COMMON VALUE: TRANSFERRING DEVELOPMENT RIGHTS TO MAKE ROOM FOR WATER

Besmira Dyca[1]

Dr Kevin Muldoon-Smith[2]

Prof Paul Greenhalgh[3]

1- Corresponding author, PhD candidate at Northumbria University, Address: Northumbria University, Ellison Building, Newcastle upon Tyne, NE1 8ST, United Kingdom, email: besmira.dyca@northumbria.ac.uk

2- Senior Lecturer at Northumbria University, Address: Northumbria University, Ellison Building, Newcastle upon Tyne, NE1 8ST, United Kingdom, email: k.muldoon-smith@northumbria.ac.uk

3- Professor Lecturer at Northumbria University, Address: Northumbria University, Ellison Building, Newcastle upon Tyne, NE1 8ST, United Kingdom, email: paul.greenhalgh@northumbria.ac.uk

Abstract: Flood is the most frequently occurring natural disaster, making up 49% of disasters and 43% of disaster related deaths globally in 2019. Exacerbating this situation, due to increased urbanization, the number of people living in precarious and flooding prone areas is increasing. In order to counter these challenges, the flood risk management narrative is evolving towards integration of blue/green infrastructure (BGI) through projects that harness nature and mimic natural processes, into the wider approach of an integrated water and land management. However, there is very little research into how BGI-related innovations will be funded. This gap in knowledge has multiple significance. Firstly, there is an immediate need to pay for such flood risk management measures across the world. Secondly, this financial imperative takes place against an international backdrop of reduced government funding. Thirdly, land management carries deep distributive-justice implications especially relevant in integrated catchment-based flood risk management. In order to reflect upon this situation, this paper investigates the role of Land Value Capture (LVC) instruments in financing Blue/green Infrastructure. This research focuses on Transferable Development Rights (TDR) instrument, which has enabled some planning authorities in the global north and south to successfully adopt preventive measures in flooding prone areas. Findings from literature review suggest that BGI have a positive impact on land markets by means of providing open spaces, improved landscapes and increasing the quality of urban environment. TDR with an emphasis on land conservation, can be an attractive instrument in terms of cross-subsidizing property windfalls of the properties benefiting from BGI and property blights of the landowners in properties where development shall be frozen to provide BGI. Yet, the success of TDR is closely linked to the specific legal, market and urban development contexts, which further research should explore within the framework BGI implementation.

"Keywords: Flood Risk Management, Blue/green Infrastructure, Land Value Capture, Transferable Development Rights

1. Introduction

Flood is the most frequently occurring natural disaster, with an annual global average[1] of 153 disasters, 73.1 million affected people and the costliest natural disaster (Dano *et al.*, 2019), in terms of economic and ecologic losses, with yearly estimated economic losses of $36.3 billion (CRED, 2019). In 2019 floods made up 49% of disasters and 43% of disaster related deaths globally (CRED, 2020). Flooding is one of the most frequent disasters and it is affecting an ever-increasing number of people and livelihoods in parallel with soaring urbanization trends. In order to counter these challenges, the flood risk management narrative is evolving towards the integration of blue/green infrastructure (BGI) with more traditional engineering solutions. Blue/green infrastructure is defined as "strategically planned network of natural and semi-natural areas with other environmental features designed and managed to deliver a wide range of ecosystem services" (European Commission, 2013, p. 3). Nevertheless, comprehensive considerations on land, taking into account the biophysical integral of natural and anthropogenic processes, are still lacking (Schanze, 2019). Seeking to contribute to a more comprehensive approach to land management in the realm of Flood Risk Management (FRM), this paper evaluates Land Value Capture (LVC) instruments' potential to facilitate the implementation of BGI, focusing on Transferable Development Rights. Land Value Capture is based on the idea that the value of land is created by society and not linked to its landowner's actions (which can increase the value of the improvements on land such as buildings, but not the value of land itself) and should therefore, in part or entirely, be reaped for the public (Alterman, 2012; Smolka, 2013; Walters, 2016). Transferable development rights (TDR) (or air rights/density transfer/purchase of development rights) is an instrument that falls under the LVC instruments implemented to address sustainable and environmentally resilient development through land conservation. The underlying research question that guides this paper is: *What is the potential for Transferable Development Rights to facilitate the implementation of BGI based flood risk management measures*?

In contrast to other types of infrastructure, research on how the implementation of BGI can be facilitated and funded is still in its early stages, with a few studies exploring alternatives of implementing Nature Based Solutions[2] on private property (Hartmann, Slavikova and McCarthy, 2019; Schanze, 2019). Also, the implementation of BGI has been surprisingly slow, considering the multiple benefits that such infrastructure can offer. Arguably this is due to higher requirements in land availability and maintenance

[1] Estimated over 2008-2017 period

[2] For the purpose of this article, Nature Based Solutions and Blue/green infrastructure are interchangeable terms

costs (van Vuren, Paarlberg and Havinga, 2015), and most pertinently for this article, the complexity of unpicking and mediating the complex politics of land ownership, value and benefit. Thus, investigating practical ways of facilitating the implementation of BGI is of high relevance. Firstly, there is an immediate need to respond to the emergency of flood risk internationally with more sustainable solutions. Secondly, the funding imperative takes place against a backdrop of reduced government funding in many developing as well as developed countries, such as UK (Clean Water America Alliance, 2012; Keeley *et al.*, 2013; Matthews, Lo and Byrne, 2015; Wright, 2016; Mell, 2020). Thirdly, land management carries deep distributive-justice implications (Alterman, 2012), especially relevant in integrated catchment-based flood risk management. This situation reveals overlapping questions around practical solutions, methods of funding, how asset owners and communities will be affected and who benefits and who pays for the intervention. With good reason, Hartmann (2016)refers to floodplains as contested land.

In order to explore the linkages between flood risk management and equitable funding, the paper combines literature and research traditionally considered in isolation. That of climate change, justice, urbanisation, flood risk management, governmental funding and land value capture. This novel reflection in literature is the methodological underpinning of the paper. The remainder of this paper is structured in the following way. The next section briefly explains BGI within the wider context of flood risk management, considering implementation challenges with a primary focus on land availability and equitable funding. Here the relationship between land (markets), flooding and flood risk management techniques is discussed. This is in order to reveal the potential for the inherent value built up in land to help fund flood risk management. The paper then focuses on how this value can be fairly captured through methods of LVC, focusing on the little considered TDR programs. The paper concludes by reflecting back upon the underlying research question and setting out a research agenda for future study.

