Floodplain buyouts and municipal finance

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Abstract

Floodplain buyouts – the acquisition and removal of flood-damaged homes – have become increasingly important in federal disaster policy. However, there has been little research on how buyouts fiscally impact *local* governments. Buyouts can reduce future disaster-relief costs, create valuable open space, and reduce maintenance costs where urban infrastructure can be permanently removed. Conversely, buyouts can reduce property tax revenues and saddle municipalities with new buyout property maintenance costs. What are the range of potential fiscal impacts of buyouts on municipalities? This paper seeks to address this question while establishing a user-friendly process for estimating accurate impact ranges. We assessed the fiscal impacts of buyouts in eight, North Carolina (USA) case study communities, developing and testing a scenario-driven spreadsheet model to explore how community characteristics, policies, and strategies for buyout program design can affect the fiscal impacts of a buyout over time. We discovered that fiscal impacts depend on at least three key factors, including 1) the spatial distribution of the acquired properties, 2) whether buyout participants relocate within their community, and 3) the management and maintenance regimes of acquired properties.

Introduction

For much of the 20th century, US policy toward controlling floods focused primarily on taming rivers with structures such as dams, floodwalls and levees (Conrad et al., 1998; Wright, 2000). Following record-breaking flooding in the Midwest in 1993, federal policy began to shift more toward non-structural measures, such as land use planning and regulation to prevent development in hazard-prone areas, and the acquisition and removal of flood-damaged homes (Godschalk, et al., 1999). Efforts to acquire flood-damaged homes, known as "buyouts," are aimed at facilitating homeowner relocation to new areas that are free from flooding.

Buyouts have since become a major focus of US flood mitigation strategy (FEMA, 1998), as the US Federal Emergency Management Agency (FEMA) has funded the acquisition of more than 55,000 flood-damaged properties across the U.S. since 1993 (FEMA, 2018d). The number of buyouts has increased dramatically within the last few years following events such as Hurricane Sandy (2012), Hurricane Matthew (2016), and Hurricane Harvey (2017), which caused extensive damage in New York and New Jersey, North Carolina, and Texas, respectively. Costs from flood damage will likely continue to rise due to continued development in floodplains, urbanization, and more extreme flooding events due to climate change (National Climate Assessment, 2014).

Recent research has explored various aspects of buyouts, including social equity and cost-effectiveness (Tate, et al., 2016), land use impacts (Zavar and Haglemen, 2016), and factors affecting homeowner's decisions about buyouts (Bukvic and Owen, 2017; Binder, et al., 2015).

Additionally, several studies have shown that buyouts can reduce the losses from future floods (FEMA, 2009; FEMA, 2016a). These studies focus on "avoided losses," estimating the flood-induced economic losses that would have occurred if homes had not been acquired and removed from flood hazard areas.

However, there has been little empirical research on the fiscal impacts of buyouts from the perspective of municipal governments (ELI 2017a; 2017b). After the 1993 Midwest flood, the Federal Interagency Floodplain Management Review Committee (IFPMRC) discovered that lost tax revenues due to buyouts were becoming a pressing issue for local governments (IFPMRC, 1994). Others have also claimed that floodplain buyouts remain a drag on municipal budgets (e.g., Zavar and Hagelman, 2016). For example, as properties are purchased and demolished (which is required under FEMA and HUD's mitigation grant [CDBG-DR] programs [HUD 2013], but not necessarily under some local government floodplain acquisition programs and HUD's CDBG grants), local governments typically inherit responsibility for maintaining a significant number of now-vacant lots (Freudenberg et al., 2016).

However, the overall municipal financial impacts of buyouts remain uncertain. Freudenberg, et al. (2016, pg. 38) assert that the impacts of removing property from the tax rolls may be less significant than public officials estimate. Recent work by Wiley (2018) also asserts that buyouts can be designed such that they minimize local tax revenue losses, or even increase local revenues by coupling the buyouts to strong land use planning strategies that enhance the community.

When a flood buyout program is proposed, the fiscal gains and losses to the local government are rarely evaluated. This type of assessment, however, is crucial to understanding the full costs and benefits of a buyout to a local government. What are the range of potential fiscal impacts of buyouts on municipalities? Our goals in this paper are to (a) assess the net fiscal impacts of floodplain buyouts on municipalities, and (b) establish a user-friendly process (and modeling tool) for estimating true range of financial outcomes for different types of communities (even in data sparse environments). These goals are relevant and timely for communities that are either still struggling to recover from recent flooding, or are likely to be impacted by such hazards in the future. Our hope is that the tool we describe in this paper can help guide researchers and governments to collect and use better information in order to improve both the process and outcomes of buyouts.

We begin by reviewing the funding sources, common spatial patterns, and financial impacts of buyouts. Next, we discuss selection of eight, highly flood-prone case study communities in North Carolina, the acquisition of buyout data from the North Carolina Division of Emergency Management (NCDEM), techniques for mapping buyout properties, and interviews with key informants (*n=25*) to understand data availability and cost profiles. The results of this research include a simple, user-friendly model (see Supplementary Material 2) to help communities estimate the financial impacts of buyout programs. Using scenario analysis, we apply this model to the City of Lumberton, NC to examine how different municipal actions can affect the net

fiscal impacts a buyout program. This model can also be used to help communities run multiple scenarios to evaluate a range of buyout implementation goals and strategies.

Background

Financing buyouts

The primary sources of funding for floodplain buyouts come from federal sources, particularly the U.S. Department of Housing and Urban Development (HUD) and FEMA. Under their Community Development Block Grants (CDBG) program, HUD offers flexible grants to help cities, counties, and states to recover from large-scale disasters, especially in low-income areas. The grants, known as CDBG-DR (for "Disaster Recovery"), can be used for "...necessary expenses related to disaster relief, long term recovery, and restoration of infrastructure, housing, and economic revitalization…(HUD, 2018b, pg. 14)." This could include, for example, rebuilding homes and infrastructure damaged by a disaster. CDBG-DR funds may also be used to provide the non-federal match for FEMA Hazard Mitigation Assistance grants, discussed below (HUD, 2018a).

FEMA administers three types of Hazard Mitigation Assistance grants: 1) Pre-Disaster Mitigation, 2) Flood Mitigation Assistance, and the 3) Hazard Mitigation Grant Program (FEMA, 2015a). All three of these grant programs are intended to reduce or eliminate risks from future disasters while also reducing the reliance on federal disaster funding. The Pre-Disaster Mitigation Grant Program, authorized by the 1988 Stafford Act, (42 U.S.C. 5133), provides funds for pre-disaster natural hazard mitigation programs, such as elevating, floodproofing or

acquiring homes. Similarly, the Flood Mitigation Assistance grant program -- which was created as part of the National Flood Insurance Reform Act of 1994 (FEMA, 2015a) -- can be used for mitigation, including the acquisition of homes, although funds are limited to projects that reduce or eliminate risks to properties insured under the National Flood Insurance Program (NFIP; see *42 USC 4104c*).

Although Pre-Disaster Mitigation and Flood Mitigation Assistance provide substantial financial assistance to communities (over $160 million in Flood Mitigation Assistance during FY 2017 alone; FEMA, 2018a), the primary source of buyout funding is FEMA's Hazard Mitigation Grant Program (HMGP; authorized under Section 404 of the 1988 Stafford Act; FEMA, 2015b), which awards grants after a disaster occurs. The HMGP is the program that we will focus on throughout the rest of this paper.

Applications for Pre-disaster Mitigation, Flood Mitigation Assistance, and HMGP can only be initiated by U.S. states, tribes, or territories. In general, these grants cover up to 75% of the total cost of a project and require a 25% non-federal match, which may consist of cash, third party in-kind services, or materials (FEMA, 2015b). After a Presidentially-Declared Disaster (a special disaster designation), FEMA provides HMGP funding to states to carry out hazard mitigation measures in order to decrease the "loss of life and property" from future disasters (FEMA, 2015b). States then allocate these funds to local and tribal governments for mitigation, including buyouts (USGAO, 2015).

An important aspect of buyout policy is that the procurement of properties through FEMA is strictly voluntary – homeowners cannot be forced to sell their homes (FEMA, 2015c). While homeowners are paid pre-flood, fair market value for their properties (FEMA, 2014), in some cases, state or local governments will provide additional funds as an incentive. For example, after Hurricane Sandy, the State of New York provided bonuses of up to 15% of a home's pre-storm price in an effort to increase participation in the buyout (Polefka, 2013).

Properties acquired using FEMA funds (as well as HUD CDBG-DR funds) must be demolished and the site must be cleared and maintained in perpetuity for, "uses compatible with open space, recreational or wetlands management practices (44 CFR 206.434(e))." Federal funds cover the cost of appraisal, acquisition and demolition as well as clearing the site, but typically exclude maintenance. The lands publicly acquired through buyouts can – in theory – be used for numerous purposes, including parks, community gardens, or wildlife habitat, or as spaces for restoring the natural flood storage capacity of floodplains. However, the most common uses of buyout lands are as vacant lots, defined as mowed grass or bare soil (Zavar and Hagelman 2016).

