Final Report to the North Carolina Policy Collaboratory

By the
University of North Carolina at Chapel Hill

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1. Executive Summary

Over the last 30 years, government-led acquisition and removal of flood-prone residential properties (known as "floodplain buyouts") has become a popular method for reducing future flood damages in the United States. Buyouts are attractive as they are voluntary and permanently remove vulnerable homes from flood hazard areas, and homeowners typically receive pre-flood, fair-market value for their home. The downside is that buyout projects occur within a complex intergovernmental framework, which makes buyouts somewhat unpredictable and time-consuming. Generally, federally-administered buyouts take 2-5 years to complete. In addition, buyouts are reactive, with most funding becoming available only after a major disaster.

Project goals: the broad goals of this project were to: 1) estimate the full costs of implementing buyout projects, separating costs associated with a normal property acquisition process from uniquely those costs associated with conducting a buyout (i.e., transaction costs), 2) document the variety of buyout funding mechanisms adopted by federal, state and local governments, 3) explore the potential role of the private sector in financing and implementing buyouts, and 4) determine whether development in floodplains outpaced the removal of flood-prone homes in certain communities and how floodplain development patterns differ across communities in North Carolina.

Methods: we relied on literature and public budget reviews, interviews with key informants (buyout consultants and government officials), and a survey of local government hazard managers in NC and state hazard managers across the United States. Much of our time was also spent on the creation and analysis of a statewide database of buyouts, amalgamated from numerous local, state, and federal datasets.

Summary of Findings

- State and local governments have adopted a variety of mechanisms to fund buyouts, including bonds, stormwater management fees, grants, and sales taxes. We found 34 total funding programs, nationwide. Many of these funding tools aim to promote autonomy from federal mitigation programs, and ultimately, faster buyout processes.
- Local governments around the United States seldom maintain any accounting of their total expenditures on buyouts costs beyond the direct cost of acquiring homes. While literature helps us identify buyout activities that incur transaction costs, the absence of cost data inhibits targeted policy reform and adoption of best practices. More detailed and standardized data collection and reporting can inform more impactful and equitable buyout policy, as well as more efficient use of public resources.
- Private sector involvement, e.g., in the financing or management of buyouts, could lead to cost-savings and a more efficient buyout process. By distributing investment risks outside the public sector, it may be possible to re-structure programs in a manner that achieves hazard mitigation objectives and better aligns stakeholder interests. Attention must be paid to oversight and equity implications.
- Many communities that have implemented buyouts concurrently allow (or even facilitate) additional development in their floodplains, thus countering any reduction in vulnerability to flooding stemming from the buyout.
- Historical data on buyouts are unreliable and difficult to use. New data management structures need to be developed to accurately maintain buyout records for any policy analysis or evaluation purposes.

Recommendations

1) The State of North Carolina should explore a wide variety of funding mechanisms that could smooth and speed buyout processes, including municipal/green bonds, revolving loan funds, local option

sales taxes, and stormwater utility fees. Special attention should be paid to the inclusive and equitable use of these funding mechanisms at the state and local scale.

2) The transaction costs associated with buyouts vary widely across the State and around the United States, but they can be substantial. These costs are likely absorbed by municipalities and landowners under current buyout processes. The State's Office of Recovery and Resilience (NCORR) could be instrumental in helping to limit these costs, along with efforts to prioritize and plan for future buyouts across the State.

3) Are communities "subsidizing" federally-funded buyouts through their organizational capacity and staff time? Our research reveals how bad past data are on this topic and suggests that the State is the only entity in a position to accurately and consistently answer this question. All spending on federal buyout grants – by federal, state, and community sources – should be tracked in detail by the State to better understand transaction costs associated with buyouts and find ways of streamlining buyout processes. Researchers at UNC can help the State create database tools to accomplish this.

4) Additional work needs to explore the legal hurdles to implementing alternative buyout processes and evaluate how those processes would ensure stronger equitable and environmental outcomes.

5) As part of exploring alternative buyout processes, the State should identify improved methods of calculating avoided loss that include aggregate risk (beyond project itself; e.g., downstream impacts) to determine whether buyouts lower flooding risk and damage elsewhere nearby.

6) The State should incentivize communities that receive federal or state grants for buyouts to restrict future residential development in flood hazard areas.

7) The State should take measures to improve its hazard mitigation data collection, management, and dissemination infrastructure. This will 1) facilitate evaluations of mitigation outcomes, 2) improve targeting of public investments to areas of greatest need, and 3) increase transparency and reduce demands on staff time. Researchers at UNC can help the State create database tools to accomplish this.