2. Flood Risk Management, Blue/green Infrastructure and Land Markets

2.1. Integrating BGI in FRM

There is now a consensus amongst researchers and practitioners that higher levees and grey protective infrastructure alone will not resolve the future flood protection needs of society. Perversely it might contribute to higher vulnerability towards disasters from unpredicted and extreme weather events (Brookes, Gregory and Dawson, 1983; Green, Parker and Tunstall, 2000; Hartmann, 2016). Recognizing the limitations of FRM practices applied, the battle against water narrative has started shifting to an alternative approach of using BGI to accommodate water (European Parliament and Council of the European Union, 2007; European Commission, 2013). Hartmann, Slavikova and McCarthy (2019) explain that in terms of flood risk management, BGI can vary in form, including Natural Water Retention Measures (NWRM), space for rivers or other measures that can contribute to more resilient urban areas such as green roofs and decentralized rainwater management.

The integration of BGI in urban areas provides many advantages, such as integrating urban green with other urban infrastructures and multifunctional benefits, serving not only its infrastructural purpose but

also an ecological, social and economic role. Additionally, BGI contributes to retain and utilize stormwater as a vital source as we face more uncertain climate (O'Donnell *et al.*, 2020). Due to its multifunctional properties, BGI is considered to be more efficient in handling complexity in an urban setting in comparison to more traditional infrastructure (Hansen and Pauleit, 2014).

Nevertheless, while BGI has attracted a lot of attention, guidelines about it have by far outnumbered the actual practices of its implementation. The Clean Water America Alliance (2012) has categorized the main barriers to BGI implementation into four groups: Technical and Physical Barriers, Financial Barriers, Legal and Regulatory Barriers and Community and Institutional Barriers. All these barriers have a common denominator: land. Indeed, seeking to mimic pre-development hydrology usually demands more available land than grey infrastructure. This is because "making room for rivers" involves planning of submergible land which is ultimately also reserved for its ecological, social and climate mitigation function. Still the implementation of BGI is hampered by lack of available rights in land (Hartmann, 2012). Tackling the issue of land scarcity for BGI calls for an analysis of the impact that BGI has on land markets, as a first step to exploring the most adequate instruments to facilitate access to land.

2.2. Land markets and Blue/Green Infrastructure

The link between BGI and land markets can be investigated by analysing how the later reacts to flood risk and safety and the social, ecological and economic benefits brought about by BGI, which in this paper will be referred to as improved urban quality.

In terms of flood risk, attempts to establish a link between disaster risk and real estate have mostly focused on the ex-post side of the event (Jung and Yoon, 2018). In broad terms, Lamond and Proverbs (2006) describe four different scenarios of how flood risk affects property values. The first scenario refers to a low risk area, where a weather event might negatively affect property values for some time, but they bounce back soon afterward because the probability of reoccurrence is low. Second, intense weather events in disaster prone areas tend to not affect the property market substantially, since the market already reflects the risk, or because of established public compensation programs or insurance schemes. The third scenario refers to extreme weather events in areas previously considered safe, which have a considerable and long-lasting effect in the property market since the area is no longer considered safe. However, the effect of natural disasters in property market values is closely linked also to the government interventions measures. Hence, the fourth scenario shows that market prices decrease temporarily after a disaster and increase even higher than before if public funds are allocated to restore the area and protect it from future natural risks. Hence the impact that BGI have on land markets in terms of providing more flood resilient environments is hard to measure and is very context dependent. Nevertheless, the likelihood of land markets responding positively to FRM measures through BGI are higher in localities where there is a high public awareness of the prominent risk (Zhang *et al.*, 2018).

Nevertheless, BGI is expected to affect the real estate market not only by providing safer environments, but also due to its recreational and landscape advantages, contributing to higher quality of urban

environments. A study by Zhang *et al.* (2018) evaluates citizens' willingness to pay for the implementation of the sponge city project (an example of making room for water) in the city of Wuhan. When asked to signal their appreciation in relation to the sponge city, provision of more green space and higher quality of public spaces were ranked of similar importance to its flood risk management role. This suggests that the impact of BGI in property values is more likely to be higher than grey infrastructure, due to its multi-functional benefits that complement its risk management role.

There is a growing body of literature that reinforces the positive correlation between the quality of urban environment, referring to proximity to blue/green spaces, improved landscapes, open spaces, and property market (Zhang, Xie and Zhang, 2012; McCord *et al.*, 2014; Liu *et al.*, 2015; Nurmi *et al.*, 2016). The range of this impact varies depending on the locality, the type of BGI, the type of property and other contextual factors. D'Acci's (2019) systematization of various case studies internationally exhibit an appreciation of 5%-117% of property values as a result of proximity to green areas and 4.9%-23.1% resulting from the property overviewing a park or green space. Although these findings should not be generalized as they are very time and location bound, it is significant that more than 50 international case studies reviewed by D'Acci (2019) attest for a significant impact of blue/green and open/recreational spaces (elements which are usually present in BGI) in real estate market prices. Yet, not enough has been achieved in exploring mechanisms through which this potential economic value created by BGI implementation can be captured by public authorities to provide alternative ways of financing BGI.

3. Land value capture and Flood Risk Management

Whether the incremented value of land is a characteristic of ownership embedded in the realm of property rights enjoyable by the private landowner or whether it is a reflection of a wider social effort contributing to the conditions in which private property is apprehended, is still part of a polarized debate on property rights, which demands further comprehension of such rights in relation to the nature of the individual and the needs of society (Alterman, 2012).

The practice on LVC is very diverse and largely depends on the political and institutional positioning of a specific locality on the spectrum of this debate. Nevertheless, experience with LVC is present not only almost everywhere geographically, but also has a long-standing history dating back to antiquity, with property tax being a very popular financial instrument in Egypt, Persia, Babylon and later on in the Roman Empire. Yet, LVC is now a generic term used to refer to almost any instrument which captures some or all 'unearned' increment of land value, the narrative of which has significantly shifted over time. As Alterman (2012) suggests, land value capture can refer to capturing of unearned increments that are not necessarily linked to governmental decisions, but rather reflect economic development trends (direct value capture) or capturing of betterment, where the rise in value of land is the result of: a) improved development rights resulting from planning or development-control decisions, such as land use plans, and b) improvement of infrastructure and services increasing the value of land (indirect value capture).