Buyout spatial patterns

The voluntary nature of buyouts complicates efforts to predict the future land use and maintenance requirements of a buyout project. Rather than accept a buyout, some homeowners will inevitably decide to rebuild after a flood, often with the assistance of NFIP disbursements. These so-called buyout "hold-outs" often occur when homeowners are given

178 inadequate information or inadequate incentives (financial or otherwise) to participate (Binder,
179 2014). Holdouts may also be unwilling to move because of strong attachment to their home,
180 land, or social aspects of their neighborhood (Henry, 2013). Alternatively, they might not be
181 able to afford to buy a similar house outside the floodplain.
182
183 Several studies have explored the different factors that affect homeowners' decisions about
184 whether or not to accept a buyout (e.g., Binder and Greer, 2016; Bukvic and Owen, 2017). For
185 example, in their case study of buyouts in Oakwood Beach, New York, following Hurricane
186 Sandy, Binder and Greer (2016) found that financial incentives appeared to encourage
187 participation, although the incentives did not necessarily relieve financial burdens for buyout
188 participants. Contrasting this, in a survey of 46 homeowners across seven coastal communities
189 affected by Hurricane Sandy, Bukvic and Owen (2017) found that most respondents would
190 make their decisions about whether to rebuild or relocate regardless of what their neighbors,
191 friends and/or family decided to do.
192
193 Holdouts (or lack thereof) can lead to a variety of spatial patterns of remaining homes in a
194 buyout area. The spatial patterns of remaining homes can determine infrastructure cost savings
195 as well as what local governments can do with acquired properties. We can categorize these
196 general patterns as follows: 1) a scattered or random pattern (sometimes called
197 "checkerboarding"; Figure 1A), a clustered pattern that can lead to either 2) extensive or 3)
198 minimal infrastructure cost savings (Figure 1B and 1C, respectively), and 4) a complete buyout
199 (all houses in a floodplain; Figure 1D). These general patterns – with the exception of the last –

200 can be seen in buyouts that took place our eight study communities (discussed in the next
201 section; Figure 3). We can also consider an additional situation, whereby 5) a “more than full”
202 buyout takes place, which could include opportunistic purchases of houses beyond the flooded
203 area or the purchase of buyout lands adjacent to existing, publicly-owned open space (Figure
204 1E).
205
206 **Financial impacts of buyouts**
207 Fiscal impact assessment has long been used to aid municipal decision-making (Burchell 1978).
208 Used to project changes in costs and revenues of governmental units as a result of
209 development (or redevelopment), a variety of techniques are frequently used to estimate the
210 costs incurred by municipal governments in providing services. In particular, techniques such as
211 “per-capita multipliers” (using average cost per capita to extrapolate costs of development
212 changes), “proportional evaluation” (assigning development an area-weighted portion of
213 municipal costs as measured across the entire city), and “case study” or “comparable city”
214 methods (getting estimates from interviews and using reference cases in other areas; Lamie et
215 al., 2012).
216
217 A number of studies have used fiscal impact assessment to evaluate the economic impacts of
218 buyouts on the public, generally. For example, several studies have shown that, in general,
219 buyouts are effective ways of reducing the public costs of future floods. These costs include
220 expenditures on emergency services, evacuation, emergency shelters, and debris removal (see
221 collection of these studies in FEMA, 2019). Under the Stafford Act, projects funded by HMGP,

including buyouts, must be shown to be cost-effective. That is, the total net benefits must be greater than the total costs (44 CFR 206.434(c)(5)). Most buyouts meet this cost-benefit test; a review of a statistical sample of HMGP grants awarded between 1993 and 2003 found (using a mathematical procedure developed to include a variety of direct and indirect factors) that the average benefit-cost ratio for FEMA floodplain acquisition grants was about 5 to 1 (Rose et al., 2007). Confirming this, a recent study by the National Institute of Building Sciences found that the impact of federal mitigation grants, including grants for property acquisition, resulted in an economic impact of $6 for every $1 invested (Multihazard Mitigation Council, 2017).

Overall, FEMA has conducted 14 flood-related "avoided loss" studies throughout the United States in Alabama, Colorado, Missouri, Iowa, Louisiana, Mississippi, California, Oregon, Washington, and Wisconsin (FEMA, 2019). "Avoided loss" refers to projections of damage that would have occurred had the buyout or mitigation measures not taken place; these projections can then be compared to the cost of the mitigation projects or land acquisitions. These studies focused on determining the avoided flood damage and effectiveness of 1) land acquisitions, 2) removal of structures in Special Flood Hazard Areas, and 3) relocations and mitigation projects funded by HMGP. The four categories used to determine overall avoided losses throughout these studies include, physical damage, loss of function, emergency protective measures and nontraditional benefits. Nine out of the 14 studies revealed a return on investment of above 1.00, meaning these mitigation projects were successful in saving money for the communities through avoided losses. Conversely, a ROI < 1.00 means that the total costs of the flood buyout project have exceeded the avoided losses, a low return on investment. The greatest return on

investment was found to be an ROI of 18.29 for 2009 Iowa flood reduction projects, and the lowest of 0.37 for the Southern California Flood Control Mitigation study (FEMA, 2019). This variation in ROI may be due to numerous factors influencing the effectiveness of a buyout or mitigation project, including the location and number of buyouts as well as the extent of an elevation or mitigation measure.

While FEMA's loss avoidance studies consider federal financial impacts, our study is focused on estimating *municipal* financial impacts, which require us to be careful to only consider costs incurred at the municipal level alone. Therefore, we can consider the financial impacts of buyouts in terms of four different categories, including 1) avoided infrastructure maintenance costs, 2) avoided emergency response and recovery costs, 3) tax revenue impacts, and 4) buyout site maintenance costs. This amounts to the calculation in Equation 1:

Net fiscal impact ($) = avoided annual infrastructure costs + avoided emergency response and recovery costs - net tax revenue loss - buyout site maintenance costs (Equation 1)

Avoided annual infrastructure costs

In general, buyouts occur along a continuum of efficiency. We can consider an "inefficient" buyout, e.g., a checkerboard pattern of acquired properties, to yield little savings or avoided costs, since a municipality would still have to operate and maintain infrastructure that now serves fewer houses. In contrast, an "efficient" buyout is one implemented such that remaining infrastructure (i.e., roads, water distribution lines, sewer lines, etc.) is permanently removed or

cut off from the existing system, saving regular operations, maintenance and repair costs. An efficient buyout can occur if the municipality acquired a large, contiguous cluster of homes. The infrastructure savings represents an avoided cost that is usually funded through a capital improvement program. Since capital improvement budgets are often quite large, decommissioning just a small percentage of the total public infrastructure could, in theory, result in substantial annual maintenance cost savings for a municipality.

For example, if a municipality with 10,000 housing units has an annual roads maintenance budget of $1,500,000 that covers 150 km of roads, and 0.4 km of roads (0.3%) are removed from a neighborhood where 20 homes have been bought out, avoided infrastructure costs would amount to just $4,000 per year. If this municipality could also permanently remove a similar percentage of water and sewer infrastructure (each with annual budgets of $4,000,000), total avoided infrastructure maintenance costs would amount to just over $30,000 per year. However, if this municipality had a more ambitious buyout program in which it acquired and removed 200 homes in a continuous area (an efficient buyout), and a larger percentage of infrastructure was removed, (e.g., 2%), it could lead to annual savings of nearly $190,000 in avoided annual infrastructure maintenance costs. Unfortunately, this sort of large, efficient buyout is quite rare and the feasibility and cost of physically removing particular segments of infrastructure are uncertain and depend on a number of factors, such as the landscape features (soil composition, slope, etc.) and the nature of the system's network and requirements (e.g., for water pressure).

Avoided emergency response and recovery costs

Following significant flooding events, municipalities often engage in a series of immediate response and recovery activities, including "Emergency Work" (i.e., debris removal, swift water rescues, opening and operating shelters, etc.) or "Permanent Work" (i.e., restoration of roads, bridges, utilities, buildings, equipment, etc.) as defined through FEMA's Public Assistance Program (FEMA, 2018b). While some of these costs would be avoided during a flood if several homes had been bought out, most municipalities get full reimbursement through FEMA (75%) and their state emergency management agency (25%) during major, declared disasters (FEMA, 2018). In North Carolina, for state, but not federally declared disasters, the local government must cover 25% of the costs for response and recovery activities, while the State reimburses for the other 75% (NCDEM, 2015). As a result, municipalities can often transfer these costs to federal and state governments.

Tax revenue impacts

Communities are often concerned about the loss of tax base due to the removal of homes (Bukvic and Owen, 2017). Unless homeowners relocate elsewhere within the same community, each home acquired and demolished reduces property and sales tax revenues to local governments. However, it is difficult to determine (and few studies have addressed) whether buyout participants remain in the same taxing jurisdiction or move somewhere else as there is no requirement for local governments to track where people move after a buyout (McGhee, 2017). In this analysis, we exclude the impacts of buyouts on sales tax revenues, as these funds are often difficult to analyze at municipal level, requiring significant additional economic impact

analysis. Moreover, in our North Carolina study areas, sales taxes are collected by the state and redistributed to municipalities, complicated by the recent (2016) enactment of a series of additional "Local Option Sales Taxes" at the county and municipal levels (UNC SOG, 2016).

Another complicating issue concerns the spillover impacts of buyouts; a rich literature has looked into the impacts of proximity to open space on home value (Brander and Koetse, 2011), with several studies observing home values increase due to added open space (e.g., Geoghegan, 2002; Anderson and West; 2006). However, these studies tend to focus on parks or greenways, not buyout lands. There have been no empirical studies on the impact of buyouts on the value of homes located adjacent to buyout parcels.

Buyout site maintenance costs

As mentioned previously, the most common product of buyouts is vacant land, which remains over long periods as either mowed grass or bare dirt (Zavar and Hagelman, 2016). These vacant lots could affect the value of nearby homes, positively or negatively. While some communities lease buyout lots to neighboring residents, who are then given responsibility for upkeep (Greenville, 2004), maintaining these vacant sites can become a financial burden to local governments (Zavar and Hagelman, 2016).

Municipal governments typically lack the information they need to estimate the true costs of buyouts, including changes to property values and the long-term cost of maintenance. In addition, local governments lack guidance on strategies to manage homeowner participation in

buyouts, which could reduce the number of holdouts and expand the range of options for using the acquired lands for community benefit. In this paper, we endeavor to create a tool to evaluate the long-term financial implications of buyouts, specifically, the loss of property tax revenues and increased maintenance costs.

