be winners and losers, and that distinction will be reflected in land values. In general, climate change will favor higher-elevation coastal lands, land with access to fresh water, temperate lands, ecologically diverse lands, fertile lands, lands with high renewable energy potential, and lands that have been protected due to human intervention. Even before impacts are felt, or public interventions are implemented, projections and plans can spark speculation and land grabbing, a trend that is already happening. To examine these complex relationships more, the impacts of climate on land values are grouped into three broad categories, detailed below. These groups are not comprehensive but illustrate some of the ways public climate action and land values relate.

1. Publicly Protected: Climate change has caused "widespread adverse impacts and related losses and damages to nature and people" that are projected to increase (IPCC 2022b). These damages – resulting from sea level rise, flooding, extreme heat, more intense storms, and more – demand public action to protect people and property. Public investments that improve the resilience of a place and its inhabitants, whether with hard infrastructure or nature-based solutions, often increase the value of the protected

properties because of the reduced risk and co-benefits associated with the investments (Kiel 2021).[5] Accurate and transparent data on climate risks and a valuation of this risk in property assessments are essential to accurately identify changes in land values, and to better inform markets. Recognizing this relationship between climate adaptation and land value increments could be powerful in releasing more financing specifically for climate adaption, which has historically been overshadowed by investments in climate mitigation, which often have better returns on investments from energy and carbon markets (Keenan et. al. 2019).

In these situations, there is also a risk of maladaptation if the intervention is inadequate or does not consider appropriate ecological and social dimensions. In this case, properties may be perceived as being safe when they are in fact still vulnerable, potentially even more so.

2. Co-benefited by Resilience: As noted previously, responding to the climate crisis requires huge investments in new and retrofitted infrastructure. Low carbon, climate resilient development – in the form of people-oriented urban form, high-quality greenspace, public transportation, and energy efficient buildings – brings additional amenities that are reflected in higher land values. For example, improved air quality, resulting from shifts away from coal-fired power plants and gasoline powered cars, has been shown to increase house prices (Chen and Chen 2017, Lord et al. 2022). There is also a rich body of evidence that shows the positive impacts of transit-oriented development on nearby land values (Grass 2001; Gu and Zheng 2008; Suzuki 2015). Additional information on this relationship is examined in the following section.

3. Climate Advantaged: Climate change impacts will make some land more valuable due natural advantages, such as geography and topography, that make human settlements and other uses more favorable (While and Whitehead 2003; Keenan et al 2018; Dunning and Lord 2020). Examples of this trend can be observed around the world. In Miami, the value of higher elevation properties, such as those in the Little Haiti neighborhood, have risen over the past five decades, while those of lower elevation properties have declined (Keenan et al. 2018). Rising prices have led to a housing affordability crisis that has forced residents out of the neighborhood, a phenomenon Keenan et al. (2018) refer to as 'climate gentrification.'

Outside of urban areas, climate change is unveiling new claims on land that influence its value. The impacts of climate change are projected to expand global farmland by almost a third, with more than half of this expansion in Canada and Russia (Hannah et al. 2020). Researchers have even proposed a global reshuffling of farmland to optimize yields and minimize negative environmental impacts (Beyer et al. 2022). As Arctic ice coverage and thickness decreases, new shipping routes are opening that could eventually rival the Suez Canal (LePan 2020). As global trade shifts in response, Arctic port cities could see increased economic activity that boosts land values. Finally, as the global economy decarbonizes, siting renewable energy such as solar and wind will intensify competition for land and increase land values in high-potential areas (van de Ven et al. 2021).

It is important to note that these climate-induced increases in land value are not the result of public action, but rather the impacts of climate change itself. However, it is the responsibility of local governments to respond with appropriate action to prevent speculation and displacement. For example, local governments may choose to allow for greater density in areas less vulnerable to the impacts of climate change in order to accommodate people displaced from more vulnerable areas, which would generate additional land value

[5] It is worth noting that decisions to protect certain places are often coupled with decisions to not protect other places, accepting future damages and land value decreases (if land remains).

increases that it could then be recovered through LVC mechanisms. It is crucial for governments to recognize this phenomenon and respond appropriately to ensure that future development occurs in an equitable and resilient manner, and in locations that can support such development.