The table below systematizes the most popular LVC instruments and maps their implementation internationally. Given the variety of instruments and practices, and their historic implementation, this summary is by no means comprehensive, but rather a general overview of LVC and the documentation of their implementation in literature. The systematization of the LVC instruments in the table follows two criteria: the rationale behind the implementation of the instrument and the type of instrument. Following Alterman's (2012) analyses, LVC instruments are designed based on the direct and/or indirect value capture rationale as explained above, or macro value capture which refers to instruments embedded in broader land regimes. The type of instrument used as a second criteria, refers to the nature of the instrument itself and its application. This systematization based on the existing knowledge on LVC instruments, is the first step in understanding which instruments could be more adequate in facilitating the implementation of BGI for FRM in different contexts, which is further analysed in the 'green' section of the table, which focuses only on LVC instruments that can be used for BGI.

RATIONALE	TYPE	INSTRUMENT	BRIEF DEFINITION OF THE INSTRUMENT	TYPES OF PROJECTS FINANCED	IN SITE/ OFF-SITE	CONTEXT	TYPE OF SOLUTION
Indirect	Fiscal	Betterment levies/ Special assessment	A fee charged on the incremented value of a property attributable to a public investment	Infrastructure (mostly transport/road network)	In Site	Existing urban area	Government Based Solution
Direct	Fiscal	Property tax	A tax imposed by local government on the ownership or occupation of property.	It is usually not earmarked (can be used for different expenditures)	Both	Existing urban area	Government Based Solution
Indirect	Fiscal	Developer exactions and Impact Fees	Developers required to install at their own expense internal/external infrastructure	Infrastructure	Both	Existing urban area	Government Based Solution
Indirect	Fiscal	Tax increment Financing/ Business Retention Strategy	Using the future flow of property tax increases generated by a public intervention to finance its costs	Urban Upgrading/ Transformation	Both	Existing urban area	Government Based Solution
Direct	Property rights management	Transferable Development Rights / Sale of Development Rights	TDR separates the development value from the property and allows its transferring to another property.	Historic and Environmental Preservation Flood Risk Management	Both	Land conservation	Market based solution
Direct	Property rights management	Cooperative Land Banking	CLB separates the private ownership of buildings from land ownership, with all the land becoming owned by a cooperative	Internal infrastructure and services for affordable housing			

			controlled by its residents.				
Direct	Property rights management	Community Land Trusts	A non-profit organization formed to hold title to land to preserve its long-term availability for affordable housing and other community uses	Social Housing			
Macro	Urban Transformation	Land Readjustment/ Land pooling	Allows reconfiguration of lots in a given area in accord with a plan that increases their value and provides the land necessary for public uses	New developments in periphery Slum upgrading Post-disaster recovery	In Site	New urban development/ Urban redevelopment	Community based solution
Macro	Urban Transformation	Land Acquisition and Resale/ Compulsory purchase of land/Active Land policy	Capturing the value created from acquiring private land, investing in infrastructure and selling of the remaining land at higher prices	Infrastructure	In Site	New urban development/ Urban redevelopment	Community and Government based solution
Macro	Urban Transformation	Land Sharing	Urban redevelopment and slum upgrading model through sharing of land between profitable developments and social housing for informal dwellers.	Social Housing Internal infrastructure inside the land sharing area			

Macro	Asset management	Nationalization of all land	Nationalizing of all land ownership	Any kind of infrastructure
Macro	Asset management	Public Land Management/Sales	A special form of capital revenue, which can be used to help finance general capital expenditures (usually related to new infrastructure)	Major Infrastructure projects New developments Social Housing
Macro	Asset management	Public land leasing	Revenues generated from leasing of public land with market prices can be used to cover infrastructure investment needs	Transport/Road infrastructure

Table 1 Summary of LVC instruments applied internationally (Source: Table compiled by author based on Harrow, 1929; Peterson, 2009; Dye and England, 2010; Rabe, 2010; Vetter and Vetter, 2011; Alterman, 2012; Lewis and Conaty, 2012; Smolka, 2013; Jacobus, 2015; Blanco *et al*., 2016; Salm, 2017)

The selection of the LVC instrument for further investigation in this article involved two main steps: ruling out instruments posing limitations for BGI implementation and analysing the applicability of the rest of the instruments in the BGI context. First, some of the LVC instruments, such as Cooperative Land Banking, Community Land Trusts and Land Sharing, have a very specific scope, mostly related to affordable housing (Rabé, 2010; Lewis and Conaty, 2012; Jacobus, 2015). Although BGI can be integrated in such projects as well, the main focus of these instruments does not comprise BGI. Second, instruments grouped under "Asset management" are usually implemented in contexts where public authorities own substantial amounts of land or where they have the financial capacity to access land markets. Facilitating the implementation of BGI in such contexts would be easier for obvious reasons, however this is not the case for the many countries where land tenure is dominated by private ownership or free leasehold.

Therefore, the table highlights in its green section the group of LVC instruments that should have priority for further investigation as BGI facilitators. These instruments are diverse, so when considering their potential with respect to BGI, there are a few aspects to be considered:

- The nexus between land value creation and value capture: The relevance with BGI is that, while some instruments are adequate to capture the value created in-site as a result of improved open spaces, landscape and overall urban quality, other instruments can be used off-site, to capture part of the value incremented by virtue of increased flood resilience, which might have an impact on areas that are not necessarily in proximity to the BGI.

- The context/purpose in which the instrument can be used: existing urban area, new urban development/redevelopment and for land conservation purposes. The same BGI can be facilitated through different LVC instruments; for example a raingarden can be financed through fiscal LVC, such as betterment levies, if it is implemented in an existing/consolidated urban area or it can be financed through a Land Redevelopment or Active land policy scheme, in a new urban area or urban redevelopment project.