Methods

We set out to create two versions of a municipal fiscal impact assessment model of buyouts (see Supplementary Material 2). The first, which we examine in depth and apply to case study communities, is aimed at retroactively understanding *past* buyouts. The second model leverages the first, but is aimed at evaluating the fiscal impacts of future, planned buyouts, as well as identifying the data necessary to determine buyout policy or incentives.

Community site selection

To establish and test our tool, we selected eight communities in North Carolina that either had implemented a buyout following Hurricane Fran (1996) or Floyd (1999), or were in the process of implementing a buyout following Hurricane Matthew (2016; NCDEM, 2018). To establish representative case studies (Yin, 2008), we sought to select communities with wide variations in population, buyout extents, and past flood protection investment. This process was severely constrained by the availability of limited data on past buyouts (discussed below). Our case study selection process yielded eight communities (Figure 2), ranging from the City of Charlotte (pop. ~730,000) to the Town of Seven Springs (pop ~130).

Our four smallest case study communities – Lumberton, Kinston, Windsor, and Seven Springs – are still in the process of recovering from Hurricanes Matthew and Florence and are considering a variety of mitigation measures, including buyouts. The other four communities – Rocky Mount, Greenville, Raleigh, and Charlotte – have had significant flood buyouts in the past, have larger populations, and in general have more robust data availability and planning capacity. All eight communities and their relevant characteristics are summarized in Table 1.

These communities exhibit a range of flood mitigation measures, from a dike built along the Lumber River aimed at reducing flooding risk for neighborhoods south and west of downtown Lumberton, to a stormwater utility in Charlotte that collects stormwater fees to fund flood risk reduction projects (David Love, Project Manager, Charlotte-Mecklenburg Stormwater Services, Personal communication, March 13, 2017). Using these fees, the City of Charlotte actively engages in the acquisition of properties that repeatedly flood (municipal-level buyouts), aiming to provide financial assistance for the relocation of the homeowner in advance of the next major flood event.

Mapping buyout properties

We obtained a statewide database of FEMA-funded hazard mitigation projects from the State Hazard Mitigation Officer at the North Carolina Division of Emergency Management (NCDEM). Using county tax parcel data, we mapped the buyout properties found within municipal limits using Geographic Information Systems (GIS) software (ArcGIS v. 15.0; Figure 3). While unique

parcel identification numbers (PINs) found in both datasets facilitated joining the majority of recorded buyouts, errors in the NCDEM data prevented mapping of ~25% or about 523 of a total 2,059 recorded buyouts. Incomplete or inconsistent latitude/longitude and address data was likely a product of unestablished or poorly executed data collection protocols at the time of the buyouts in the 1990s. In some cases, missing data such as home purchase price had to be manually corrected and augmented using the original HMGP project closeout sheets for the buyouts provided by NCDEM. Along with a PIN and address, each property record contained the associated total purchase price and date of acquired homes.

For communities that were able to acquire a cluster of neighboring properties, some recreational amenities have been put in place, such as a greenway in Lumberton (Figure 3). In other cases, a "checkerboard" pattern of scattered buyouts is more prominent (e.g., Town of Seven Springs, Figure 3F).

Estimating buyout fiscal impacts and key informant interviews

To determine the net fiscal impacts of buyouts, we sought to create a streamlined method for simplifying the theoretical fiscal analysis discussed in our background section (Figure 4). Along with cadastral and infrastructure GIS data, we relied on 25 semi-structured interviews with key informants (Gillham 2005), including local urban planners, emergency managers, city managers, elected officials, and stormwater managers, state emergency management personnel (involved in specific buyouts), as well as local budgeting, and public works staff that were involved with

flood recovery or administration of the buyout program. Supplementary Material 1 contains a list of all key informants.

Local government key informants were identified and selected using a snowball sampling approach (Yin, 2008), beginning with phone calls or emails to current town managers and planners who then suggested additional staff or former officials knowledgeable about (or responsible for) administering past or ongoing buyout programs. In several communities, key informants were identified through past interactions with researchers, who had assisted in recovery planning efforts after Hurricane Matthew. Interviews – which averaged about seventy minutes in duration – were conducted in groups of two to five people at a time and included a mix of ~25 questions. Questions asked respondents about a range of topics, including the numbers of properties acquired during past buyouts and their current uses. Several questions focused on the extent of costs and whether state or federal grants reimbursed cities for evacuation, search and rescue, operating shelters, debris removal, infrastructure repair and other local response and recovery activities.

Unfortunately, we could not include a number of municipal fiscal impacts in our analysis, either because reliable data could not be found, or because impacts could only be calculated in a way that would have included costs or benefits beyond the scope or jurisdiction of the municipality. For example, it was not feasible to include sales tax revenue or utility revenue as factors since they are often not confined to just the municipality.

Avoided emergency response and recovery costs

To accurately determine the net fiscal impacts of emergency response on municipal governments, we included only those costs to the municipality that were not reimbursed by the state or federal government. We estimated avoided emergency response and recovery costs by confirming with key informants the actual level of reimbursement municipalities received for various emergency and permanent work activities.

Avoided annual infrastructure costs

Annual infrastructure operating and maintenance costs can be avoided only if the municipality has removed or permanently closed off either road or water and sewer infrastructure in the course of a buyout project. Among our case studies, our interviews revealed that municipalities rarely removed infrastructure. Where removals did take place, they were rarely documented, leaving insights from key informant interviews again as our chief tool for estimating avoided costs. We estimated these avoided costs by calculating the amount of removed infrastructure (e.g., estimated length of road serving a given number of buyout properties) relative to the total city-wide amount and relating it to the number of housing units that support the capital improvement funding stream, as well as the annual amount of money the municipality budgets for activities (e.g., total road maintenance and repair budget). Within fiscal impact assessment methodology, generally, this well established (but flawed; see discussion section) technique is known as a *per-capita multiplier technique* (e.g., Burchell 1978).

Buyout site maintenance costs

Our key informant interviews revealed that expenditures specifically towards maintaining buyout properties (i.e., through mowing, landscaping, fertilizing, etc.) are also not a well-documented aspect of buyouts in most municipalities. Therefore, our interviews aimed to determine annual, municipal spending on maintenance for all city-owned parkland or vacant lots (which we determined were the dominant post-buyout land use). Along with the known acreage of buyout lands, calculating this per-area unit cost allowed us to determine the relative cost of buyout property upkeep. This calculation is greatly affected by existing staff capacity and quality of equipment and – like our avoided infrastructure cost estimation – it assumes that buyout site maintenance costs are equivalent to other municipal properties. However, this calculation was unnecessary in cases, such as in Greenville, NC, where buyout properties were leased to nearby residents or commercial property owners, who were then tasked with the responsibility for site maintenance and associated costs, in exchange for being allowed to use the acquired land for low-impact uses such as gardening or parking.

Property tax revenue impacts

To estimate the total amount of property tax revenue lost due to a buyout, we multiplied city and/or county property tax rates by the total assessed value of the buyout properties (the value that is subject to property taxes) prior to the buyouts. However, there are two main caveats to this process.

First, there are many challenges with identifying the historic assessed value of a property from before the various flooding events prompting buyouts, which most commonly were Hurricanes

460 Fran and Floyd in 1996 and 1999, respectively. Most local governments do not keep digitized,
461 historic assessed value records and, if they do exist, they are typically only available for the past
462 10-15 years. While some records can be individually obtained by manual archival research,
463 these data are obtained only with enormous effort.
464
465 Given the variation and uncertainty with collecting historic assessed property values, we
466 elected to use sales values as a proxy measure for assessed value. Buyout participants receive
467 the pre-storm fair market value of their home, data that were available as part of the NCDEM
468 dataset on historical buyout properties. To determine if the buyout sale price could sufficiently
469 estimate property tax revenue, we compared current (2017) sale prices and assessed values for
470 1,029 homes in Greenville, NC (Pitt County, 2018). This analysis included parcels in Greenville,
471 North Carolina that sold January 1, 1996 - January 1, 2003, and which contained only one 1000-
472 2000 ft^2 building (avg. = ~1,500 ft^2 in buyout area). When dividing the current tax value by the
473 historical sale price, the found that assessed value averaged 7.2 percent higher than sales
474 values (*avg. ratio* = 1.072, *sd = 0.485*). However, when summed, there was just a 2.64% total
475 difference between sale price and assessed value.
476
477 We acknowledge that sale price and assessed value are often quite divergent (Clapp and
478 Giaccotto 1992), and that a current analysis is not necessarily indicative of past relationships
479 between assessed and sales values. However, when averaged across a large number of buyout
480 properties, the differences between sales and assessed values likely had a minimal impact on
481 our analysis. Moreover, few alternative methods exist to help create more precise estimates in

such a data-sparse environment. Therefore, all calculations for property tax revenue utilized the fair market value that was offered to the buyout participant at that time.

Second, calculating historic property tax revenue loss should take into account how local property tax rates change from year to year. We obtained historic property tax rates for each of the eight case study municipalities and counties described above between 2000 and 2017 from the North Carolina Department of Revenue (NCDOR, 2018). To calculate how a changing property tax rate affected revenue generation over time, we compared calculations of marginal annual revenue to that of an averaged tax rate.

As an example, we can take a hypothetical $40,000 property (assuming a static real value) for Greenville, North Carolina, and calculate the property tax revenue generated from 2000 to 2017, taking into account the specific, yearly property tax rate at both city and county levels. We can then compare this to an average of property tax rates over the same period and use it to estimate the property tax revenue generated over time. The results showed less than 1 percent difference between the two methods ($8,397 using the marginal method and $8,384 using the averaged method; Figure 5). Therefore, we used the simpler and relatively accurate averaged property tax rate method, which exploits the stable property tax rates in our study area communities over time.