These three categories, while not comprehensive, demonstrate the multiple – and often interrelated – ways that public responses to climate change impact land values. In each instance, there is a potential for public action to increase land values, whether it is from protecting properties from climate risks, generating co-benefits, or encouraging development in less vulnerable areas. These relationships suggest that LVC should play an important role, not only in helping to finance the necessary investments in climate action, but to also ensure that the investments result in equitable outcomes and that land speculation doesn't further marginalize certain populations.

Climate Action and Value Generation

The first of the three interrelated components of LVC recognizes that the process depends on public action that increases land values. There is a growing body of evidence to build upon that finds a positive relationship between land values and both direct infrastructure investment and administrative action for climate adaptation and mitigation. A few notable examples are described below, with an emphasis on nature-based solutions.[6] It is important to note that the impacts from climate interventions are context specific and land values are influenced by many factors. Each example is context specific, and while they do provide indications on how these investments may affect property values in other places, the results can't be directly translated.

Urban trees and tree cover

Urban trees are often cited as one of the most effective climate strategies because of their simultaneous adaptation and mitigation potential. Demonstrated benefits of urban trees include carbon sequestration, air quality improvement, stormwater retention, energy conservation, and urban heat mitigation (Roy et al. 2012). Additionally, several studies have demonstrated their impact on property values:

- Portland, OR (USA): Increases of more than $7,000 were found for the property value of the immediate property, with additional value increases for neighboring properties. The average property value increase within 30-meter radius of tree was more than $12,800 (Donovan and Butry 2010).
- Cali (Colombia): Grafakos et al. (2019) found significant and positive impacts on property value. For one neighborhood, trees had a cumulative positive impact of $8 million on land values. The study also found that the combined economic value of trees is likely much greater than the impact of individual trees, so the actual impact may be underestimated.
- Florida (USA): Escobedo et al. (2015) found that home buyers value tree cover more than individual trees, as suggested by the Grafakos et al. study. One tree increases home prices by $1,586, but a one unit increase in Leaf Area Index increases value by $9,348.

Green Infrastructure and Open Space

Green infrastructure, including parks, stream restoration, and stormwater basins, reduce climate risks and increase climate resilience. Many definitions exist for green infrastructure, but in this context, it refers to any human-engineered systems that utilize natural systems to reduce flood risks. Similar to tree cover, green infrastructure provides multiple co-benefits, including carbon sequestration, increased biodiversity, and urban heat mitigation (Grafakos et al. 2019).

- St. Louis, MO (USA): For every 1,000 ft closer to a greenway and open space, home prices increase 1 percent (Kousky and Walls 2014).

[6] See Kiel (2021) for an excellent literature review of climate adaptation measures and property values. The paper provides a more comprehensive review of existing studies.

- Buenos Aires (Argentina): A recent study found replacing traditional grey stormwater infrastructure with green infrastructure in a dense urban setting can improve flood control and water quality, while also increasing land values for adjacent parcels by more than 30 percent (Kozak et al. 2019).
- Cali (Colombia): Grafakos et al. (2019) estimated that investments in green infrastructure increase land values by 5.4 percent.
- New Haven, CT (USA): Cohen et al. (2023) find an 8.8 percent increase in single-family property values due to the presence of nearby bioswales.

Urban Form

Urban form – including density, accessibility, land use mix, and connectivity – is a key determinant of GHG emissions. Denser, more compact and accessible cities have less per capita GHG emissions (Monkkonen et al. 2022). Investments in pedestrian facilities and public transportation, combined with regulatory actions to promote compact development, are essential to reduce urban GHG emissions. Such actions have been well documented to increase land values (Suzuki 2015).