- The type of solution presented by the instrument through government approach, market approach or community approach (Crabbé and Coppens, 2019),

Amongst the instruments in the green section in the table, this paper focuses on Transferable Development Rights for two main reasons: First, except from fiscal LVC instruments, TDR is the only instrument which allows for value to be captured and invested both in site and off-site, giving more flexibility in its application. Fiscal instruments which also offer this kind of flexibility have not been used for land conservation purposes so far. Which brings us to the second reason, the historic implementation of TDRs for land conservation/ environmental purposes, make this instrument attractive in terms of BGI facilitation. The numerous applications of TDR for conservation/environmental purposes, especially in the US, present great potential for further empirical research on how that experience can be adapted for BGI projects that rely on land conservation.

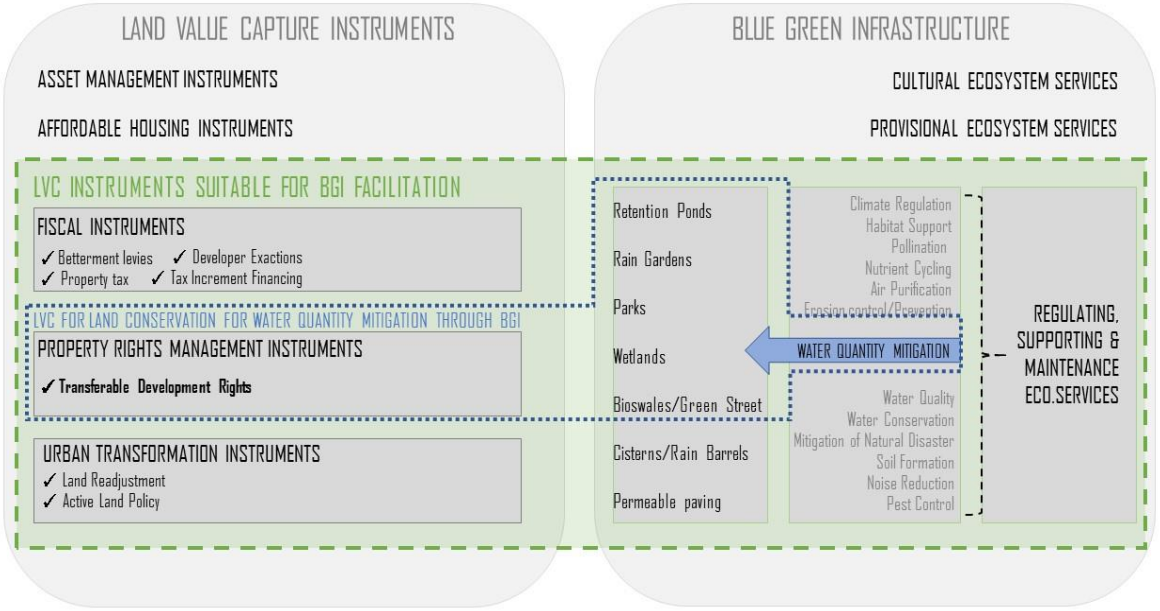

Figure 1 Conceptual framework

4. The potential for Transferable Development Rights as an instrument to make room for blue/green infrastructure

4.1. How does TDR work?

TDR builds on the idea that property rights exist as a separable bundle of rights, such as the right to use, to farm, to build, to mine and the like, which can be transferred and/or can be made available for market transactions (Kaplowitz, Machemer and Pruetz, 2008; Nelson, Pruetz and Woodruff, 2012). TDR focuses especially in the right to develop and considers this right transferable from designated "sending areas" to designated "receiving areas". TDR programs operate under specific legislation, in combination with zoning and/or land use regulations that allows additional development potential in areas deemed appropriate for densification or other types of development benefits, defined as "receiving areas" (Shahab, Clinch and O'Neill, 2018). Such legislation considers the maximum carrying capacity of receiving areas, as well as mechanisms of transferring such development rights from giving areas; be it through the creation of Banks or other mechanisms.

Traditionally used as an instrument to preserve heritage, farmland and environmentally sensitive areas, currently TDR practices have expanded their scope to serve various local government planning goals, such as creation of parks, BGI, scenic views and landscape preservation, trails and other community benefits (Nelson, Pruetz and Woodruff, 2012; Puertz, 2016). Landowners of the designated "sending areas" participate in the program voluntarily or compulsorily by selling their

development rights to developers in “receiving areas”, either through direct negotiation, through the mediation of the local government or through a bank. Once this is carried out, a legal instrument (conservation easement) is registered with the property deed in the giving area which permanently limits or freezes the development of land, in fulfilment to the predefined planning goals (Puertz, 2016). Figure 2 shows how "sending areas" in a TDR program can contribute to land provision for BGI.

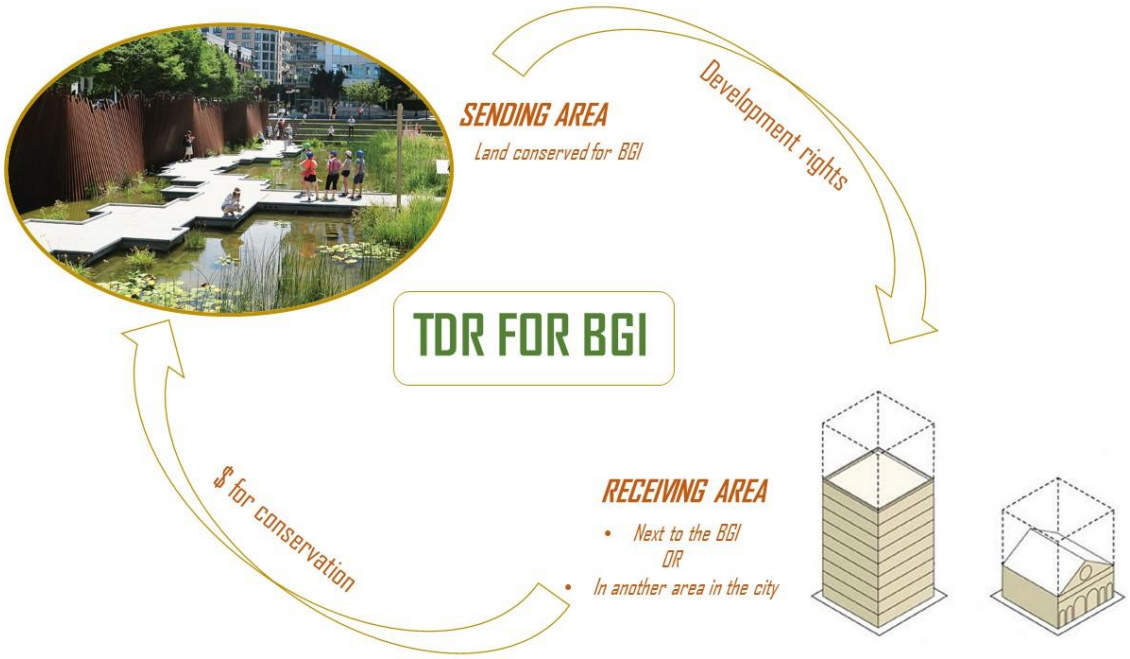

Figure 2 Schematic representation of the rationale behind Transferable Development Rights Programs