Net present value adjustments

Given our dual goal of creating a tool for estimating the impacts of both past and future buyouts, we must establish methods for adjusting for inflation and social discount rates (i.e., the time value of money). To estimate the total net fiscal impact due to a *future* buyout, we can simply take the net present value of the stream of losses, shown in Equation 2:

$$n_i = \sum_{t=0}^{N} \frac{c_i + c_e - dvr_p - c_b}{(1+r_d)^t} \quad \text{(Equation 2; future buyouts)}$$

$$n_i = \left\{ c_i + c_e - c_b - \left(dvr_p \frac{C_c}{C_b} \right) \right\} t \quad \text{(Equation 3; past buyouts)}$$

n_i= Net fiscal impact (present $USD)

t_l = Annual property tax revenue lost (dvr_p)

d = Percentage of buyout residents departing the municipality

v = Buyout property value (present $USD)

r_p = Property tax rate (average; assumed static)

c_i = Avoided annual infrastructure costs (present $USD)

c_e = Avoided emergency response and recovery costs (present $USD)

c_b = Buyout site maintenance costs (present $USD)

r_d = Social discount rate

C_c = Consumer price index (housing) in current year

C_b = Consumer price index (housing) during buyout year

N = Number of years until end of period (e.g., calculate net impact over 10 or 20 years)

t = Time of cash flow (Equation 2) or number of years since buyout (Equation 3)

To estimate the total net fiscal impact due to a *past* buyout, we must adjust for inflation associated with the tax revenue impacts using the consumer price index for housing in the buyout year relative to the current year (BLS, 2018). This simulates the cumulative property taxes a homeowner would be paying if they still lived in a home on the now vacant property.

We are already collecting (or estimating) data on the rest of the fiscal impacts based on current values (in current$); therefore, we multiply the annual net impact (including the inflation-adjusted tax revenue impact) by the number of years since the buyout occurred. The resulting equation – shown as Equation 3 – allows us to flexibly estimate net impacts given varying values, frequency, and timing of buyouts.

Results

We organize our results based on the four types of financial impacts that we have characterized and incorporated into our model, each with summaries of relevant interview findings and data availability in our study communities. This is followed by a detailed scenario analysis for the Town of Lumberton, NC – the study area where we were able to collect the most detailed and complete information – where we explore eight different scenarios that we hypothesized would affect buyout financial impacts.

Disaster response and recovery costs avoided

Our interviews (*n=25*) confirmed that most, if not all, of the avoided costs due to buyouts are eligible for reimbursement by a 75/25% federal-state cost-share through the FEMA Public Assistance program. Key informants from two of communities noted that of the costs avoided--the removal of debris associated with damaged or destroyed buildings and its contents or fallen tree limbs--often make up the largest percentage of known expenses that would be avoided due to buyouts. Many municipalities may have incurred slightly lower costs for swift water rescues, shelter operations, and overtime for police or fire departments due to past buyouts and fewer people being affected.

One interviewee stated that one of the largest benefits of the buyout is "...not having to worry about the buyout properties during a flood event from a police and rescue standpoint." However, after a Presidentially Declared Disaster guarantees 100% reimbursement of these eligible costs, informants made it clear that the reduced number of people affected due to past buyouts is fiscally insignificant to a municipality.

While federal and state governments will often end up incurring the costs and would therefore stand to benefit from additional buyouts, our interviews also revealed that much of the response and recovery work completed in the municipality is done by volunteers, faith-based groups or officials from neighboring towns or counties. Identifying how many hours of in-kind services and the costs those groups might avoid due to past buyouts remains extremely difficult to calculate after-the-fact and is beyond the scope of this project.

Another cost that was neither well documented nor easy to estimate concerned the amount of avoided staff time or administrative costs due to buyout-related reductions in applications for disaster recovery programs run through municipalities. Key informants from all eight communities reported that multiple staff members – often planners, engineers, county managers and clerks, along with hired consultant groups – spent 6 months to 1.5 years working nearly full time on flood recovery after Hurricane Matthew, but were unable to estimate what proportion of that time may have been spent on the buyout program alone. One community described that they had to pay out of pocket for a consulting group to prepare necessary paperwork and documentation while waiting for a grant agreement for federal programs to be established. However, they have also been employing the consultants for recovery or general community planning work (as the town does not have its own planning staff) for almost 2 years prior to Matthew's impacts.

Along with buyout-related reductions to workload and staff time devoted to administering the buyout program, past buyouts also translate to a reduced emotional toll on staff who, in many cases, described the painfully long process of updating anxious residents about the buyout program's status over the course of a year or more. One community also described the potential for buyout-related cost savings having experienced two events that inflicted significant localized flooding, but did not warrant a Presidential Disaster Declaration. These events led to the municipality incurring 25% of the costs normally covered by the state and federal government.

Avoided infrastructure costs

Since seven of the eight study communities had incomplete buyouts, which resulted in spatially inefficient patterns, it is rare that road, water, or sewer infrastructure was permanently removed. In Kinston, a large-scale, highly spatially efficient buyout rendered ~5% of the municipally owned roads no longer publicly accessible (and eliminated maintenance), with barricades placed alongside signs stating, “No dumping.” The “larger buyout” scenario (described below), which assumes that 2% of a municipality’s infrastructure is removed, can provide some significant savings in the long term. All other scenarios used in our model assume 0% of the municipality’s infrastructure is removed due to a buyout, providing no fiscal benefits. Key informants in Greenville echoed other communities’ sentiments, describing why a higher percentage of infrastructure removal is uncommon:

> “...there weren’t any areas that we could magically cordon off, and go I’ll tap the sewer on the end of that and we’re just going to walk away. No. We still had that checkerboard pattern, a little bit here, a little bit there.”

More detailed conversations with a local water and sewer utility staff member suggested that quantifying these savings or costs is extremely case specific, and that infrastructure removal could lead to a number of unintended consequences that incur costs. Several interviewees mentioned possible negative outcomes, such as having to relocate sewers to maintain operations that could compromise grade-related operations and lead to more frequent cleaning, or having to account for lateral blockage issues, mainline blockages, or storm sewer overflows in the area during removal. In addition, one interviewee argued that abandoning the

612 water infrastructure and “creating a dead end system could also lead to water quality issues
613 and diminished fire protection.”
614
615 **Buyout site maintenance costs**
616 Both the total area of buyout land maintained by municipalities, and the annual cost per acre to
617 maintain it, varied substantially across our communities (with several lacking detailed
618 information that would allow for accurate estimation). Many municipalities were responsible
619 for maintaining 100% of the buyout properties, while others leased a fraction of the vacant lots
620 to neighboring residents, who use the space for agreed-upon, low-impact uses such as parking
621 or gardening.
622
623 To reduce site maintenance costs and offer potential benefits to remaining residents, one
624 community was able to lease as much as one third (~90 total lots) of the buyout properties to
625 adjacent residents or organizations for a nominal fee. In multiple cases, a single individual now
626 helps maintain several properties along a street. One community leased a portion of a buyout
627 property to a nearby church that now uses the space for overflow parking, which the town
628 considered the highest and best use.
629
630 A majority of municipally-owned lots are vacant patches of grass that are mowed several times
631 year by public works or parks and recreation departments, incurring costs for staff, equipment,
632 and fuel that total anywhere from $192/acre to $1,398/acre annually, depending on frequency
633 of mowing and available equipment. These per-acre costs were inferred using data from

municipal public works or parks and recreation interviewees regarding the acreage maintained, frequency of maintenance, and costs. In one of the smallest of our case study communities – the Town of Seven Springs – buyout maintenance became a significant stressor for the part-time town clerk, who was additionally tasked with mowing several acres of buyout property multiple times a month during each summer using old and/or inefficient equipment.

Along with maintaining vacant lots, several municipalities have also used buyout properties to create new parks or green space/greenways that may also connect with or supplement existing park space. These included a 9-hole disc golf course in Windsor, a disc golf course and dog park in Rocky Mount, and community gardens in Charlotte (Figure 6).

While difficult to estimate the exact financial benefits, interviewees in Windsor noted that the amenity value of the disc golf course has served as an economic driver, attracting large groups or teams that participate in tournaments, leading to a small economic boost for local restaurants and shops. Town officials also acknowledged that having the amenity in close proximity to remaining residents likely has a negligible effect on their property values, given their location in a flood-prone area. With additional buyouts in the same neighborhood approved for Hurricane Matthew, the disc-golf course may be expanded, adding more recreational tourism to the municipality. Similarly, key informants in Lumberton used the proximity to 1) existing schools and 2) parks where green space could be expanded, as criteria for prioritizing and targeting certain areas for their Hurricane Matthew buyout program.

When estimating the annual fiscal impact of buyout property site maintenance using our model, the associated annual costs range from $774.50 to > $8,600 depending on a number of factors, such as the percentage of land leased to a third party, the relative cost per acre, and the total area of buyout property.

Property tax impacts

Among our interviewees, the potential loss of municipal property tax revenue was certainly the greatest worry from a fiscal impact standpoint when a community is considering or implementing a buyout program. Interviewees noted that some buyout participants relocate outside of the municipality due to a lack of available affordable housing, delays in receiving or inadequate amount of financial aid, or ties to family or friends elsewhere. However, based on the responses from our key informants, the percentage of participants that relocate within a municipality was almost universally unknown or undocumented.

In some cases, however, this percentage was associated with policies that stipulate where participants can locate in order to be eligible for additional financial incentives offered through the N.C. State Acquisition and Relocation Fund (SARF). For communities who had an established policy like this, they estimated as much as 90-95% of participants stayed within the municipality, at least for the first few years following the buyout.