- Beijing (China): Houses within 1,000 meters of rail stations were found to have price premiums of up to 20 percent (Gu and Zheng 2008).
- Washington, DC (USA): Property values increased 19 percent due to proximity to METRO stations (Grass 2001).
- USA (Multiple Cities): An analysis of 15 different metro area found that a one-point increase in the area's walkability score increased property values between $500 - $3,000 (Cortright 2009).

Air Quality

Investments in improved air quality, such as those described above and other investments to decarbonize our economy, have been shown to create new opportunities for urban development and impact land markets, which is especially relevant in rapidly urbanizing areas. Studies, mainly focused on Chinese cities, show a significant and positive relationship between improved air quality and housing costs. Improved air quality makes places more livable and more attractive for development, which can drive climate-positive infrastructure when accompanied with appropriate regulations and building codes.

- Shanghai (China): Air pollution has significant and negative impact on home prices. Reductions of SO_2 and $PM_{2.5}$ can increase house prices by up to 1% (Chen et al. 2017).
- Shenzhen, Suzhou, and Zhengzhou (China): This study found a significant negative correlation between air quality ($PM_{2.5}$) and land values in all three cities. Specifically, a 10% decrease in air pollution was associated with 6.3%, 9.5%, and 7.7% increases in land values for Shenzhen, Suzhou, and Zhengzhou, respectively (Lord et. al. 2022).

Value Appropriation for Climate Investments

The myriad ways climate change, and responses to it, have the potential to increase land values suggests that LVC should be considered as a possible approach to recover the increments in land values associated with them. A variety of value capture instruments exist that can be used to recover the increase in land value, such as betterment contributions, charges for building rights, land readjustment, and transfer of development rights (Germán and Bernstein 2020). All are rooted in the same premise: public action should generate public benefit. Generally, typical LVC instruments recover only the portion of land value increments that are the result of direct public action (Smolka 2013). Beyond generating revenue, LVC instruments can also act as powerful development management tools that impact land markets and development patterns. In the context of climate change, this is a very important consideration. Not only can LVC tools help fund climate investments, but they can also encourage climate, resilient development and temper soaring land values associated with speculation.

The examples below highlight a selection of existing LVC tools and suggests how they could be used to address some mitigation and adaptation challenges presented by climate change. For the most part, the potential climate applications included are hypothetical and illustrative. The application of each tool depends on legal and institutional context.

Potential LVC Tool	Climate Actions
Infrastructure Levy/Betterment Contributions/Special Assessments Owners of select properties that benefit from public actions pay a fee that covers all or part of the action.	Climate investments with direct benefits to specific properties, such as seawalls or levees that protect a neighborhood from sea level rise, green infrastructure that reduces localized flooding, or new low-carbon transit lines, could utilize betterment contributions.
Developer Obligations/Impact Fees Local governments can require developers to pay a one-time charge intended to cover additional costs associated with the development's impact on public infrastructure and services.	To compensate for increased flood risks or energy use, new climate adaptation and mitigation infrastructure is often needed as a result of new developments. Already, some jurisdictions utilize impact fees to offset additional stormwater management costs associated with new developments. Similarly, governments could utilize impacts fees to pay for the additional costs of protecting new residents and/or infrastructure from the increasing impacts of climate change. See the Boston example below.
Charges for Building Rights In exchange for additional development rights (such as increased density), developers pay a few to the government which funds additional public investments.	Climate resilient urban form, such as increased density and integrated green infrastructure, can be promoted with charges for additional building rights to achieve multiple climate goals. By allowing additional densities in appropriate areas, cities can promote climate-resilient urban form. Charges could be waived for the inclusion of on-site climate investments, such as energy efficiency or green infrastructure. Additionally, the funds collected from the charges could be used to finance other climate mitigation or adaptation projects or used as collateral for loans for larger projects whose benefits are felt in the area. See the Quito example below.
Transfer of Development Rights Landowners sell development rights of parcels in "sending areas" that are purchased by another landowner and used in "receiving areas" in the form of increased density.	In some areas, climate impacts will become so frequent and severe that the most appropriate adaptation measure is to relocate settlements, either in their entirety or partially. Transfer of development rights could be utilized to transition development from areas of high risk to areas out of harm's way. This approach would take time but could be used for larger scale relocation efforts. See the Curitiba example below.
Land Readjustment Landowners collectively pool their land to be reconfigured and redeveloped, with the inclusion of infrastructure and service upgrades. Landowners receive a smaller tract of land, whose value is higher than the original plot because of the improvements and new land use regulations.	As climate change worsens, investments to improve services and integrate adaptation measures in poorly serviced neighborhoods that are vulnerable to climate impacts will be essential. Cities will also need to find ways to site new infrastructure associated with decarbonized and decentralized energy sources, or new low-carbon public transportation systems. Land readjustment is one strategy that could be utilized in both situations. See the Tokyo example below.