Although the main purpose of TDR lies on the 'giving areas', hence it focuses on the conservation/preservation aspect, TDR is classified as an LVC instrument since it balances property blight/ wipe-outs resulting from planning restrictions with windfalls, by capturing some of the value increase resulting from zoning regulations (Germán and Bernstein, 2018; Theilacker, Lotze and Loza, 2019).

Evidently, the motivation to participate in the program should derive from extra benefit created for developers in receiving areas, having covered the costs of participating in the TDR program and of providing bonus development (Puertz, 2016). Depending on the nature of giving areas, they can be located in close physical proximity to receiving areas, as is the case with some TDR programs aiming at historic preservation or land conservation for BGI in urban areas (Nelson, Pruetz and Woodruff, 2012; City of New York - Department of City Planning, 2015), or they can be located away from receiving areas, which is usually the case with TDR programs that contribute to conservation of farmland, environmentally sensitive land or areas affected by coastal erosion (Linkous and Chapin, 2014). This distinction is relevant when assessing the agents that contribute to the market potential in the receiving areas. In the first case, the quality of giving areas, especially in the case of BGI as

described in the first sections of this article (D'Acci, 2019) can contribute to the market potential of the receiving areas, reflecting in incremented land prices not only by virtue of density bonuses but also due to improved urban quality. On the other hand, this is not the case when giving and receiving areas are apart from each other, in which case, the incremented value captured in receiving areas is contributing off-site, to cover the costs of land preservation in giving areas. This distinction becomes particularly relevant when discussing matters of distributional justice in both cases, as is further discussed in the cases presented below.

4.2. Facilitating Blue/green infrastructure through Transferable Development Rights

Stinson (1996) suggests that amongst the main concerns that brought about TDR programs are higher demands for open spaces in congested metropolitan areas and economic incentives to develop environmentally sensitive areas. TDR addresses such pressures by reconstructing the economic incentives in land use. Up to date, more than 320 cities around the world have implemented TDR programs, 283 of which in US, while the rest in 11 other countries such as Australia, Brazil, Canada, China, France, India, Italy, Japan, Mexico, Spain, and the Netherlands (Puertz, 2016). More than half of these programs were designed to address environmental challenges and protect natural resources (Nelson, Pruetz and Woodruff, 2012).

Although the experience with TDR programs for flood risk management is limited, such cases attest for the untapped potential of this instrument. Some coastal TDR programs, initially designed to protect the ecosystems of environmentally sensitive areas, have expanded their objectives to target adaptation to sea level rise. For instance, 13 out of 20 counties in Florida that have implemented TDR programs are coastal counties (Linkous and Chapin, 2014). Additionally, some US counties have utilized TDR programs for BGI provision. The High Line project in New York is one example of how a major BGI can be implemented through the facilitation of TDR, with receiving areas located next to the giving area. The High Line consists of a public park built on top of an abandoned elevated train line, the implementation of which was rendered possible through a TDR program, which unlocked the development rights of the giving area, namely properties underneath and immediately to the west of the high line, by encouraging their transfer to the receiving area, mostly focused on nearby Avenues 10 and 11 (City of New York - Department of City Planning, 2015).

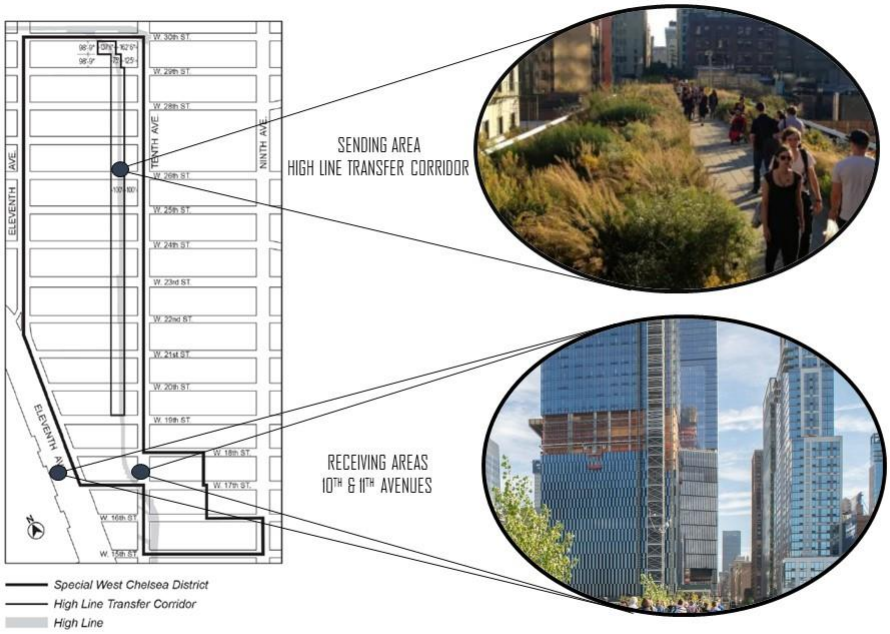

Figure 3 High Line TDR Program

The fast-growing region of Adams County in Colorado has approved a TDR program seeking to preserve its floodplain and habitat surrounding the South Platte River (Puertz, 2011). The six defined receiving areas are located in parts of the counted deemed suitable for hosting bonus intensities of development according to the County's Development Standards and Regulations. Similar TDR programs aiming at tackling flood risk through land conservation and BGI have also been piloted in other areas around US such as the Hudson River Park Trust in New York (Fenton, 2018), American Fork City TDR program in Utah, Johnson Creek Basin Plan District in Oregon, Fort Washington Office Park in Philadelphia (Puertz, 2011). So far, research on measuring the implementation and impact of these TDR programs in achieving their objectives is lacking.