8) The State should prioritize and fund establishment of FAIR data standards – ensuring data is Findable, Accessible, Inter-operable, and Reusable – for all buyout- and hazard mitigation-related data, creating policies and data use agreements to standardize and curate metadata, streamline researcher and community group access, and enhance accessibility to the public. As part of this, buyouts- and hazard-related data should be stored in a publicly accessible data repository (e.g., UNC Dataverse) that facilitates good user experiences, and easy and effective data dissemination. Ultimately, these actions will save staff time and dramatically lower costs in response to data requests.

2. Project Deliverables

Scholarly papers published
Kelsey Peterson, Emily Apadula, David Salvesen, Miyuki Hino, Rebecca Kihslinger and Todd BenDor. A Review of Funding Mechanisms for US Floodplain Buyouts. *Sustainability* 12(23): 10112. https://doi.org/10.3390/su122310112

Scholarly papers in peer review
William Curran-Groome, Hallee Haygood, Miyuki Hino, Todd K. BenDor and David Salvesen. Assessing the Full Costs of Floodplain Buyouts. *Climatic Change* (In Review)

Tibor Vegh, Todd BenDor and Jonas Monast. Alternative Mechanisms for Financing Floodplain Buyouts and Aligning Stakeholder Interests. *Land Use Policy (In Second Review)*

Scholarly papers in process (yet to be submitted as of 5/1/21):
Miyuki Hino, Todd K. BenDor, Jordan Branham, Nikhil Kaza, Antonia Sebastian, and Shane Sweeney. One step forward, two steps back: managing floodplain development in North Carolina. In progress.

Miyuki Hino, Mai Nguyen, Sarah Riley, Nora Schwaller, and Todd BenDor. Improving Livelihoods through Managed Retreat: Lessons from Housing Policy.

Will Curran-Groome, Hallee Haygood, Miyuki Hino, Todd BenDor and David Salvesen. Where Does the Money Go? Evaluating the Structures and Costs of Floodplain Buyout Projects.

Presentations
Hallee Haygood, Will Curran-Groome, Todd BenDor, David Salvesen, and Miyuki Hino. Budgeting for Floodplain Buyouts. Ecological Restoration Business Association 2020 Conference.

Miyuki Hino, Mai Nguyen, Sarah Riley, and Todd BenDor. Where do buyout households go? Managed retreat and the geography of opportunity. Association for Public Policy Analysis and Management Fall Conference 2020.

Miyuki Hino, Todd K. BenDor, Jordan Branham, Nikhil Kaza, Antonia Sebastian, and Shane Sweeney. One step forward, two steps back: managing floodplain development in North Carolina. Association of Collegiate Schools of Planning Annual Conference 2020.

Miyuki Hino, Todd K. BenDor, Jordan Branham, Nikhil Kaza, Antonia Sebastian, and Shane Sweeney. Measuring floodplain management parcel-by-parcel in North Carolina. Natural Hazards Research and Applications Workshop 2020.

Datasets

A large number of datasets, including our final NC Buyouts Dataset which, with permission from NCDEM, could be made publicly available via UNC's Resilience Dataverse: https://dataverse.unc.edu/dataverse/resilience

3. Research Questions Addressed

This project sought answers to the following questions:

1. What mechanisms have been used by federal, state, and local governments to fund buyouts?
2. What is the full cost of implementing a buyout project? Specifically, what are the transaction costs associated with buyouts?
3. In what ways could private sector involvement reduce the costs and improve the efficiency of implementing buyouts?
4. To what extent have the flood mitigation gains from buyout projects in NC been undermined or offset by new development in the floodplain?

To address these research questions, we developed two, multi-part projects, described below:

A. Estimating the full costs of buyouts and identifying the range of buyout funding mechanisms,
B. Assessing the overall or net physical risk reduction as a result of new development in floodplains in communities that have removed flood-prone homes through a buyout.

A. Estimating Full Costs of Buyouts and Identifying Funding Opportunities

Federal buyout programs have long been criticized as being time-consuming, lacking transparency, and not providing sufficient funding to acquire the total number of qualifying properties. Given these shortcomings, some local and state governments have created their own buyout funding programs, drawing on a variety of both established and innovative funding mechanisms. However, little work has comparatively documented the frequency and geography of these programs, the range of funding mechanisms used, or the number of buyouts they implement.

Similarly, compared to other natural hazard risk reduction techniques, there has been comparatively little research on the cost of implementing buyouts, particularly for local and state governments. Buyouts can be quite costly for federal, state and local governments. In addition to property purchases, surveys, appraisals, title searches, and other tasks generally associated with real property transfers, expenses that are uniquely part of a buyout process include outreach, administration, counseling, negotiation, closing, relocation and demolition (which we term the "transaction costs" of buyout programs). In addition, the entire process is time-consuming; buyouts frequently take two-five years to complete (and often longer; Weber and Moore 2019). This lengthy processing time often discourages participation, as many homeowners opt to repair their homes rather than wait for it to be acquired.

