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# Open space protection and flood mitigation: A national study

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ABSTRACT

Open space protection is increasingly being used for flood mitigation at the local level. However, little if any empirical research has been conducted on the effectiveness of this land use policy in terms of reducing actual damage caused by floods. Our study addresses this issue by statistically examining the performance of open space dedicated for flood mitigation purposes across a nationally representative sample of local jurisdictions. We measure the amount of open space protection designated under FEMA's Community Rating System (CRS) program for 450 local communities, and then test the degree to which this strategy reduces insured flood damages over an eleven-year period from 1999 to 2009. Results indicate that, even when controlling for environmental, socioeconomic, and policy-related variables, open space protection is an important land use planning tool for mitigating the adverse impacts of flood events in the U.S. Our findings provide insights for local planners and decision makers interested in pursuing an avoidance strategy of flood mitigation, where people and structures are essentially removed from the most vulnerable locations.



## Introduction

Open space protection has long been used as a land use strategy to maintain various natural amenities within local communities. Zoning provisions, land acquisition, and other regulatory mechanisms are traditionally implemented to ensure the protection of multiple values, including recreation, wildlife habitat, water quality, aesthetics, etc. (Bengston et al., 2004). Not until fairly recently has the designation of open space been used systematically for flood mitigation in the United States (U.S.). While the protection of open space, floodplains, and other natural areas is a growing trend at the local level, little systematic research has been conducted on the effectiveness of this land use policy in terms of reducing the adverse impacts of floods.

Our study aims to fill this research gap by statistically examining the performance of open space dedicated for flood mitigation purposes across a nationally representative sample of local jurisdictions. Specifically, we measure the amount of open space protection designated under FEMA's Community Rating System (CRS) program for 450 local communities, and then test the degree to which these mitigation policies reduce insured flood damages over an eleven-year period from 1999 to 2009.

In the following section, we describe open space protection as an emerging planning tool that when implemented at the local level can be an effective approach for reducing flood losses. We then present the CRS as a vehicle for designating open space land use within local communities. Next, we describe the research methods utilized in the study, including sample selection, concept measurement, and data analysis. Results are then presented as cross-sectional time series models that isolate the influence of protected open spaces on reducing observed flood damage over time. Through this analytical approach, we can identify the per-unit dollar amount saved by designating open space for flood mitigation. Lastly, we discuss the policy and planning implications of the findings and provide guidance for local decision makers on how to mitigate flood impacts in the face of increasing development in high-risk areas.

## Open space protection as a flood mitigation tool

Open space protection has long been a cornerstone of land use planning and policy across the U.S. This designation is ubiquitously

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embedded within local land use or comprehensive plans and often implemented through zoning ordinances. Open space is employed as a land use strategy for multiple purposes, including establishing public parks and recreation areas, separating conflicting land uses, protecting naturally occurring wetlands and riparian corridors, and providing water retention/detention (Bengston et al., 2004). A national survey showed that 46 of the 50 states in the continental U.S. had some form of open space preservation program in place (Geoghegan, 2002). For example, in the year 2000, Leon County, FL generated $400 million through a local sales tax specifically for open space protection (Daniels and Daniels, 2003). In addition to straight zoning provisions, open space can also be designated through land use techniques, such as land acquisition, conservation easements, transfer of development rights, and buffers or setbacks.

It was not until the 1990s that local policy makers began using open space protection explicitly for flood mitigation purposes (Randolph, 2004). Protecting floodplains, particularly riparian areas, can help maintain natural storage capacity and reduce the severity of inundation (Freitag et al., 2009; Opperman et al., 2009). Greenways are especially effective in establishing a buffer between waterways and developed areas while still allowing public access and recreational use. According to Kusler and Larson (1993), over 500 communities have implemented multi-objective greenway programs for their rivers and streams. For example, in the late 1990s, Lincoln County, Montana acquired approximately 30 acres of floodplain area around Parmenter Creek as a greenway to allow flood waters to drain naturally rather than force runoff into a restricted channel (Daniels and Daniels, 2003). The implementation of this open space protection policy resulted in reduced flood threats to surrounding residents.

In general, open space protection in the floodplain (where there is a one percent change of inundation every year) is considered a key element of an "avoidance" strategy of flood mitigation (Beatley, 2009) for several reasons. First, open space land use designations remove people and structures (aside from some recreational buildings) from the most flood-prone areas. Thus, the opportunity for property loss and economic disruption is eliminated. In particular, setbacks from or buffers around riparian areas make space for natural fluctuations of riverine systems and reduces adverse impacts to structures that would otherwise be placed in harm's way. Linear protected areas associated with rivers and streams can be considered the horizontal equivalent of freeboard (elevation about base flood) in that it spatially extricates development from floodplain areas (Medlock, 2008). While elevation of structures takes an engineering approach to flood mitigation, establishment of protected areas addresses the problem through land use planning and growth management.