Table 2 shows estimates for the hypothetical revenue lost based on what percent of participants remain inside the municipality. For example, if 50% of participants in Charlotte

were retained, the city would have failed to collect just under $1 million in total tax revenue in the years since the buyouts occurred (Charlotte's 2017 municipal budget was $2.28 Billion in comparison). For Kinston, where the actual estimated percentage of residents remaining is nearly 100%, the estimated revenue loss is minimal ($84,000) when compared to the case where 0% remain in the municipality ($2.79 million). Seven Springs estimated that nearly all participants from past buyouts relocated out of the town, which resulted in an estimated $47,000 loss in total tax revenue since the buyouts. Compared to Charlotte, this is a major impact and is roughly equal to the Town's general fund revenue ($48,000) or about 10% of the town's total revenue (~$473,000) for one year (NCDST, 2018).

Scenario analysis for the City of Lumberton

To demonstrate the relative importance of different controllable and uncontrollable variables on the net fiscal impact of a buyout project, we conducted a sensitivity analysis resulting in eight scenarios, including a base or "business-as-usual" case. The seven scenarios show how changes in buyout implementation can affect net fiscal impacts. The alternate values used for each of the scenarios represented either what is considered a more positive outcome or simply the most likely alternative based on what was observed in other communities, including one scenario that represents the 'best case' or combination of more favorable variables. Figure 7 shows how each factor influences the net fiscal impact as it relates to the business as usual case. Figure 7A displays Scenarios 1-5, 7 (represented by a cluster of bars), where each bar represents individual estimates for three of the four cost categories (avoided infrastructure maintenance costs are negligible in these scenarios). Figure 7B displays Scenarios 6 and 8 (also

700 contrasted with the base case Scenario 1), which have higher costs and benefits (and have non-
701 negligible avoided infrastructure maintenance costs, but with negligible avoided emergency
702 recovery costs). Each scenario's net fiscal impact is compared to the *business-as-usual* case.
703
704 We chose the City of Lumberton for scenario analysis because it had the most complete data
705 set available. Anecdotally, Lumberton also appeared to representative among our case studies
706 as it did not have a complete buyout, officials did not remove any infrastructure during the
707 buyout, and the buyout properties remain as vacant lots, which was typical among our case
708 studies. Lumberton is also near the median of the population (~21,500), household income
709 (~$32,000), and buyout count (29 total) ranges of our study communities (Table 1).
710
711
712 *1. Business-as-usual.* The 'business as usual' scenario (pattern shown in Figure 3D) estimates
713 the net fiscal impact from 1996 to 2017 due to the City of Lumberton's 21-property buyout,
714 which occurred following Hurricane Fran (1996). In this instance, the average buyout property
715 price was $16,180; distributed across 2001, 2004, and 2005 buyout years, but we model the
716 buyout as occurring in a single year, 2004) and the per-acre cost to maintain the buyout
717 properties is $1,400 (100 percent of original buyout properties are now maintained by the city).
718 We estimate that 100 percent of disaster response and recovery costs have been reimbursed to
719 the city, and that 10 percent of buyout participants have relocated within the municipality. In
720 the business-as-usual case, we assume that no neighborhood infrastructure was removed as a
721 result of the buyout.

Given these assumptions, for our business-as-usual scenario, we estimate a total fiscal loss to the City of Lumberton of $158,850 over the course of 14 years (2004-2018), or $11,347 per year (Lumberton's 2017 municipal revenue: $72,538,103). This net negative impact is not surprising when considering the difficulty in retaining residents and their tax contributions, the accruing cost to maintain now-vacant property, and the negligible avoided losses that are not fully reimbursed following a Presidentially Declared Disasters.

2. Relocation policy. In this scenario, we simulate Lumberton offering additional financial incentives to buyout participants, but with a stipulation that they relocate within the municipal boundaries as a way to minimize property tax revenue loss: a policy implemented in a number of the communities studied including Kinston and Rocky Mount. If Lumberton did this effectively and retained 95% of buyout participants, the net negative fiscal impact over time would be reduced by nearly 22 percent, to ~$123,520.

3. Buyout property leasing and partnerships. If we assume that, instead of 100% of the buyout properties needing to be maintained by the City, 50% of the land was leased to nearby residents or other organizations, who then take over responsibility for maintenance (at little to no municipal cost). Reducing annual site maintenance costs by half reduces the overall fiscal impact by about 38% (~$98,129).

4. No Presidentially Declared Disasters. When there is a more localized flood event that impacts a municipality, but is not associated with a Presidentially Declared Disaster, the local government is often only reimbursed for 75% of the response and recovery costs. The other 25% could be (partially) avoided through a buyout program.

However, in the case of Lumberton, where the buyout project covered only about 5% of the total area impacted by Hurricane Matthew, we calculate that this reduces the net negative fiscal impact to ~$63,232. Overall, these newly avoided costs are fairly significant, saving approx. 60%, when compared to the business-as-usual case (where 100% of those costs are reimbursed). Moreover, if the buyout neighborhood consisted of a larger percentage of the total impacted area, or if no state disaster declarations were made (leading to less or no reimbursement; because costs will not be reimbursed unless a state or presidential disaster is declared), the benefits could have been much greater.

5. Reduced site maintenance costs. Because there was some variation in the amount that communities spend per acre on property maintenance, one option would be to use a less expensive annual rate of $250 per acre, a figure based on the average of rates found in Greenville and Charlotte. This reduced rate produced a net fiscal impact that saved the municipality 63% (~$99,755), relative to the business- as-usual case, yielding a total net negative impact of ~$59,094.

764 *6. Increased buyout extent and efficiency*. The Hurricane Fran buyout in Lumberton purchased
765 21 properties. While not insignificant, this is a relatively small buyout project when compared
766 to some of the more ambitious programs found in North Carolina following Hurricane Floyd
767 (1999) where some municipalities such as Kinston or Greenville purchased hundreds of
768 properties. If we estimate using the same average home value, lot size, participant departure
769 rate, and site maintenance costs as the business-as-usual case, but increase infrastructure
770 removal from 0% to 2%, and the number of homes bought out from 21 to 200, the net negative
771 fiscal impact becomes positive (nearly $1.55 million) because of substantial avoided costs due
772 to the removal of infrastructure (nearly $2.9 million over 14 years), despite the loss of over
773 $350,000 in property tax revenues and the inherited, buyout site maintenance costs of $70,000
774 per year ($980,000 total). This demonstrates how influential the size and efficiency of a buyout
775 project can be on avoided infrastructure costs, maintenance costs, and property tax revenue
776 loss, ultimately leading to a positive fiscal impact.
777
778 7. *Higher average home value*. Knowing that the average value of the properties bought out in
779 Lumberton was low ($16,180 [1999 USD]; $24,817.15 [2018 USD]), this scenario reflects the
780 same small-sized buyout, but placed in a more moderately priced neighborhood where the fair
781 market value might have averaged $50,000 per property. This effect increases the net negative
782 fiscal impact by nearly 50%, up to ~$237,000. In some NC communities, buyout properties have
783 been purchased for over $200,000, which can multiply the effect of lost property tax revenue
784 loss, assuming the household relocates outside the municipality.
785

8. Best case scenario. Finally, a more idealized scenario for a small-scale buyout that combines the preferred implementation options of the other scenarios, including higher within-municipality relocation rate (95%) and percentage of property leased (50%), low site maintenance costs ($250/acre), and some infrastructure removal [0.2%]) results in a positive net fiscal impact of ~$275,000. While difficult (or perhaps nearly impossible) to achieve, this scenario highlights the extent to which negative fiscal consequences can be significantly mitigated and even reversed.

Discussion

By testing the range of scenarios using our model, we were able to explore the relative impact of different factors--related to characteristics of the community and design of buyout program--on the net fiscal impact to the municipality over time. With a more efficient and contiguous buyout pattern, a municipality may be able to realize the greatest savings through avoided maintenance costs, if infrastructure is permanently removed or abandoned. However, achieving the types of savings modeled is much more difficult in practice because of the buyout program's voluntary nature and unknown costs that may be associated with removing a significant amount of infrastructure. Further research is needed to clarify the wider range of circumstances and cases in which major portions of infrastructure were abandoned or removed as a result of a buyout and the potential benefits and costs of taking such action.

When state or local government offer to provide participants with additional, non-FEMA financial assistance during a buyout (e.g., NC's post-Hurricane Floyd SARF program), they can

808 also stipulate that participants must relocate within the municipal boundary or extraterritorial
809 jurisdiction. If the municipality possesses a sufficient stock of housing (as we learned was the
810 case for Rocky Mount, Kinston, and Greenville), then this strategy may help retain residents and
811 the associated property tax base. Our analysis reveals that – at least in areas where property
812 taxes are a significant form of municipal revenue – this type of "relocation policy" may be one
813 of the strongest influences on the net fiscal impact of buyouts on a municipality, reducing the
814 total negative impact by nearly 22%.
815
816 However, many complicating factors can limit the feasibility of this policy option, including lack
817 of transparency in how local governments select homes for acquisition (Siders, 2019) and multi-
818 year delays in buyout implementation that discourage homeowners from participating or
819 creates financial hardship for those that do (e.g., post-Hurricane Katrina buyouts in Louisiana,
820 see Green and Olshansky, 2012). In some areas, there may be a lack of safe, affordable housing
821 within municipality. In Rocky Mount, North Carolina, the city council denied a buyout
822 participant the supplemental relocation funds since the homeowner bought a home outside
823 city limits. Moreover, policies devoted to incentivizing participants to relocate within the same
824 municipality may not ensure that homeowners are able to relocate to a comparable home in a
825 less hazardous area (see Binder and Greer, 2016, McGhee, 2017).
826
827 In terms of reducing buyout site maintenance costs, we simulated the actions of several
828 communities - including Windsor, Rocky Mount, Greenville, and Seven Springs -- in finding
829 willing residents and commercial property owners to take responsibility for maintaining buyout

properties. Leasing out buyout properties to a third party can significantly reduce costs to the municipality (38% reduction in Scenario 3). For the large percentage of communities that experience an inefficient pattern (e.g., “checkerboarding”), successfully implementing this action or other efforts to reduce maintenance costs (Scenario 5) can make a real financial difference. Furthermore, this opens the possibility for involving interested organizations (i.e., watershed advocacy groups, community land trusts, or other park systems) to improve ecosystem or recreational services of buyout areas that are contiguous.