Finally, there have been no studies on the potential benefits of private sector involvement in funding buyouts, e.g., to acquire homes on behalf of a local government. Private investors may look to buyouts as an opportunity to realize financial returns by providing efficiencies for buyout-related services, including partnering or managing buyout programs currently run by governments, or by negotiating with buyout funders to keep some portion of reduced transaction costs. Private financing mechanisms could allow the public sector to distribute the risks and uncertainty associated with achieving buyout success (roughly measured, from the perspective of governments, as accumulated avoided costs from future flood damage) beyond taxpayers.

<u>Project A goals:</u>

1. Identify the different mechanisms used at the federal, state and local level to fund buyouts.
2. Create a framework for estimating the federal, state, and local costs attributed to designing and implementing a buyout project. Implement this model to estimate range of transaction costs in NC.

3. Explore the conditions under which private firms could productively engage in buyout processes to reduce buyout program costs or improve buyout program performance.

B. Buyouts, Physical Risk Reduction and Development in Floodplains

The implementation of buyouts is intended to help communities become more resilient to natural hazards. However, resilience improvements due to buyout projects can be offset by new development in floodplains. Even communities that have participated in buyouts, or who are taking other steps to reduce flood risk, might be allowing new development in floodplains. While some communities work to steer new construction away from floodplains and acquire existing flood-prone houses, others might ignore floodplains altogether in their decision-making. Yet, with little data available on how development in floodplains has changed over time, our understanding of which communities have effectively managed their floodplains – and how – has remained limited.

In recent years, the availability of data to measure development has dramatically expanded, creating new opportunities to assess empirically floodplain management performance. In this project, we measured floodplain development at the parcel scale to evaluate municipal performance in managing exposure to flood hazards, and identified which communities have avoided developing in floodplains while continuing to grow.

Project B goals:

1. Determine whether development in floodplains outpaced the removal of flood-prone homes
2. Assess how floodplain development patterns differ across communities, and;
3. Assess the extent to which other flood risk management activities were associated with limited floodplain development.

4. Research Methods

A. Estimating Full Costs of Buyouts and Identifying Funding Opportunities

We segmented Project A into three major tasks.

A1. Identifying Federal, State and Local Funding Mechanisms for Buyouts

In order to document the variety of mechanisms adopted at the state and local level to fund buyouts, we conducted a census of buyout funding programs across the United States. In doing so, we documented the extent of their use and created a typology of funding mechanisms. We reviewed the scholarly literature, news articles, and government documents to describe buyout programs and the unique local, state, and federal funding tools used to implement them.

A2. Creating a model for estimating costs of designing and implementing a buyout

Reviews

To investigate the extent to which buyout transaction costs are documented in the literature, we searched relevant publications using the Google Scholar citation search engine. We reviewed over 1,100 publications overall, using a combination of terms such as flood, floodplain, buyout, property acquisition and land acquisition.

The second aspect of this task involved a budget analysis to determine how community, county, and state governments track and categorize their own spending on FEMA-funded buyouts. To construct our sampling frame of communities, we relied on a FEMA's public dataset of hazard mitigation projects. We limited our investigation to communities where buyouts were approved on or after January 1, 2015, and sampled every community with more than 50 properties acquired between 2015 and 2020 (*n = 48*

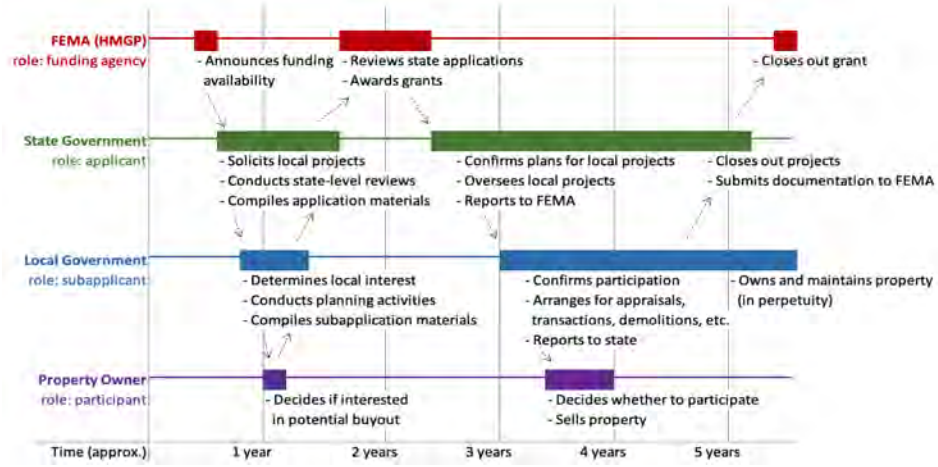
communities). In addition, we randomly sampled five percent of the remaining communities with 50 or fewer properties acquired over the same time period (*n = 50* communities) and those counties where more than 100 properties had been acquired. After accounting for places where no budget data was available, our effective sample comprised 67 unique communities, 62 unique counties, and 25 unique states.