Property Tax A tax levied by the government based on the appraised value of a property.	The direct link to property value increases from some climate investments may be difficult to communicate, such as increased tree canopy, or have diffuse impacts, like air quality improvements. These increases may be best captured by property taxes. In addition to being a fundamental source of revenue for many subnational governments, a well-functioning property tax system should generate more revenues from higher property values near public climate investments.
Land Value Tax A tax levied by the government on the unimproved value of the land, which excludes the value of the buildings on the property. The application of the land value tax differs from the other tools mentioned in that it can be used to recover any increases in land values, not just those associated with public actions.	The land value tax could be used for the public to recover the unearned increments of private landowners who may benefit from the impacts of climate change (i.e., coastal land at higher elevations). At the same time, the land value tax could limit speculation and climate gentrification, preventing landowners from benefiting from the impacts of climate change at the expense of the greater public.

Table 1. Potential LVC tools related to climate action. Adapted from Germán and Bernstein, 2020.

The above examples showcase some of the existing LVC tools that could be used to fund climate adaptation and mitigation investments. Just as local governments have found new ways to apply the principles of LVC in the past, such as financing affordable housing, new innovations in the application of LVC may emerge to meet the scale of the climate crisis and the new conditions it presents. Encouragingly, LVC is a versatile tool that has been applied in a wide variety of contexts, from developing countries to mature economies, and many of the most notable innovations in its application have come from the Global South. Given that climate impacts will be disproportionately felt in developing countries – and that international finance flows from countries responsible for historic emissions are woefully insufficient – new innovations for LVC to address climate change may arise from the Global South. These approaches should go beyond simply identifying new sources of revenues and develop integrated policy approaches that increase local resiliency and increase and maintain land values over time.

A Virtuous Cycle of Value Utilization

The final component of the LVC process is the utilization of the recovered land value increments. Once land value increases resulting from public action on climate change have been generated, identified, and recovered, they can be reinvested in yet more equitable, climate resilient actions. As the public benefits of these investments in climate mitigation and adaptation are realized, the surrounding areas will become more attractive to additional private investments, generating a virtuous cycle of revenue generation, growth, and improved climate resilience (Lord et. al. 2022). For this to occur, however, LVC approaches must bridge the gap between municipal finance and urban planning. Urban planning and governance structures play key roles in the distributional and equity outcomes of LVC tools (Friendly 2020). LVC tools should be integrated into urban planning processes and land use plans and decisions to ensure that public investments are directed in a way that maximizes public benefit and creates inclusive, resilient communities. The value added from LVC, particularly in the context of climate change, is more than a source of revenue, but as a tool to encourage and promote equitable, well-planned development that is fiscally sustainable.

This connection is particularly relevant in emerging cities. When such frameworks around land use management and revenue generation are put into place, and infrastructure is developed in synchronization with growth, then emerging and urbanizing places can leapfrog climate-intensive development patterns and avoid the creation of poorly planned and under-served informal settlements, seizing the opportunity to create more inclusive, climate resilient communities. This approach – building it right the first time – is manifestly easier and less costly than reconfiguring

established settlements. Given the urgency of action and the permanence of infrastructure, is arguably the only viable option in the face of climate change.