In the event of a hyper-local flood (affecting a single municipality only), a municipality can incur non-reimbursable costs related to disaster response and recovery. Officials in Windsor acknowledged that they likely avoided some of these costs since past buyouts have reduced the number of homes in flood zones that would have been affected by two hyper-local floods. Likewise, key informants in Raleigh acknowledged that many of their buyouts in recent past were completed not because of a major storm, but because more localized events have repeatedly flooded some properties, making them eligible for buyout through the National Flood Insurance Program Repetitive Flood Claims Grant (FEMA, 2018c).

Different communities have varying resources and capabilities to effectively manage an increased amount of vacant land created as a result of a flood buyout program. One scenario (5. *Reduced site maintenance costs*) estimates how reduced per-acre costs to maintain buyout properties affect buyout fiscal impacts. Some community officials recognized that checkerboard pattern of buyout properties could add to maintenance costs due to having to move between

each of the randomly scattered lots, as opposed to mowing several contiguous parcels of land all at once. Since there was not a clear relationship gathered during our interviews between a community's characteristics and the annual per-acre property maintenance, municipalities should consider other ways of reducing maintenance costs, including using more fuel-efficient equipment or allowing land to return to its original function as a natural floodplain.

Using a combination of each of these factors, the idealized (and minimally possible) *Best Case* scenario (8) demonstrated that a combination of policies could minimize costs and maximize savings, creating a significantly more favorable fiscal impact. However, based on collected data and interviews with key informants, no single community was able to achieve this idealized situation. Moreover, given the great lengths that a community would need to go to in order to create such a scenario, this finding suggests that communities should fully acknowledge the realistic fiscal implications of buyouts prior to proceedings with them.

Two of the final scenarios (6*. Increased buyout extent* and 7. *Higher average home value*) were modeled to show the multiplier effect that a significantly larger (or more expensive) buyout could have on property tax revenue lost, site maintenance costs, and avoided infrastructure maintenance costs. These scenarios mimic the buyout experiences of other communities, such as Kinston and Seven Springs (relatively large buyouts) and Raleigh and Charlotte (more valuable homes). With a greater number of more expensive homes bought out, a municipality's ability to influence these factors becomes increasingly important to achieve a favorable fiscal

result. That being said, we do not suggest that buyout size or home value should drive buyout decisions, but rather that they play a role in overall fiscal impacts.

A summary of the factors explored in the scenarios, and how they relate to the range of experiences seen in our study communities, is shown in Table 3. Using available quantitative and qualitative data from interviews, we were able to observe how each municipality's unique situation produced a set of outcomes that influenced buyout effectiveness and fiscal impact. During our interviews, we asked informants whether they thought buyouts were generally favorable for their municipality; the consolidated response is summarized in the last column of Table 3 and illustrates that most view buyouts as positive programs overall, primarily because they permanently reduce flood risks and create opportunities for new or enhanced amenities (e.g., parks, greenways, etc.). The relatively special case of Seven Springs, whose extremely small size (population 134 before Matthew; estimated at 50-55 as of spring 2018) and relatively large buyout (n= 10 homes) has magnified the negative effects of property tax loss and site maintenance. Since Matthew struck in 2016, the Town has considered becoming unincorporated due to population loss as a result of Hurricanes Floyd and Matthew.

In searching for what made buyouts successful from a fiscal standpoint, interviews with nearly every informant revealed several reasons why the program was challenging for a municipality to implement successfully and for residents to participate in. Perhaps the biggest question or influencing factor is related to the number and location of residents who voluntarily apply for and choose to participate in the buyout. Reasons we heard that residents chose not to

participate include: a strong sentimental attachment to or family history associated with the home and/or neighborhood; the inability to afford a new home of same quality nearby and outside the floodplain, especially if on a fixed income; the unwillingness to abandon a home that has been paid off; and the inability to wait multiple years for their home to be acquired as part of a buyout. For Hurricane Matthew, interviewees in Greenville and Rocky Mount noted that there were plenty of interested participants, but when compared to past storms, there was not enough money appropriated by Congress to acquire all the homes. An official in Greenville stated,

> "This one [Matthew] was more frustrating… and Congress only gave us 1% of what the whole state asked for. In Floyd, we got plenty of money…. We weren't turning people away because we didn't have the money. There's people being turned away now because we don't have the money."

Convincing residents to participate is the first step and finding ways to encourage or incentivize them to relocate within town is yet another challenge. Interviewees in Seven Springs and Windsor noted that buyout participants had no choice but to relocate outside of the municipality to find affordable housing. After Hurricane Floyd, Rocky Mount managed to take advantage of state infrastructure grants that helped fund the development of new affordable housing within the city. The new units were meant to house buyout participants, but by the time the units were constructed and available almost 2-3 years later, most participants had settled into permanent housing elsewhere.

Buyout efficiency

In light of our analysis, it is important to think about buyout "efficiency" in more rigorous way, and in terms of both 1) the opportunities for post-buyout land uses and 2) relative infrastructure cost savings. In the former case, we can consider efficiency as the clustering of buyout properties that facilitate environmental improvements (e.g., bottomland forest restoration, streambank restoration) or passive public uses like parks. For example, in the case of a random (checkerboard) buyout pattern (Figure 1A), it is difficult to build a greenway or park if even a few homes remain in in-opportune locations.

In the infrastructure cost savings case, we can define a global measure of a buyout's spatial efficiency (E_s; Equation 4) as the ratio of houses *remaining* in a buyout area (h_f) to the infrastructure operations and maintenance costs (C_f) that will be required to support those remaining houses; essentially, this is the number houses per dollar of required ongoing infrastructure maintenance costs (the inverse, dollars per house, would give the relative "inefficiency").

$$E_s = \frac{h_f}{C_f} \qquad \text{(Equation 4)}$$

This calculation is related to the efficiency of the buyout itself (E_b; Equation 5) which we define as the ratio of infrastructure maintenance cost savings from the buyout (initial costs [C_i] - final costs [C_f]) and the houses purchased (initial houses [h_i] - final houses [h_f]):

$$E_b = \frac{C_i - C_f}{h_i - h_f} \qquad \text{(Equation 5)}$$

These efficiencies differ in that a high buyout efficiency E_b may include significant cost savings, but may still leave an enormous final cost (C_f) for remaining residents (h_f]). While a buyout may remove a number of houses at a major cost savings, we can imagine the result being a street with nearly all the homes removed, except for one or two houses at the end (a high buyout efficiency E_b and a low spatial efficiency E_s). Infrastructure and utility service provision to the few remaining homes after this type of buyout could become difficult to justify (an issue has been described in work on "shrinking cities" across the US; Ryan, 2012; Hollander et al., 2009). This would yield a high buyout efficiency E_b and a low spatial efficiency E_s. Examples of high and low buyout spatial efficiencies E_s are shown in Figures 1D and 1E, respectively.

Using these metrics, we can also consider a situation, shown in Figure 1E, in which a "more than full" buyout takes place, whereby a city opportunistically purchases houses beyond the flooded area in order to create a contiguous zone at a scale that is relevant for ecological restoration or for certain recreational activities, such as a community-scale park that is large enough to include ball fields. By coupling spatial and buyout efficiency considerations, future research could consider the spillover land value impacts of alternative post-buyout land uses.

Conclusions

In this paper, we sought to answer a simple question: what is the fiscal impact of buyouts on municipalities? Stated another way: are municipalities better or worse off financially for participating in a buyout program? The answer is dependent on at least three key factors: 1)

960 the spatial layout of the acquired properties, 2) whether buyout participants relocate within the
961 community, and 3) how the acquired properties are managed or maintained.
962
963 *Spatial layout* – As we have discussed in this paper, floodplain buyouts can result in a number
964 of different spatial patterns for the homes that remain, however, the most common pattern is
965 random (i.e., checkerboarding). The spatial distribution of the acquired properties largely
966 determines how the properties can be used afterwards, e.g., as a park or as scattered, vacant
967 lots. If the acquired properties are sufficiently clustered or contiguous, the municipality could
968 create an amenity, such as a park or greenway, which could add value to surrounding
969 properties, thus boosting the tax base. If, however, the pattern is random, a community's
970 options for using the acquired properties are limited. A contiguous pattern also increases the
971 possibility for permanently removing or abandoning infrastructure (e.g., roads, water, and
972 sewer) which would lead to avoided annual maintenance costs.
973
974 *Relocation* – One of the main fiscal impacts of a buyout is the loss of tax revenues from homes
975 that are acquired and demolished. Those tax revenues will be permanently lost if buyout
976 participants move outside the municipality. The only way the community would retain at least
977 some of the lost tax revenues is if the buyout house itself was relocated within the municipality,
978 or the homeowner purchased a vacant lot in the same community and built a house on it.
979
980 There has been little literature on where buyout participants relocate after they sell their home.
981 Recognizing the potential loss of population, community connectedness, and taxable income,

some communities have offered financial incentives to encourage buyout participants to relocate within the same municipality.