For each community sampled, we implemented an online search for budget documentation from the fiscal year(s) during which the community was initially approved for funding, as well as the years directly after the approved buyout (until the earlier of either 2020 or the year in which the buyout project was officially closed out) to account for possible time lags in project implementation. We used this same process to identify budgets for encompassing counties and states, since multiple levels of government are often involved in administering buyout funding and activities. This generated a total sample of 859 budget-years. Of these budget-years, 223 (26%) were not available online, and an additional 76 (9%) were not machine readable (resulting in an effective sample size of n = 560 budget-years).

Survey

Finally, to address outstanding questions regarding the activities comprising floodplain buyouts, as well as these activities' attendant costs (transaction costs and otherwise), we developed and distributed a 33-item web survey. The intention of this survey was to solicit information from respondents about the activities they undertook during buyout projects (Figure 1), as well as the costs of those activities. Survey questions asked respondents to report information about a buyout project in which they were significantly involved; that occurred recently enough such that they remembered the details of the project; and that was either complete or as close to complete as possible. Prior to distribution, the survey was reviewed by the University of North Carolina at Chapel Hill's Institutional Review Board (IRB #20-0834).

Figure 1: Timeline and broad activities in a typical HMGP-funded buyout. Reprinted and adapted with permission from Weber and Moore (2019).



We developed an initial sample of potential respondents (n = 225) comprising buyout consultants (n = 9), North Carolina County Emergency Management Officers (n = 99), North Carolina Certified Floodplain Managers (n = 19), State Hazard Mitigation Officers (n = 54), relevant staff from North Carolina municipalities that have conducted floodplain buyouts (n = 44), and various other individuals identified by the project team or by pre-testing interviewees to be substantially involved with floodplain buyouts (n = 11).[1] Additional respondents (n = 25) were identified via snowballing; respondents were asked to refer other individuals whom they knew had worked on floodplain buyouts. This yielded a final sample of 249 potential respondents, including state government staff (n = 65), local government staff and hazard managers (n = 171), and buyout consultants (n = 13). We concentrated on identifying respondents in

North Carolina owing to strong connections between project staff and various state and local government officials, and because North Carolina has conducted a significant number of floodplain buyouts (*n = 263* FEMA-funded projects, second-most after Pennsylvania, and accounting for more than $320 million, third-most after Texas and New Jersey; FEMA 2021). Our final sample included 175 respondents involved with floodplain buyouts in North Carolina; 13 respondents who were not associated with a particular state (e.g., consultants); and 60 respondents who were involved with floodplain buyouts in 53 other states, territories, and the District of Columbia.

The survey was distributed via email in August, 2020 to the initial sample. Respondents who had not yet completed the survey were sent follow-up reminders at the two-, three-, and four-week marks. Respondents identified via snowballing were emailed the survey and reminders along a similar follow-up schedule.

A3. Exploring Private Sector Funding and Implementation of Buyouts

In this task, we used two primary methods. First, we derived the conditions under which a "privatized" buyout process could reduce buyout program costs or improve buyout program performance. We did this specifically by exploring the mathematical conditions under which the buyout processes could be structured in a way that reduces transaction costs, saving public funds and speeding the buyout process

Next, we reviewed available literature on environmental finance mechanisms that could, hypothetically be used to make buyout processes could use to become more flexible.[1] Those mechanisms could include bonds (e.g., green bonds), which can be issued by local governments to raise capital for a floodplain buyout, insurance linked securities, and conservation tax credits. Using these financing mechanisms, we explored several alternative structures for financing buyouts, creating a typology of private involvement in buying processes.

B. Buyouts, Physical Risk Reduction and Development in Floodplains

As part of this project, extensive datasets on flooding, buyouts, floodplains, and a variety of other aspects of hazard mitigation in North Carolina were obtained from NC Division of Emergency Management (NCDEM). Unfortunately, because the data are not reported or stored in standardized forms, it took a great deal of work on behalf of NCDEM to gather and share it. It took several months to get access to these data (some of which were in proprietary/outdated formats or corrupted), and *many* further months to obtain enough metadata (i.e., information about what the data contained, when it was collected, what it means, etc.) to actually use that data. Once data and metadata were acquired, they were loaded onto UNC's Resilience Dataverse (https://dataverse.unc.edu/dataverse/resilience) for sharing internally with researchers on this project (this could be opened up to the Public upon NCDEM's approval).

Dataverse is an open source, data repository software framework, which facilitates the dissemination of research data (https://dataverse.org/). Dataverse is a widely used, well-designed platform for disseminating – either openly or using constraints or data use agreements – data of all types, and UNC's operating Dataverse platform ("UNC Dataverse") is operated by the Odum Institute for Research in Social Sciences (PI Todd BenDor is the Director; https://odum.unc.edu/).