Funds generated through LVC instruments also represents a practical own-source revenue stream for subnational governments that is critical for locally driven development paths. Not only do such revenues offer a level of autonomy at the subnational level that is seldom available with national or international funds, but they can complement other sources of financing. It is not reasonable to expect revenues streams from LVC to cover a capital budget in its entirety. But it is a revenue stream that is available and should be included in the capital finance matrix and leveraged to the extent possible (UN-Habitat 2016). It can also be a powerful instrument to improve a government's creditworthiness and access additional financing (Vetter and Vetter 2016; UN-Habitat 2017). In the context of developing countries, this own-source revenue is crucial, but it should not absolve developed economies – who generated wealth through resource extraction, exploitation, and depletion that has contributed to climate change – from the responsibility to provide financial assistance to developing countries who have contributed the least to climate change.

In order to maximize the benefit of LVC approaches, it is important to think broadly about the value utilization stage of the process. The examples provided in the next section highlight a few examples of how governments have successfully recovered and reinvested land value increments for climate action.

Examples of LVC Approaches for Climate Action

Despite a lack of widespread attention, examples exist globally that show the potential of LVC to finance climate adaptation and mitigation interventions in a variety of development and institutional contexts. The examples included below are only a small subset of many subnational governments that have successfully applied LVC to fund and promote climate resilient development. The examples were chosen to reflect the diversity of contexts in which LVC can be applied, and to show the variety of climate action that can benefit from such approaches.

Adaptation

Boston (USA)

Much of the city of Boston, home to nearly 700,000 people, is built on landfill – manmade land built on marshes and tidal flats. This includes all of the city's bustling Seaport district. What provided additional developable land for the city to grow, now contributes to its vulnerability to climate change impacts, notably sea level rise. For much of the city's history, the Seaport was an industrial area oriented towards fishing and trade. However, since 2010, the Seaport has become one of the fastest growing real-estate markets in the city and the country. But the new high-end residential developments and office space face potentially devastating climate impacts. Sea levels in the Boston area are likely to rise 16 inches over 2000 levels by 2050 (Sweet et al. 2022). By mid-century, more than 90% of critical infrastructure, commercial buildings, and roads in the Seaport could be inoperable due to flooding (First Street Foundation 2021). Adaptation measures, such as seawalls, will be critical to protect the Seaport from rising seas.

In one area of the Seaport, where there is still opportunity for new development, the city is utilizing LVC to fund adaptation measures in the face of sea level rise. In addition to being required to meet climate resilient building standards, developers must pay exactions to the city that are collected in a Climate Resiliency Fund. The city finances adaptation measures, including a seawall, and then uses the Climate Resiliency Fund to pay off associated debt. Because the benefits to developers and landowners are very direct, the city has not faced opposition or reluctance. In this one area alone, the city expects to collect $40 million in developer exactions to fund critical improvements necessary to safeguard the Seaport from rising seas and protect public assets (Rosen 2021). The city is considering similar approaches in other areas of the city.

Curitiba (Brazil)

Curitiba, the capital and largest city of the Brazilian state of Paraná, has long been an innovator in sustainable urban development, including pioneering the world's first bus rapid transit system. However, the city of nearly 2 million inhabitants is facing increased risks from climate change, particularly flooding associated with recurrent extreme rainfall events. The city is surrounded and crossed by six waterways, including the Iguaçu River. Increased urbanization and climate change exacerbate flooding in the city, which disproportionally impacts low-income populations that reside in informal settlements often located in flood prone areas (Suzuki et al. 2010).