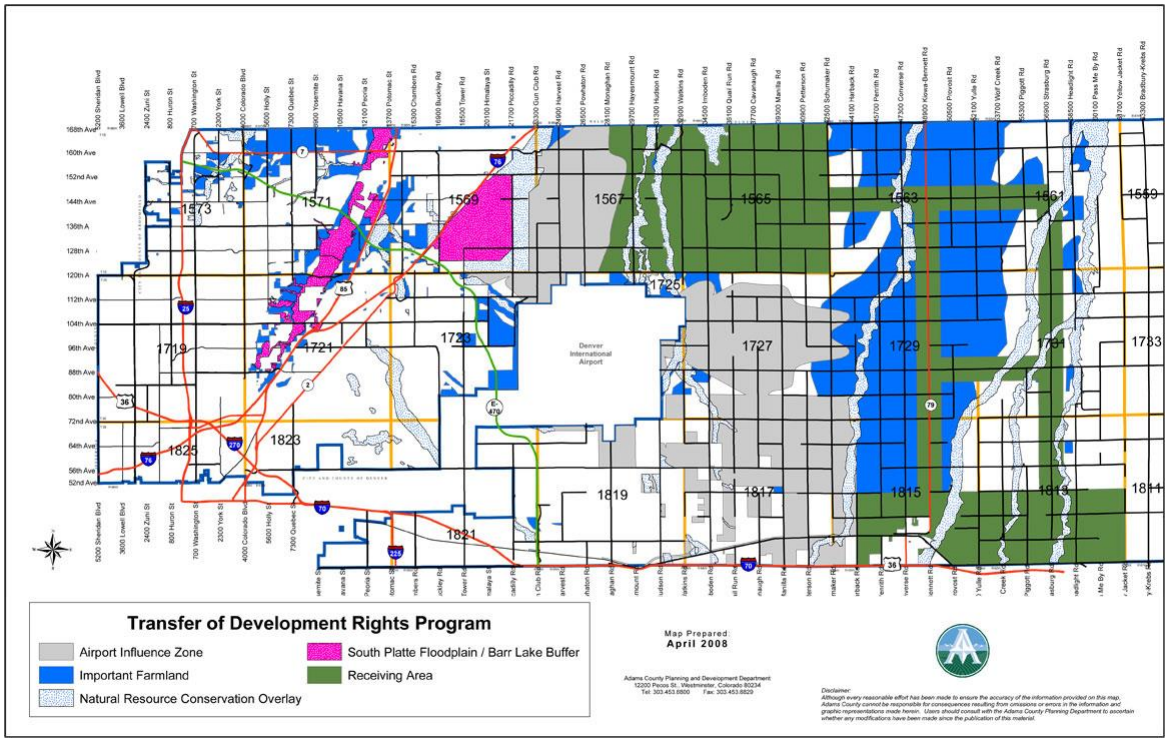

Figure 4 Adam County TDR Program (Source: Pruetz, n.d., retrieved from: www.https://smartpreservation.net/)

Ultimately, the success of TDR programs relies largely on the additional profits that developers take advantage of by participating in the program in the receiving area. Henceforth, refining the calculation of the developers' demand to exceed baseline development in receiving areas becomes central to the success of a TDR program (Puertz, 1997). In many cases, profits were linked with more square meters developed, hence the bonus units approved in receiving areas, such as in the case of Adams County (Puertz, 2011). In other cases, such as in the case of the High Line, the market potential in receiving areas is not only increased by the bonus units approved but also by their proximity to the High Line. In this sense, the impact of BGI in the market values of the nearby properties can be translated in increased potential to absorb more development right, but also in higher market values of the same development rights. Balancing windfalls on properties benefiting from the implementation of BGI with property blight of the properties whose development is limited or frozen because of the implementation of GI should be the next step of research towards new models of TDR programs.

4.3. Challenges in implementing TDRs

Some scepticism surrounding TDR programs rises because of concern on the bonus development rights granted in the receiving areas and how they might impact the quality of life there. It is important to bear in mind that TDR programs should not intensify development but rather redistribute according to more sustainable development models (Chiodelli and Moroni, 2016). However, in contexts where established development rights emerging from land use plans are already permissive for developers, such as the case of Flanders in Belgium, the incentive to participate in a TDR program

is low (Crabbé and Coppens, 2019), because once an area is zoned, it is difficult to reduce its development rights through downzoning (Nelson, Pruetz and Woodruff, 2012).

Another challenge of managing TDR programs is that the timing of issuance of TDRs in sending areas might not coincide with the timing of TDR purchase from developers in receiving areas. This could challenge that needs to be addressed especially when it comes to BGI, where a conservation easement needs to be in place for the land preserved before work for the implementation of the BGI starts. Hence, separation of TDR extermination from acquisition has called for intermediary institutions such as development rights banks (Stinson, 1996; Puertz, 2016).

Transaction costs incurred by participants of a TDR program present an additional challenge, especially since their distribution and cost per transaction might discourage landowners to participate in a TDR program. Such costs may arise from efforts to negotiate TDR sale prices, contract agreements and collecting information on potential TDR participants (buyers and sellers) (Shahab, Clinch and O'Neill, 2018). It is essential that planners account for the transaction costs when designing TDR programs and that they provide more information on TDR sale prices and potential buyers and sellers (Shahab, Clinch and O'Neill, 2018).

TDR programs are an attractive LVC instrument which engages the market to balance out the costs and benefits incurring from land use planning, including policies related to integrated FRM. Such programs have been piloted in various localities in US, aiming at creating more room for water retention, by land conservation for BGI. Their success in achieving these objectives depends on the way the TDR program is designed and the context where it is implemented, as elaborated above. Nevertheless, empirical evidence regarding the success rate of TDR programs with a focus on FRM is generally lacking, and it constitutes an important field for future exploration.

5. Conclusion

So, what is the potential for TDR to fund BGI based flood risk management measures? This paper puts forward this question at a time when it is becoming more and more clear that flood risk management needs cannot fully be realized only through the deployment of public funds. There are several considerations to keep in mind while exploring the answer to this question.