In addition to the NCDEM data, We acquired four separate datasets that include buyouts in North Carolina, each with discrepancies across the number of buyouts, locations, addresses, and a number of other identifying attributes. The five datasets used in creating a "master" buyout list for North Carolina are listed in Table 1 and summarized below:

[1] This is in contrast to Task 1 of Project A, which looked at actual funding programs that have already been created around the United States.

Datasets

- FEMA FOIA[2] #1 (for NC/SC; acquired by University of Delaware Professor A.R. Siders)
- FEMA FOIA #2 (Nationwide; acquired by Dr. Katharine Mach and Caroline Kraan, University of Miami [FL])
- FEMA FOIA #3 (Nationwide; acquired by National Public Radio [NPR])
- Charlotte Mecklenburg County data, for buyouts financed through their stormwater program
- North Carolina Emergency Management (NCEM), data for any and all buyouts involving NC State agencies.

Table 1: Datasets used to create authoritative list of floodplain buyouts. FOIA indicates "Freedom of Information Act" request.

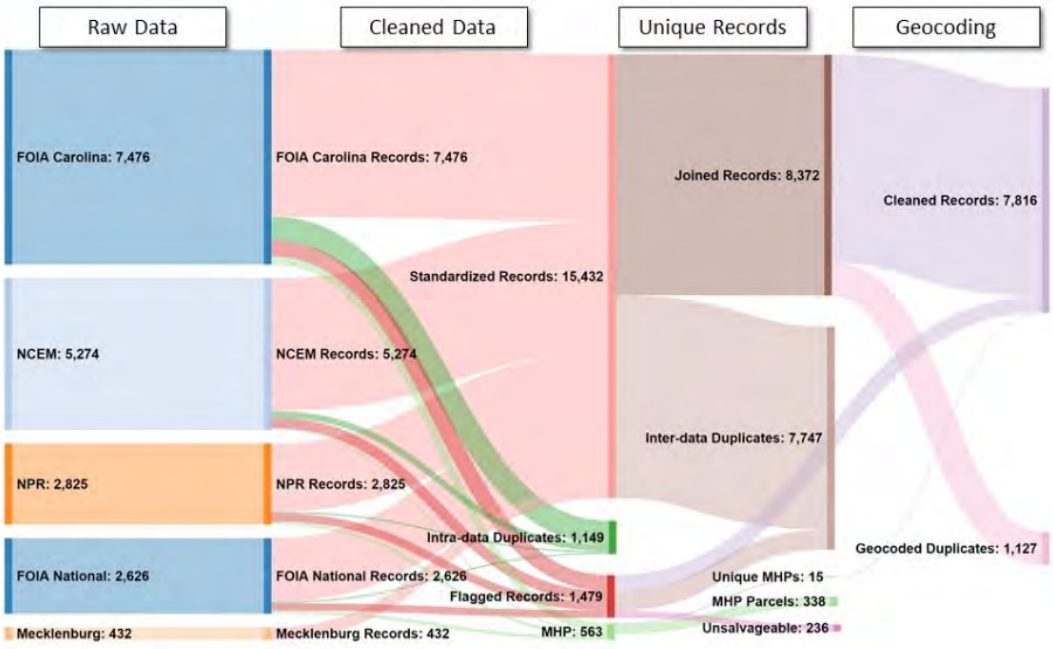
Dataset	Date of Acquisition	Buyout Dates	Provider	# of NC Buyouts	Important Fields
FEMA FOIA #1 (Siders)	2018	9/96-10/17	FOIA request submitted to FEMA in 2018 by University of Delaware Prof. A.R. Siders	7,476	Damaged Address Line 1, Status, Date Approved, ZIP, Actual Amount Paid, Latitude Number, Longitude Number
FEMA FOIA #2 (Stanford)	2018	1989-2013	FOIA request submitted to FEMA in 2018 by Stanford University	2,625	Damaged Address Line 1, ZIP, Latitude Number, Longitude Number, Date Closed, Status, Actual Amount Paid
FEMA FOIA #3 (NPR)	March 5, 2019	1989-2016	National Public Radio (NPR): https://apps.npr.org/fema-table/	2,825	Address, Fiscal Year, Zip, Status, Price Paid
North Carolina Emergency Management (NCEM)	January 29, 2020	N/A	Paul Ervin, Economist - NC Department of Public Safety	5,274	Address, ZIP, Municipality, Latitude, Longitude, Parcel ID, Type
Charlotte-Mecklenburg Buyout Program (Meck)	January 28, 2020	9/2000-9/2019	David Love, Project Manager of Charlotte-Mecklenburg Storm Water Services	432	Total Mitigation Costs, Owner House Address; Geographic Coordinates, Date Mitigation Complete.