Rather than implement a costly grey infrastructure system of concrete culverts and dams that would just transfer flooding issues downstream, the city implemented a natural green infrastructure system by leveraging an innovative LVC approach – transfer of development rights (TDR). The city designated areas in flood prone areas along riverbanks as the TDR sending areas. Property owners in these areas can transfer their development rights to areas more appropriate for urban development, designated as TDR receiving areas, where development is incentivized in by allowing additional density above the limit established in the city's land use regulations. The TDR sending areas are converted to greenspace capable of capturing and retaining stormwater (Grafakos et al. 2019). The city's largest park, Barigui Park, was created as a result of this LVC scheme. It has also been used to relocate residents in flood prone informal settlements to safer housing.

The results of Curitiba's innovative TDR system have been overwhelmingly positive. Compared to traditional grey infrastructure solutions, the system of green stormwater infrastructure has been five times less expensive to build. Since 1970, the system has significantly increased forested areas in the city (by over 50 times) which also contributes to carbon sequestration. Additionally, property values along the newly created parks have increased, which have partially been captured through the collection of property taxes (Dharmavaram 2013). This examples highlights the potential of LVC to be more than a source of funding. By integrating LVC into land use planning, Curitiba was able to promote development in safe areas of the city while relocating residents out of harm's way.

<u>Mitigation</u>

Quito (Ecuador)

Despite its marginal contribution to historical GHG emissions, Ecuador's capital city, with a population of nearly 2 million people, has committed to reducing its carbon footprint and improve the quality of life of its residents. The transportation sector represents one of the largest sources of emissions for the city, which is being made worse by patterns of sprawling urbanization at the periphery of the city. Not only does it contribute to greater emissions, but sprawling development also reduces the quality of life of residents, increases the cost of providing services for the city, and impacts natural lands providing valuable ecosystem services (UHPH 2020).

Recognizing the importance to address these issues, the city developed an innovative LVC tool with the aim of transforming Quito into a more compact, low carbon city. In 2016, the city passed the Eco-Efficiency Ordinance for the Metropolitan District of Quito, which utilizes the sale of additional building rights to incentivize energy efficient construction in transit-accessible areas. The city sells additional building rights (in the form of increased building heights and density) to new developments close to public transportation that comply with climate-positive design standards, including water and energy efficiency (UHPH 2020). Additional incentives are given to new developments that include affordable housing units. Since its implementation, at least 35 buildings have been approved, which has generated more than $10 million dollars that will be used to fund additional urban improvements. Quito's policy, which won a Guangzhou Award for Urban Innovation in 2021, is an excellent example of the ability of LVC approaches to bridge the gap between municipal finance and urban planning and advance multiple goals.

Tokyo (Japan)

As demonstrated previously, investments in compact development and low-carbon transportation systems are fundamental urban climate mitigation actions. With a metropolitan population of 39 million people, Tokyo is one of the largest urban areas in the world. Its transportation sector accounts for more than one-fifth of its total GHG emissions (Bureau of Environment 2019). Completed in 2005, the Tsukubu Express rail extension was proposed in response to increasing demand for housing in the suburban northeast of Tokyo, driven in part by proximity to Japan's largest research center, Tsukubu Science City. To meet this demand and avoid increased reliance on automobiles for lengthy commutes, the Tsukubu Express extension was proposed along with new developments to increase the supply of housing close to the new high-speed rail line. To accomplish this, municipal and prefectural governments leveraged the LVC approach known as land readjustment to fund the extension of a low-carbon light-rail line and create transit-oriented suburban development (Suzuki 2015).

Enabled by recent national legislation, local governments obtained land contributed by private landowners along the proposed rail line and reconfigured the parcels for rights-of-way, new stations, and new transit-oriented development. Land for rail rights-of-way and stations was sold to the private rail companies, and the remaining parcels were sold to private developers. The parallel development of the railway and new hosuing ensured that ridership would be high for the new line even upon initial opening. On average, private landowners saw an increase in their land value of more than 40% because of the new public facilities and increased development potential, despite a reduction in total acreage. Engaging local governments in this process helped ensure the new development met local needs. In addition to the avoided emissions from the project, additional energy efficient measures were incorporated into the new stations and housing developments, including solar panels (Tokyo Development Learning Center 2015).