First, empirical research on the impact of BGI on land markets is still in its initial stage, however there is a large body of work assessing the effect of blue/green spaces, open spaces and improved landscapes on land markets. Indeed, such studies show that the quality of life and the quality of urban environments are becoming increasingly important factors, especially when it comes to residential areas, and they positively impact the real estate market, although the extent of this effect is very context related.

Second, the implementation of Blue/green Infrastructure projects remains stubbornly slow, granted their socio-economic and ecological added value, mostly due to increased land requirements that such infrastructure poses in comparison to grey infrastructure, as well as higher maintenance costs. By

merging literature that is typically considered separately, such as literature on land markets on one hand and flood resilience on the other, this article highlights the necessity to look for solutions and lessons to be learned from Land Value Capture instruments and the vast experience in using such instruments to finance road networks, transport or other types of infrastructure. How can public authorities capitalize on the added value of BGI, in terms of increase of rental values in the land market, to finance such infrastructure? This research seeks to initiate this conversation by systematizing the experience and body of knowledge on Land Value Capture instruments (Table 1), as a way to accentuate the need for further investigation in the field. The variety and degree of success of Land Value Capture instruments is diverse, and as such, it is important to carefully consider each instrument in the realm of a given context and evaluate its potential to facilitate Blue/green Infrastructure provision.

Transferable Development Rights, an LVC instrument with an emphasis on land conservation, can be an attractive instrument in terms of cross-subsidizing property windfalls of the properties benefiting from Blue/green Infrastructure and property blights of the landowners in properties where development shall be frozen to provide Blue/green Infrastructure. TDR requires attractive land markets to subsidize land conservation and perpetually freeze development for BGI provision. The positive impact that BGI has on land markets of the beneficial areas presents an incentive for such areas to be designated as receiving areas. Receiving areas can be designated to host additional development rights, should the carrying capacity of the area allow to do so. However, it is important to estimate the amount of additional development rights and their value and to balance them with the development rights to be transferred from the giving area. For the most part, this is one of the main reasons why some TDR programs fail.

Nevertheless, Transferable Development Rights programs operate within specific legal contexts, in which the Right to develop is part of the bundle of rights of property and is separable and transferrable. Without such legal embedding and without approaching development rights as a social construct, granted from the society to the individual landowner, the implementation of TDR for any purpose would be difficult, if possible, at all. Therefore, while TDR has the potential to be implemented for land provision scoping to mainstream Blue/green Infrastructure, further research should explore the legal and institutional implications that this entails.

Alterman, R. (2012) 'Land-Use Regulations and Property Values: The "Windfalls Capture" Idea Revisited', *The Oxford Handbook of Urban Economics and Planning*, pp. 1–34. doi: 10.1093/oxfordhb/9780195380620.013.0034.

Brookes, A., Gregory, K. J. and Dawson, F. H. (1983) 'An assessment of river channelization in England and Wales', *Science of the Total Environment, The*, 27(2–3), pp. 97–111. doi: 10.1016/0048-9697(83)90149-3.

Chiodelli, F. and Moroni, S. (2016) 'Zoning-integrative and zoning-alternative transferable development rights: Compensation, equity, efficiency', *Land Use Policy*. Elsevier Ltd, 52, pp. 422–429. doi: 10.1016/j.landusepol.2016.01.006.

City of New York - Department of City Planning (2015) *A Survey of Transferable Development Rights Mechanisms in New York City*. New York. Available at: http://www1.nyc.gov/assets/planning/download/pdf/plans-studies/transferable-development-rights/research.pdf.

Clean Water America Alliance (2012) *Barriers and Gateways to Green Infrastructure*.

Crabbé, A. and Coppens, T. (2019) 'Swapping Development Rights in Swampy Land: Strategic Instruments to Prevent Floodplain Development in Flanders', in Hartmann, T., Slavikova, L., and McCarthy, S. (eds) *Nature-Based Flood Risk Management on Private Land: Disciplinary Perspectives on a Multidisciplinary Challenge*, pp. 85–97.

CRED (2019) *Natural Disasters 2018*. Brussels. Available at: https://www.emdat.be/.

CRED (2020) *Disaster* Year in Review 2019, Cred*. Available at: https://www.emdat.be/publications?field_publication_type_tid=All.

D'Acci, L. (2019) 'Quality of urban area, distance from city centre, and housing value. Case study on real estate values in Turin', *Cities*. Elsevier, 91(November), pp. 71–92. doi: 10.1016/j.cities.2018.11.008.

Dano, U. L. *et al.* (2019) 'Flood susceptibility mapping using GIS-based analytic network process: A case study of Perlis, Malaysia', *Water (Switzerland)*, 11(3). doi: 10.3390/w11030615.

European Commission (2013) *COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS Green Infrastructure (GI) — Enhancing Europe's Natural Capital*.

European Parliament and Council of the European Union (2007) *Directive 2007/60/EC of the European Parliament and of the Council of 23 October 2007 on the assessment and management of flood risks*.

Germán, L. and Bernstein, A. E. (2018) *Land value capture Tools to Finance our Urban Future*, *Policy Brief*. Available at: http://archive.citiscope.org/story/2014/how-sao-paulo-uses-.

Green, C. H., Parker, D. J. and Tunstall, S. M. (2000) 'Assessment of Flood Control and Management Options', (November).

Hansen, R. and Pauleit, S. (2014) 'From multifunctionality to multiple ecosystem

services? A conceptual framework for multifunctionality in green infrastructure planning for Urban Areas', *Ambio*, 43(4), pp. 516–529. doi: 10.1007/s13280-014-0510-2.

Hartmann, T. (2012) 'Land Policy for German rivers: making Space for the Rivers', in Warner, J., van Buuren, A., and Edelenbos, J. (eds) *Making space for the river: Governance experiences with multifunctional river flood management in the US and Europe*. IWA Publishing.

Hartmann, T. (2016) *Clumsy Floodplains - Responsive Land Policy for Extreme Floods*. Routledge.

Hartmann, T., Slavikova, L. and McCarthy, S. (2019) 'Nature-Based Solutions in Flood Risk Management', in Hartmann, T., Slavikova, L., and McCarthy, S. (eds) *Nature-Based Flood Risk Management on Private Land*. doi: 10.1007/978-3-030-23842-1.