Data merging and cleaning involved a multi-step process that took an extensive amount of time and energy (Figure 2). This process included efforts to standardize addresses, assess and standardize mobile home park buyouts, geocode addresses and joining data to parcel information. Many counties appear to have a policy of removing buyout parcels from cadastral databases (even in counties that maintain public

[2] FOIA indicates "Freedom of Information Act" request.

lands in their parcel data) and/or changing the addresses of buyouts after-the-fact. These practices make efforts to locate past buyouts impossible for most researchers, and only possible with intense effort for those with significant assistance from local officials or access to historic data.[3]

Figure 2: Sankey diagram depicting flow from raw data to final, geocoded buyout dataset.



Moreover, the State places few requirements on counties to send accurate or complete data that it merges into its state-wide parcel dataset. These lack of requirements, along with apparently little quality assurance and control, created countless hurdles to retrospective location of buyouts.

> Addresses disappeared. Parcels disappeared. "Buyout" records yielded parcels that were privately owned or seemingly had conflicted ownership (depending on the database consulted). FEMA data routinely included buyouts that were never completed (due to decisions either by FEMA, communities, the State, or homeowners themselves). In many cases, buyout addresses were recorded in ways that prevented location at all (e.g., "located next to the big field near an intersection" inappropriately given as a complete property description).

Our data cleaning process yielded a final buyout database, replete with a scoring system that gauged our relative certainty that each buyout record was, in fact, an actual, completed buyout. We offer a variety of findings and recommendations for improved data collection, management, and dissemination.

To identify which municipalities have undergone floodplain development, as well as which have endeavored to limit flood risk, we created a novel, parcel-level dataset to measure changes in floodplain land uses over time (2001-2016) in North Carolina. To assess the relationship between floodplain development and risk over time, we leveraged North Carolina's statewide, structure-level elevation dataset (unfortunately, this was created in 2009 and only sporadically updated since then). We also

[3] To give a sense of the scale of this difficulty: we had two graduate students – both with extensive database management experience (e.g., in big data/urban analytics and banking settings) – work on this data integration task for nearly a full calendar year.

leveraged data on community socioeconomic and demographic characteristics, Community Rating System scores, and zoning policies, to examine patterns in floodplain development.

To identify communities that have experienced either intense or limited floodplain development, we constructed measures of how much development has occurred in floodplains, as a share of total development, and how much developable land within the community is within the floodplain, as a share of total developable land. We focused our analysis on communities in North Carolina that participate in the National Flood Insurance Program (NFIP).

We measured development in two forms: new housing construction and increases in impervious surface, using the impervious surface layer from the National Land Cover Database. By comparing the percentage of impervious surface estimated in 2001 and 2016, we could map the locations of new development. Our primary source of flood hazard information was FEMA's Digital Flood Insurance Rate Maps (DFIRMs), which are widely used in local policy and regulation, including insurance rate-setting and building code enforcement.

We overlaid the parcel locations on the official floodplain maps to assign it to a flood zone. Then, as with the impervious surface measure, we calculated the total amount of new housing constructed from 2001 to 2016 and the share of that housing that was within the floodplain.

Finally, we explored how floodplain management practices relate to floodplain development outcomes. We evaluated three types of floodplain management actions: property buyouts, zoning (in NC's urban communities with available zoning data), and the community's score under the Community Rating System.