Second, by enabling critical natural functions, such as wetlands in riparian areas to persist, the water storage capacity of the landscape is maximized and flooding beyond the extent of the actual protected area can be minimized. In other words, protecting naturally occurring wetlands associated with riverine systems can prevent the inundation of a larger surrounding area. The flood mitigation effectiveness of wetland systems is fairly well-documented (Mitch and Gosselink, 2000; Lewis, 2001; Bullock and Acreman, 2003). For example, in Massachusetts, federal and local governments collaborated to acquire 8500 acres of wetlands along the Charles River for natural flood storage area. These wetlands were later estimated to have a per-acre present value for flood prevention of $33,370 (Fausold and Lilieholm, 1996). Similarly, a study along the Des Plaines River in Illinois predicted that a marsh of only 5.7 acres could retain the natural runoff of a 410-acre watershed. Based on these results, it was estimated that only 13 million acres of wetlands (3 percent of the upper Mississippi watershed) would have been needed to prevent the catastrophic flood of 1993 (Godschalk et al., 1999).

More recent empirical research in Texas and Florida also demonstrates the economic value of naturally occurring wetlands in reducing the adverse impacts of floods (Brody et al., 2011). Brody et al. (2007a) found that the development of wetlands significantly increased the number of exceedances in stream-flow across 85 watersheds in Texas and Florida. Also, using multiple regression models that controlled for socioeconomic and geophysical contextual characteristics, Brody et al. (2008) showed that the loss of naturally occurring wetlands across 37 coastal counties in Texas from 1997 to 2001 significantly increased observed amount of observed property damage from floods. Based on the number of wetland permits granted over the study period, the authors found that, on average, wetland alteration added over $38,000 in property damage per flood. A parallel analysis for all counties in Florida showed even greater economic value of wetlands (Brody et al., 2007b). In this case, the alteration of wetlands increased the average property damage per flood at the county level by over $400,000. Based on this rate of change, wetland development costs the state over $30 million per year in flood losses.

## FEMA's Community Rating System

In 1990, FEMA established the Community Rating System (CRS) to encourage local jurisdictions to exceed NFIP's minimum standards for floodplain management. Participating communities implement flood mitigation policies in exchange for an NFIP insurance premium discount of up to 45 percent. The CRS program consists of mitigation activities categorized into four "series" containing 18 individual mitigation "activities" (see Table 1). Credit points are assigned based on the degree of implementation for the different flood mitigation activities falling within designated series. The total number of credit points obtained by a participating locality is used to determine the extent of insurance premium discounts. Credit points are aggregated into "classes," from 9 (lowest) to 1(highest). Discounts range from 5 (class 9) to 45 percent (class 1) depending on the extent to which a participating community mitigates against the adverse impacts of floods. It is important to note that while a locality implements each activity, the individual homeowner receives the discount on their flood insurance premium. In 2009, there were 1110 participating CRS communities in the U.S., a fraction of the more than 23,000 NFIP-designated communities. At the same time, however, CRS communities represented approximately two-thirds of all NFIP policies in effect (CBO, 2009).

One of the 18 mitigation activities covered under the CRS is open space preservation (Activity 420) in recognition that one of the most effective approaches to prevent flood damage is to keep flood-prone areas free of development. Several different methods of preserving floodplain lands as open space (OS) are recognized under this activity. To be considered "open space," the area must be "free from buildings, filling, or other encroachment to flood flows" (FEMA, 2007; 420-2). This requirement is meant to prevent or minimize development that obstructs floodwaters, exposes insurable buildings to damage, or adversely impacts the function of the floodplain. Additional credit points are given if the parcel has a deed restriction prohibiting development or has been preserved in or restored to its natural state.

A locality can earn up to 900 credit points for the open space preservation activity. Up to 725 of these points are provided for maintaining vacant lands within the floodplain. OS preservation can be achieved by keeping the land publicly owned as a private preserve, or by regulating development to disallow new buildings or filling on the land. Scores are weighted by the proportion of the regulatory floodplain designated as open space. Deed restrictions that prevent future owners from developing the parcel enable communities to earn an additional 75 points. An additional 100