Jacobus, R. (2015) *Inclusionary Housing: Creating and Maintaining Equitable Communities*. doi: 10.1080/08920759009362099.

Jung, E. and Yoon, H. (2018) 'Is flood risk capitalized into real estate market value? A mahalanobis-metric matching approach to the housing market in Gyeonggi, South Korea', *Sustainability (Switzerland)*, 10(11). doi: 10.3390/su10114008.

Kaplowitz, M. D., Machemer, P. and Pruetz, R. (2008) 'Planners' experiences in managing growth using transferable development rights (TDR) in the United States', *Land Use Policy*, 25(3), pp. 378–387. doi: 10.1016/j.landusepol.2007.07.004.

Keeley, M. *et al.* (2013) 'Perspectives on the use of green infrastructure for stormwater management in cleveland and milwaukee', *Environmental Management*, 51(6), pp. 1093–1108. doi: 10.1007/s00267-013-0032-x.

Lamond, J. and Proverbs, D. (2006) 'Does the effect of flood ever go away?', *Structural Survey*, 24(5), pp. 363–377.

Lewis, M. and Conaty, P. (2012) *The Resilience Imperative - Cooperative Transitions to a Steady-State Economy*. New Society Publishers; First Edition edition.

Linkous, E. R. and Chapin, T. S. (2014) 'TDR program performance in florida', *Journal of the American Planning Association*, 80(3), pp. 253–267. doi: 10.1080/01944363.2014.985697.

Liu, L. *et al.* (2015) 'Developing an effective 2-D urban flood inundation model for city emergency management based on cellular automata', *Natural Hazards and Earth System Sciences*, 15(3), pp. 381–391. doi: 10.5194/nhess-15-381-2015.

Matthews, T., Lo, A. Y. and Byrne, J. A. (2015) 'Reconceptualizing green infrastructure for climate change adaptation: Barriers to adoption and drivers for uptake by spatial planners', *Landscape and Urban Planning*. Elsevier B.V., 138, pp. 155–163. doi: 10.1016/j.landurbplan.2015.02.010.

McCord, J. *et al.* (2014) 'Effect of public green space on residential property values in Belfast metropolitan area', *Journal of Financial Management of Property and Construction*, 19(2), pp. 117–137. doi: 10.1108/jfmpc-04-2013-

0008.

Mell, I. (2020) ‘The impact of austerity on funding green infrastructure: A DPSIR evaluation of the Liverpool Green & Open Space Review (LG&OSR), UK’, *Land Use Policy*, 91(November 2019). doi: 10.1016/j.landusepol.2019.104284.

Nelson, A. C., Pruetz, R. and Woodruff, D. (2012) *The TDR handbook : designing and implementing successful transfer of development rights programs*.

Nurmi, V. *et al.* (2016) ‘Green Roof Cost-Benefit Analysis: Special Emphasis on Scenic Benefits’, *Journal of Benefit-Cost Analysis*, 7(3), pp. 488–522. doi: 10.1017/bca.2016.18.

O’Donnell, E. *et al.* (2020) ‘The blue-green path to urban flood resilience’, *Blue-Green Systems*, 2(1), pp. 28–45. doi: 10.2166/bgs.2019.199.

Puertz, R. (1997) *Saved by Development: Preserving Environmental Areas, Farmland and Historic Landmarks with Transfer of Development Rights*. Arje Pr.

Puertz, R. (2011) *TDR Updates*. Available at: https://smartpreservation.net/tdr-updates/.

Puertz, R. (2016) ‘Eco-Cities and Transferable Development Credits’, *Reflections Series*, (18).

Rabé, P. (2010) *Land Sharing in Phnom Penh and Bangkok: Lessons from Four Decades of Innovative Slum Redevelopment Projects in Two Southeast Asian ‘Boom Towns’, Examining ‘The places we live’: Slums and Urban Poverty in the Developing World*. Available at: http://siteresources.worldbank.org/INTURBANDEVELOPMENT/Resources/336387-1272506514747/Rabe.pdf.

Schanze, J. (2019) ‘Foreword: Nature-Based Flood Risk Management’, in Hartmann, T., Slavíková, L., and McCarthy, S. (eds) *Nature-Based Flood Risk Management on Private Land*, pp. v–viii.

Shahab, S., Clinch, J. P. and O’Neill, E. (2018) ‘Timing and distributional aspects of transaction costs in Transferable Development Rights programmes’, *Habitat International*, 75(xxxx), pp. 131–138. doi: 10.1016/j.habitatint.2018.03.006.

Smolka, M. O. (2013) *Implementing Value Capture in Latin America: Policies and Tools for Urban Development Policy Focus Report Series*, *Lincoln Institute of Land Policy*. Available at: www.lincolninst.edu.

Stinson, J. D. (1996) ‘Transferring Development Rights : Purpose , Problems , and Prospects in New York’, *Pace Law Review*, 17(1), pp. 319–357.

Theilacker, J., Lotze, N. and Loza, A. (2019) *Transfer of Development Rights (TDR), Legal Foundations of Land Use Planning*. doi: 10.4324/9780203787359-7.

van Vuren, S., Paarlberg, A. and Havinga, H. (2015) ‘The aftermath of “Room for the River” and restoration works: Coping with excessive maintenance dredging’, *Journal of Hydro-Environment Research*. Elsevier B.V, 9(2), pp. 172–186. doi: 10.1016/j.jher.2015.02.001.

Walters, L. (2016) *Leveraging Land: Land-based Finance for Local Governments*, *Global Land Tool Network*. Available at: https://gltn.net/download/leveraging-land-land-based-finance-for-local-governments-a-reader/.

Wright, K. (2016) ‘Resilient communities? Experiences of risk and resilience in a time of austerity’, *International Journal of Disaster Risk Reduction*. Elsevier, 18, pp. 154–161. doi: 10.1016/j.ijdrr.2016.06.003.

Zhang, B., Xie, G. and Zhang, C. (2012) ‘The effects of public green spaces on residential property value in Beijing’, *Journal of Resources and Ecology*, 3(3), pp. 243–252. Available at: https://doi.org/10.5814/j.issn.1674-764x.2012.03.007.

Zhang, S. *et al.* (2018) ‘The influences of sponge city on property values in Wuhan, China’, *Water (Switzerland)*, 10(6), pp. 1–20. doi: 10.3390/w10060766.