5. Findings

A. Estimating Full Costs of Buyouts and Identifying Funding Opportunities

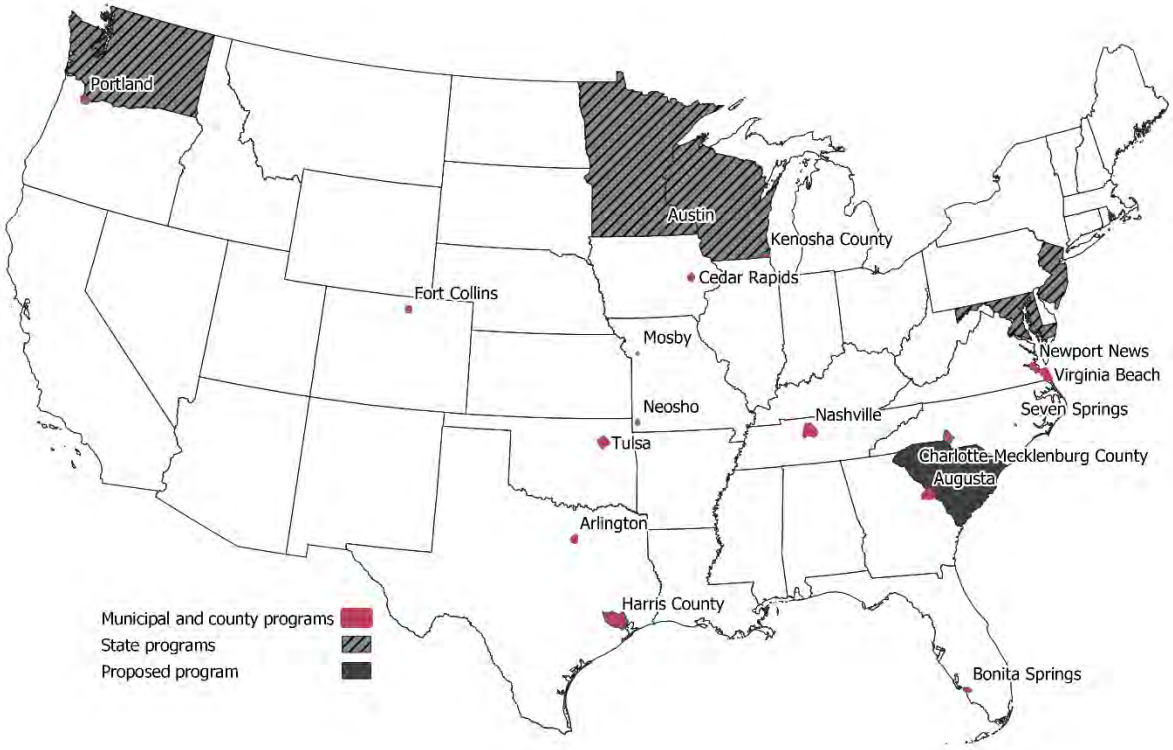
A1. Identifying Federal, State and Local Funding Mechanisms for Buyouts

Published as: Kelsey Peterson, Emily Apadula, David Salvesen, Miyuki Hino, Rebecca Kihslinger and Todd BenDor. A Review of Funding Mechanisms for US Floodplain Buyouts. *Sustainability* 12(23): 10112. https://doi.org/10.3390/su122310112

On the federal level, we identified a total of nine buyout funding programs, including the FEMA and HUD programs discussed earlier, as well as one lesser-used program, two now-repealed programs, and one proposed program. At the state level, we found six programs using three different financing mechanisms, including grants, revolving loan funds, bonds, and – to some extent – tax credits and incentives. At the local level, we found 19 programs in 17 municipalities using four financing mechanisms, including stormwater utility fees, local option sales taxes, and municipal bonds. Most (88%) of the state and local funding programs were aimed, at least in part, at creating a source of local or state funding that could be used as a federal cost-match (Figure 3).

State and local funding programs nationwide have resulted in the purchase of some ~9600 flood-prone properties or structures. As most of these buyouts occur with funding from programs that share costs with FEMA, they represent nearly 25% of the over 40,000 total properties acquired with federal grants.

Figure 3. Map of state and local buyout funding programs in the United States. Municipal and county programs are labeled.



As state and local programs continue to emerge and evolve, they can address some of the shortcomings of federally-funded buyouts identified here, namely: funding, flexibility and uncertainty. First, the inability to provide the local contribution for federal funds can discourage local governments from participating in a buyout (FEMA's grants generally require a 25% local match). State and local programs offer one path for streamlining cost matches to obtain federal funds.

Second, programs that are funded independently of federal programs can operate with more flexibility, buying homes more quickly than through federal programs: for example, six months in Charlotte versus five years for federally-funded buyouts (Weber 2019). Moreover, state and local governments can be proactive in acquiring flood-prone homes, rather than acting after-the-fact, as with federal grants.

Third, state and local buyout programs can reduce the complexity and uncertainty of federal programs; specifically, they can add certainty as to the timing and amount of funding availability, as well as which homes will be eligible. However, the extent to which these non-federal funding sources systematically increase the number of properties bought and reduce the timeline of buyout projects, are areas in need of further investigation. Additional research is needed to evaluate the relative cost-efficiency of state and local programs compared to federally funded programs. Such research is particularly timely given the projected increased changes in sea level and in the intensity of storms and frequency of flooding, which may increase the demand for buyouts.

A2. Creating a model for estimating costs of designing and implementing a buyout
In peer review as: Will Curran-Groome, Hallee Haygood, Miyuki Hino, Todd BenDor and David Salvesen. Assessing the Full Costs of Floodplain Buyouts. *Climatic Change*.

Reviews

FEMA alone has spent more than three billion dollars on floodplain buyouts, yet we found limited sources with relevant cost information, none of which report transaction costs. Very few published documents (*n = 23*; 2% of reviewed documents) itemized the costs, either in terms of expenditures or person-hours, of specific activities comprising floodplain buyouts. Of the 23 documents, the large majority (*n = 19*; 83%) specified only property purchase prices, while three documents (13%) provided information on property purchase prices and another activity, and one document (4%) only described asbestos testing costs. Other itemized activity costs included site maintenance (4%); property purchase price and relocation costs (reported jointly; 4%); appraisal, property purchase price, and demolition (reported jointly; 4%), and asbestos testing (4%).