Considerations for Implementation

Conventional fiscal policies largely neglect the fact that the costs of providing adequate infrastructure and services are borne by all taxpayers, but their benefits accrue only to certain property owners. As cash-strapped governments face mounting investment needs to confront the climate crisis, there is a need to think more creatively about alternative funds, which has contributed to the growing interest in the use of LVC instruments. The encouraging news is that land value increments resulting from such investments are often much higher than the cost of the intervention and, when implemented well, can create a virtuous cycle of development, revenue generation, and reinvestment. Indeed, the documented examples of successful LVC tools being used for climate action demonstrate its potential, but it can do much more to match the magnitude of the climate crisis. The considerations presented below point to steps that subnational governments can take to maximize the use and impact of LVC instruments to advance climate goals.

Complementary policies and institutional capacity

Successful LVC approaches require an enabling environment that consists of complementary policies, institutional capacity, and political will. Without these key factors, LVC instruments are likely to underperform. The national legal framework in most countries is not particularly constraining when it comes to LVC, but in some instances urban development laws at the national levels will need to be reformed to grant local governments authority to mobilize land value increments or enable them to generate own-source revenues. In fact, LVC tools are being used in countries around the world, but their implementation is often inefficient and unpredictable. Despite being used globally, nearly 80% of countries lack a legal definition of LVC (OECD/Lincoln Institute of Land Policy, 2022). More importantly, strong local development policies and land tenure systems are needed to ensure that the LVC instruments are successful. For example, land use, building height, and density regulations need to be in place for any sale of additional building rights or TDR programs to be effective. Climate resilience must be incorporated into these policies to ensure that new development is contributing towards advancing climate goals.

Institutional capacity at the local level is crucial for the effectiveness of any LVC instrument. Up-to-date cadasters (preferably digital) and land records provide the necessary information to assess the impacts to land values. Designing and implementing a new LVC instrument is challenging but is primarily a practical and technical challenge. Lessons learned from other cities who have already implemented similar policies are invaluable. However, each application of LVC will depend on local context. Ultimately, there is no better way to increase institutional capacity than through experience. Political will is fundamental to take this first step, which largely depends on garnering public acceptance.

Public acceptance of LVC for climate action

The success of LVC approaches depends in large part on the degree to which they are understood and accepted by the public. The benefits of the public intervention should be explicit, along with the risks of inaction. People experience the impacts of climate change locally, and local governments are often responsible for responding to these impacts. Local governments should leverage this understanding of locally recognized problems to communicate the value of public action and the positive contribution LVC can have to enable action. Open and transparent communication, clearly established legislation, and progressive fee structures are all critical to foster public support (OECD/Lincoln Institute of Land Policy 2022).

However, climate risks – such as hurricanes, sea level rise, wildfires, and flooding – are not currently well understood by property owners, nor are they adequately reflected in real estate markets. In the United States, regions most at-risk of climate impacts continue to grow in population as the majority of homebuyers are not considering climate-related risks when purchasing a home (Katz and Sandoval-Olascoaga 2021; Shin 2021). Quantifying and disclosing these risks, and alternatively the value in risk avoidance, helps increase awareness and will contribute to a greater acceptance of LVC instruments associated with climate action that reduces risk and increases land values. The benefits of public action on climate must be understood to generate willingness to contribute to investments in climate solutions. Additional research is needed that quantifies the impact of different climate investments on land values.

Equity implications

When designing and implementing LVC policies, local governments must intentionally consider its equity impacts to avoid perpetuating spatial inequalities. Certain LVC tools such as developer obligations only apply to new development projects, and in these instances there is the possibility that benefits will only accrue in limited, often wealthier areas that already receive outside investment. This presents particular concern with in-kind, onsite adaptation measures, which could result in islands of protected areas amidst a sea of increased risk. Given these concerns, governments should explore mechanisms that distribute benefits across a broader geography or target areas most at risk.