Management - As shown by Zavar and Hagelman (2016), most buyouts end up as vacant, mowed lots, not parks or greenways. Either way, the local municipality ends up paying to maintain the land to support recreation or minimize unsightly vegetation growth. The costs for maintenance can be substantial, particularly for smaller communities. As mentioned previously, some communities (e.g., Greenville, Rocky Mount, Seven Springs, and Windsor) simply lease the vacant lots to adjacent property owners, in some cases for $1 per year, thus transferring the cost of maintenance directly to members of the community.

One of the factors that skews the analysis of the fiscal impact of buyouts on municipalities is that many of the avoided costs never enter into the cost calculations, since typically they are covered by the federal, rather than local, government. For example, one of the benefits of buyouts is that they can reduce the damages or costs of future floods. If, however, the costs of search and rescue, sheltering, or for debris removal are reimbursed by FEMA, then those avoided costs accrue to the federal government, not the municipality.

Still, buyouts provide value beyond just the avoided losses. Buyouts can provide much-needed open space. For example, city staff in Greenville acknowledged that they essentially got a park for free: “[we] did gain some park areas that the city didn’t physically have to go out and purchase…” and “...so they (federal government) essentially paid for the dirt.” The Town of

Windsor has also found that after administering multiple rounds of buyout programs over the past 18 years, it has essentially purchased all the homes in flood-prone areas, aside from a single residence or two in certain locations that were not eligible or did not participate in previous buyout programs. This means that future floods are likely to cause much less damage.

Our research has suggested that the fiscal impact of buyouts on local governments depends in large part on the design and implementation of the buyout itself. For example, spatial layout of acquired properties affects how the lands are used, and this in turn affects local costs to manage or maintain the lands acquired. Other research has focused on how buyouts can reduce avoided losses, in particular, losses to the federal government (including losses to local governments that subsequently are reimbursed by FEMA).

While some researchers (e.g., Siders. 2019) have argued that buyouts can adversely affect local tax revenues, until now, there has been no empirical analysis of the overall fiscal impact of buyouts on municipalities. Understanding the fiscal impacts can help local governments design and implement buyouts that create better financial outcomes while strengthening their resilience to future disasters. As it is now, most local governments are operating in an information vacuum, with little understanding of the full fiscal costs and benefits of buyouts. Future research should further examine and test the long-term fiscal impact of buyouts on homeowners, neighborhoods, and municipalities (Greer and Binder, 2017).

Limitations and future research

A major factor that skews our analysis concerns the quality and detail of data that are available. If we were using data collected in the late-2010s, we would likely be able to look at much more detailed budgetary and infrastructure data. In a more data-rich situation, we could additionally explore how the scale of our study cities affect our results (e.g., the role of extra territorial jurisdiction, extent of additional services provided, etc.).

Unfortunately, our estimates do not account for the potential long-term added value of post-buyout land uses, whether they are community gardens, parks, or restored wetlands that provide flood retention benefits. This type of analysis is ripe for further research. Cities could benefit greatly from guidance on post-buyout "land value capture," which involves assessments of how different land uses create spillover effects on the value of neighboring parcels (e.g., improved subway service can partly be funded from the increased tax revenue that new subway stops create when they boost neighborhood land values (Medda, 2012). As part of this, additional research should focus on better understanding the relationship between the spatial pattern of buyouts and the resulting efficiency of future uses and reduction in infrastructure costs. Research should also focus on how buyouts affect downstream flooding patterns to reduce the needs for additional buyouts in the same community.

The various scenarios used to assess the estimated fiscal impact of a buyout program in Lumberton could and have occurred in some combination or form in other communities that implemented a buyout. Using our spreadsheet model (see Supplementary Material 2), researchers and municipal governments can generate estimates of a range of possible

outcomes to help plan and make decisions about the most effective strategies or policies in implementing a buyout program. In addition to providing a resource for local governments, this type of assessment can help state policymakers make better decisions about how to allocate federal grants for mitigation. Currently, many of the calculations involve some assumptions and degree of uncertainty. However, with better data and recordkeeping, researchers and municipalities can create more accurate estimates of the fiscal impacts of buyouts. Thus, the spreadsheet model serves as a potentially powerful tool to help local governments evaluate the likely impacts of a buyout.

Acknowledgements

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Data availability statement

All data used during this study were provided by a third party. Direct requests for these materials may be made to the provider, as indicated in the Acknowledgements. The models used in this study are available in Supplementary Material 2.

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Table 1. Eight NC case study communities for fiscal impact analysis. Buyout count includes total past HMGP-funded buyouts with reliable data that allowed mapping. Race and median household income characteristics are from the US Census's 2013-2017 American Community Survey 5-year Estimates. Population is from the 2010 Decennial U.S. Census.

Municipality	County	Population	% White	Median household income	Number of buyouts
Charlotte	Mecklenburg	731,424	50.0	$58,202	166
Raleigh	Wake	403,892	59.0	$61,505	37
Greenville	Pitt	84,554	54.0	$36,496	189
Rocky Mount	Edgecombe, Nash	57,477	30.5	$37,607	322
Lumberton	Robeson	21,542	39.2	$32,054	29
Kinston	Lenoir	21,677	31.1	$29,920	685
Windsor	Bertie	3,328	38.0	$29,440	32
Seven Springs	Wayne	134	92.4	$26,419	10

Table 2. Estimated annual property tax revenue lost due to buyouts in NC communities. ND = no data available. Buyout years are estimates based on available NCDEM data.

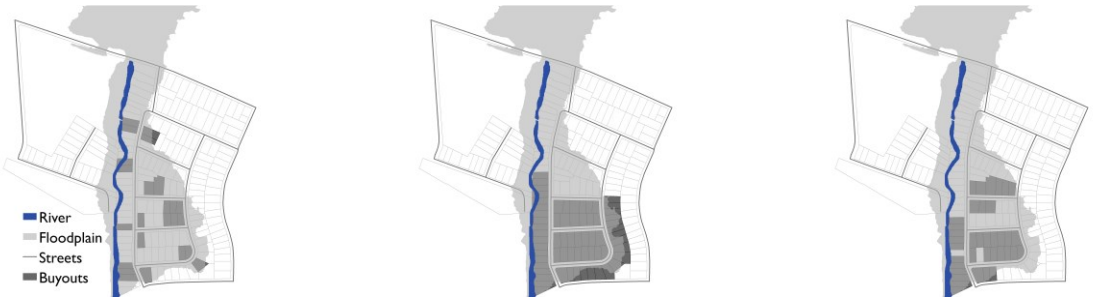
		Hypothetical annual revenue loss (% participants leaving municipality)						
Case study	Buyout years	100%	75%	50%	25%	Estimated actual revenue loss	% residents actually remaining	2017 municipal revenue
Charlotte	2001, 2002, 2008	$1,920,000	$1,440,000	$960,000	$480,000	ND	ND	2,283,848,000
Greenville	2001, 2002	$1,051,729	$788,797	$525,864	$262,932	$788,797	25%	$357,642,139
Kinston	1997-2003	$2,796,432	$2,097,324	$1,398,216	$699,108	$83,893	97%	$93,221,536
Lumberton	2001, 2004, 2005	$54,080	$40,560	$27,040	$13,520	$43,264	20%	$72,538,103
Raleigh	1999, 2011	$599,150	$449,362	$299,575	$149,787	ND	ND	$941,691,637
Rocky Mount	2000, 2001, 2003, 2003	$3,137,786	$2,353,340	$1,568,893	$784,447	$313,779	90%	$239,044,797
Seven Springs	2001-2003	$47,033	$35,275	$23,516	$11,758	$47,033	0%	$473,236
Windsor	2001-2002, 2011	$35,276	$26,457	$17,638	$8,819	ND	ND	$8,876,031

Table 3. Summary of factors influencing buyout effectiveness

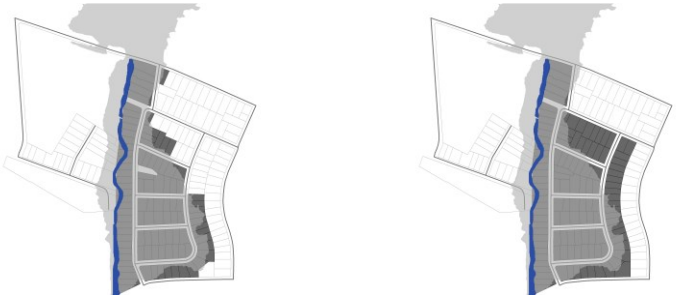
	Buyout efficiency (Efficient/ inefficient)	Buyout size	Current buyout land uses	% properties leased to 3rd party	% participants relocated within municipality	% costs reimbursed	Municipal perspective on program outcome (Positive/ negative)
Charlotte	Efficient	Small	Amenity (Park)	ND	ND	ND	Positive
Raleigh	Efficient	Small	Amenity (Park), Vacant	ND	ND	ND	Positive
Greenville	Both	Medium	Amenity (Dog Park, Greenway), Vacant lots	30	25	~ 100	Positive
Rocky Mount	Both	Medium	Amenity (Park), Parking, Vacant, lots, Reforested Area	< 10	90	~ 100	TBD
Lumberton	Both	Medium	Amenity (Park) Vacant	0	20	~ 100	TBD
Kinston	Efficient	Large	Returned to Nature, Vacant	ND	97	ND	Positive
Windsor	Both	Medium	Amenity (Frisbee Golf), Vacant lots	<5	ND	> 80	Positive
Seven Springs	Inefficient	Large	Amenity (Park), Vacant lots	< 10	0	~ 100	Negative

Figure 1. Categories of buyout patterns, including (A) scattered or random patterns, clustered patterns that would facilitate (B) extensive or (C) minimal infrastructure maintenance cost savings, (D) complete buyouts, and (E) "more than complete" buyouts (beyond the affected floodplain itself).

(a) (b) (c)



(d) (e)



1322 **Figure 2**: Map of North Carolina case study communities

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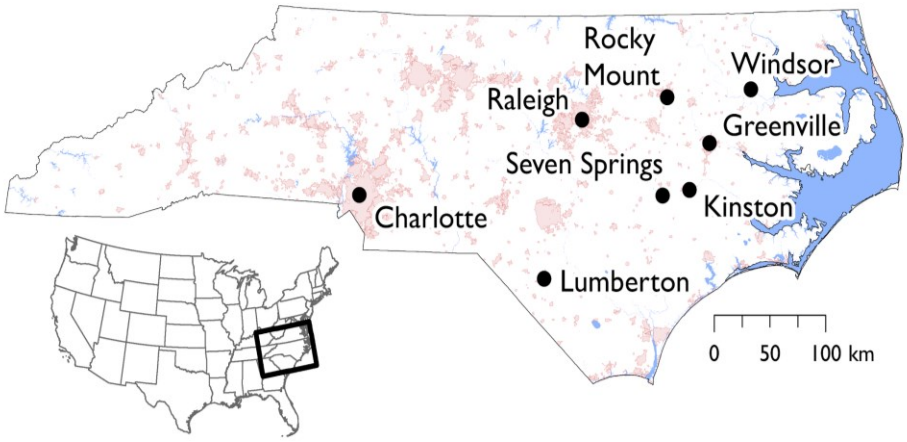

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Figure 3: Spatial patterns of buyouts in eight North Carolina communities, including A) Charlotte, B) Greenville, C) Kinston, D) Lumberton, E) Rocky Mount, F) Seven Springs, G) Windsor and H) Raleigh. Post-buyout land uses that are non-vacant land are labeled, where identifiable.

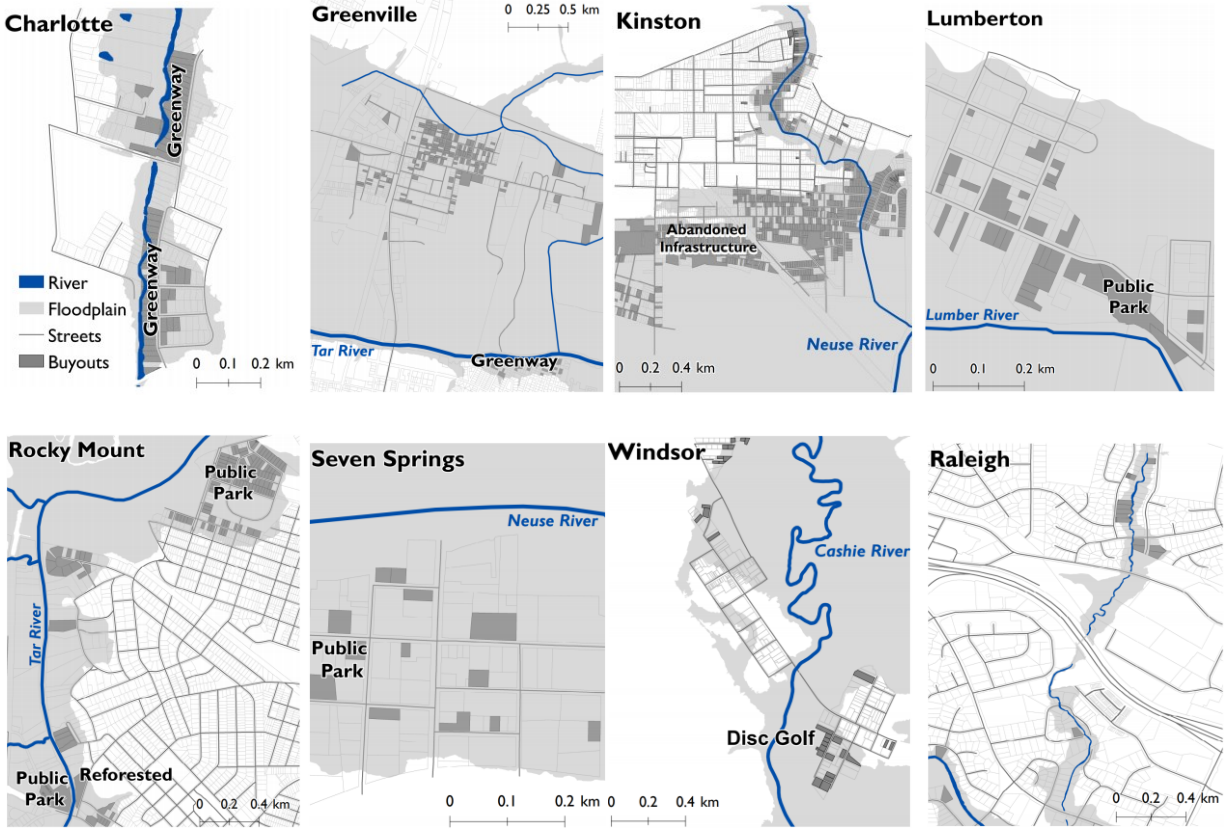

Figure 4. Buyout fiscal impact assessment framework. Flood events and buyouts are indicated, and annualized costs (bottom) and benefits (top) are weighted against each other.

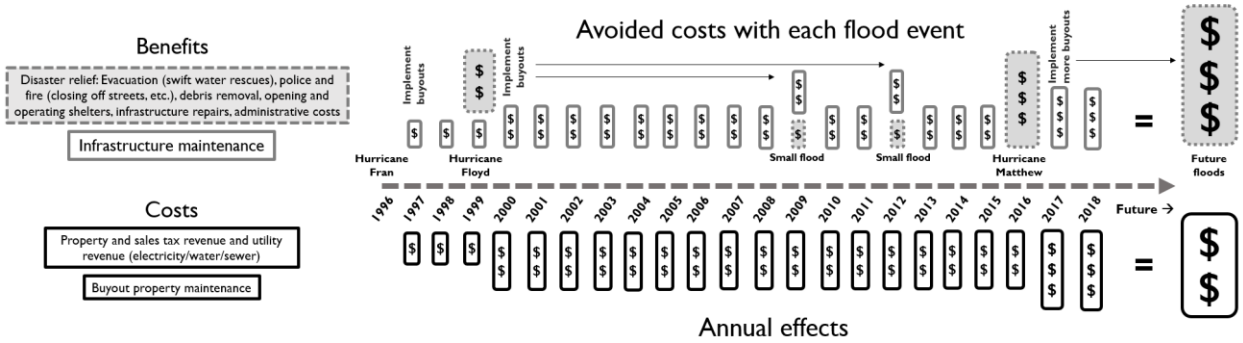

Figure 5. Marginal and averaged (2001-2017) approaches to estimating longitudinal property tax revenue from a hypothetical $40,000 property in City of Greenville, North Carolina.

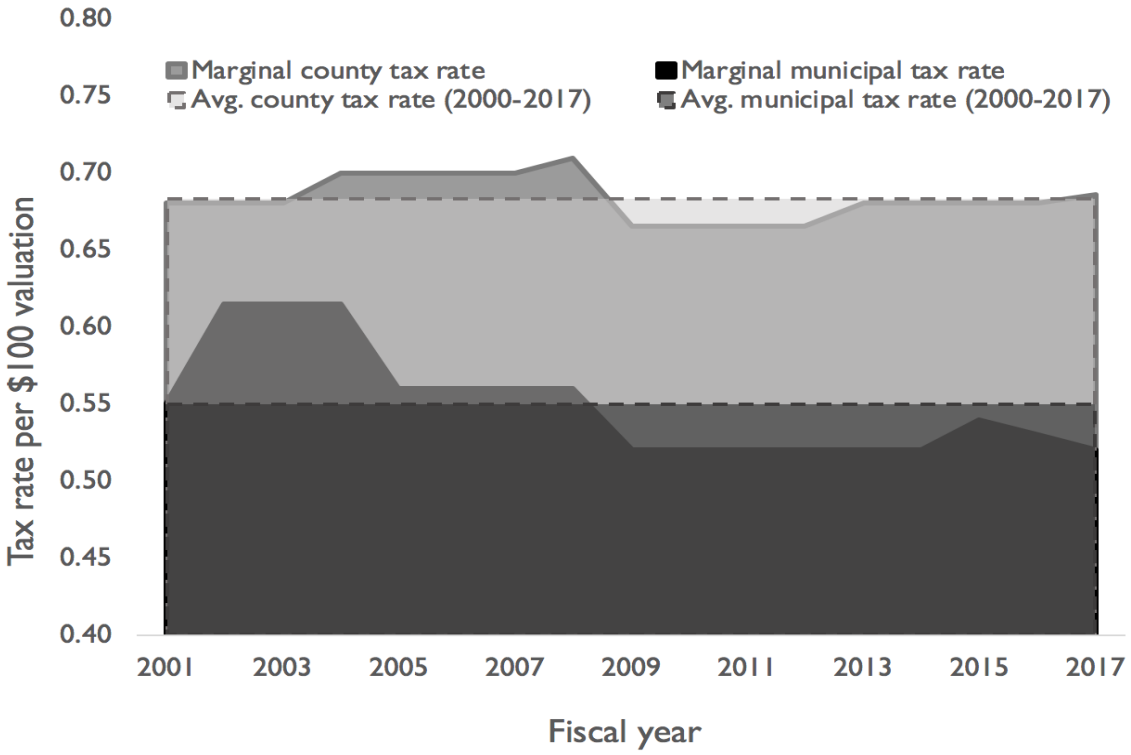

Figure 6: A disc golf course (a) and dog park (b) were created by the City of Rocky Mount, North Carolina on lands purchased as part of a floodplain buyout.

Figure 7. Net fiscal impact scenarios for City of Lumberton buyout, with (A) Scenarios 1-5 and 7, and (B) Scenarios 6 and 8 (which has a larger magnitude of costs and benefits).