Likewise, LVC charges such as infrastructure levies cannot be applied evenly across the population. In general, poor and marginalized communities are most exposed to climate risk, due to generations of systematic exclusion and disinvestment. Exemptions based on income and other factors should be considered. In this sense, LVC tools have great redistributive potential and the capability to break cycles of disinvestment and exclusion.

When local contexts are appropriately considered, LVC can promote equity goals by sharing value with the community that otherwise would not have been available. It also shifts the burden of paying for infrastructure and services, such as climate action, away from just the public sector, which should ultimately unlock greater funds that can be used for greater public benefit.

LVC and other revenue sources

In order to respond adequately to the climate crisis, local government must be fiscally healthy. Governments must view LVC as one of many own-source revenue streams and financing sources available, which should be utilized to

the greatest extent possible. Local governments cannot maximize their own-source revenues without LVC mechanisms. When governments do not utilize LVC, it is the equivalent of leaving money on the table. In an era of unprecedented investment needs, this is unacceptable.

Furthermore, while LVC instruments alone will not generate sufficient revenues to fund all necessary climate interventions, they do stregthen the ability of local governments to access other sources of revenue, such as bonds or other debt instruments. Healthy and predictable own-source revenues, including LVC, can increase a municipality's credit rating and its ability to borrow. In contexts where municipalities are restricted in their ability to collect taxes, LVC may serve as an alternative, non-tax source of revenue.

LVC for inclusive climate resilience

Proper climate action should make cities and human settlements more inclusive, safe, resilient, and sustainable. LVC instruments are a particularly useful tool to because they integrate municipal finance and urban planning to advance multiple goals. For example, the previous example of Quito showed how the city is utilizing LVC to foster compact, transit-oriented development while also ensuring new construction is energy-efficient and provides affordable housing. Curitiba leveraged TDR to reduce the impacts of flooding, create open space, and relocate residents of informal settlements. In this way, LVC is both a source of revenue and a planning and development management tool.

Furthermore, LVC has the potential to "level the playing field" and begin to eliminate winners and losers resulting from climate change and the public responses to its impacts. Already, the impacts of climate change exacerbate existing inequalities. The investments to address climate change should not intensify those. Public action to adapt to and mitigate climate change should not benefit only a select few landowners, but rather the public should share those benefits. By recovering increases in land value resulting from public action and reinvesting those in additional public benefits, LVC has the potential to create a virtuous cycle of revenue generation and reinvestment, resulting in more equitable, climate resilient development.

Conclusion

The urgency to respond to the climate crisis demands local governments respond to the impacts of climate change through local adaptation and mitigation efforts. This chapter has demonstrated the various ways that these public climate interventions can positively impact land values and how subnational governments can recover those increments through LVC instruments in order to invest in additional climate action and public benefit. In fact, local governments globally have utilized LVC to help finance public climate action and produce broader co-benefits.

The challenge now is to further the acceptance and embrace of LVC for climate action. This will require overcoming the common barriers to LVC in general, as established by Smolka (2013) and others. These include a lack of awareness of the relationship between public investments and land values, the technical capacity needed to identify and determine land value increments, and the political and public will required to champion LVC measures. Additional research is needed that clearly demonstrates the link between public climate action and land values. More importantly, future research should focus on the implementation of LVC in different contexts, including different land tenure systems, urban planning regimes, and governance structures. This research may uncover innovative applications of LVC in the context of climate change.

However, the magnitude of climate change and the urgency to respond and protect local populations from the increasingly devastating impacts may provide an opportunity for governments to explore new ways of financing climate action and managing development. No longer can the predominant system of development favor a select few with unearned windfalls from public investments when the consequences are so significant. Perhaps the imminent

threat of climate change will accelerate the acceptance of a new paradigm in which the benefits of public action are shared with the public and used to promote inclusive, climate resilient development.

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