Similarly, our budget review found little on the specific costs of buyouts. Despite drawing our sample from budget-years in which we knew HMGP buyout grants were active, only a small proportion of budgets itemized buyout costs. Of those that did, many described their buyout activities with only a single line-item in the budget. None of the budgets that provided buyout cost information provided information on FTEs dedicated to buyouts or on how costs were broken down across various buyout activities.

We also examined two public FEMA datasets in an effort to quantify the costs incurred by different buyout activities. While the definitions of variables provided in these datasets were so vague as to limit our ability to draw high-confidence conclusions, our analyses supported the idea that buyout projects frequently incur significant costs beyond those associated with purchasing properties. Indeed, of the 936 we analyzed, 18% (n = 170) spent a third or more of their total funding on activities other than those encompassed by FEMA's "Actual Amount Paid" variable, which primarily reflected property purchase costs. In conjunction with the results of the systematic review and budget review discussed above, these findings suggest that, although property purchase prices receive the bulk of the attention in the discussion of floodplain buyouts and their costs, other activities may play an important and significant role in determining total buyout project costs.

Survey

In preparation for peer review as: Will Curran-Groome, Hallee Haygood, Miyuki Hino, Todd BenDor and David Salvesen. Where Does the Money Go? Evaluating the Structures and Costs of Floodplain Buyout Projects.

Of our sample of n = 257, 73 respondents completed the two screener questions[4], producing a raw response rate of 28%, and an adjusted response rate of 38%. Twelve percent of respondent (n = 5) were consultants working with local governments; 50% (n = 21) were local government employees; and 38% (n = 16) were state employees. Respondents described buyout projects from 16 states, with the majority (n = 23; 58%) detailing projects from North Carolina. The majority of projects occurred in response to flood events within the last five years, including 18 projects (46%) involving flood events in 2016 and 9 projects (23%) involving flood events in 2018; this reflects in part the number of North Carolina-based projects, and the significance of flooding following Hurricanes Matthew (2016) and Florence (2018).

[4] The screening questions included: "Have you ever worked on a floodplain buyout project?" and "Are you the best person to complete this survey, or has someone else at your organization been more significantly involved in floodplain buyout work?"

Respondents reported using funding from a range of sources to support buyout costs. Primary funding sources included FEMA's Hazard Mitigation Grant Program (HMGP; n = 32 respondents; 91%), state government budgets (n = 8; 23%), HUD's Community Development Block Grant (CDBG); n = 3; 9%), CDBG-Disaster Recovery program (CDBG-DR; n = 8; 20%), FMA (n = 3; 9%), and local government budgets (n = 3; 9%). Virtually every respondent reported receiving a majority of their project's total funding from federal sources; a single respondent (4%) reported an equal split between funding from state and federal sources. After omitting projects funded by the Harris County Flood Control District (Texas), which is the single largest local funding source of buyout programs in the country, HMGP accounted for 68% of total funding, followed by state budgets at 17% and other state-level sources at 11%.

The use of consultants to support buyout projects is, anecdotally, a widespread practice. While consultants have been alluded to in the literature, little prior work has systematically described the characteristics of consultants' engagement with buyout projects. Twelve local government respondents (75%) reported hiring a consultant, whereas only five (33%) of state government respondents reported hiring a consultant. Few respondents were able or willing to report the amount they paid consultants; of those who did report this value (n = 4), amounts ranged from $26,000 (1.25% of total project funding) to $203,000 (9.10% of total project funding).

As pictured in Figure 4, many activities at both the local and state levels were conducted as part of nearly all respondents' projects. Conversely, there were also many activities that were completed only by roughly half of local government respondents, including environmental and historical reviews, post-buyout surveys and interview, and various community engagement and education activities, such as calling and mailing eligible households about the opportunity to participate in a buyout. Respondents also identified a number of write-in activities (not included in Figure 4), including additional forms of community engagement and education (e.g., television, radio, newspaper, and social media advertising), Uniform Relocation Act reviews for buyouts of properties that included renters, substantial damage determinations, and elevation surveys.

We also asked respondents to report the costs they incurred for each buyout activity they undertook. As visualized in Figure 5, we grouped these individual buyout activities into broader phases—community outreach, planning, implementation, and post-buyout—in order to better understand which phases of buyout projects incurred the greatest expenses. As shown in Figure 5, buyout projects incurred anywhere from 1% to more than 15% (mean = 6.8%) of their total project costs on activities across these four phases.

Figure 4: Respondents identified a variety of buyout activities conducted by (A) local and (B) state governments

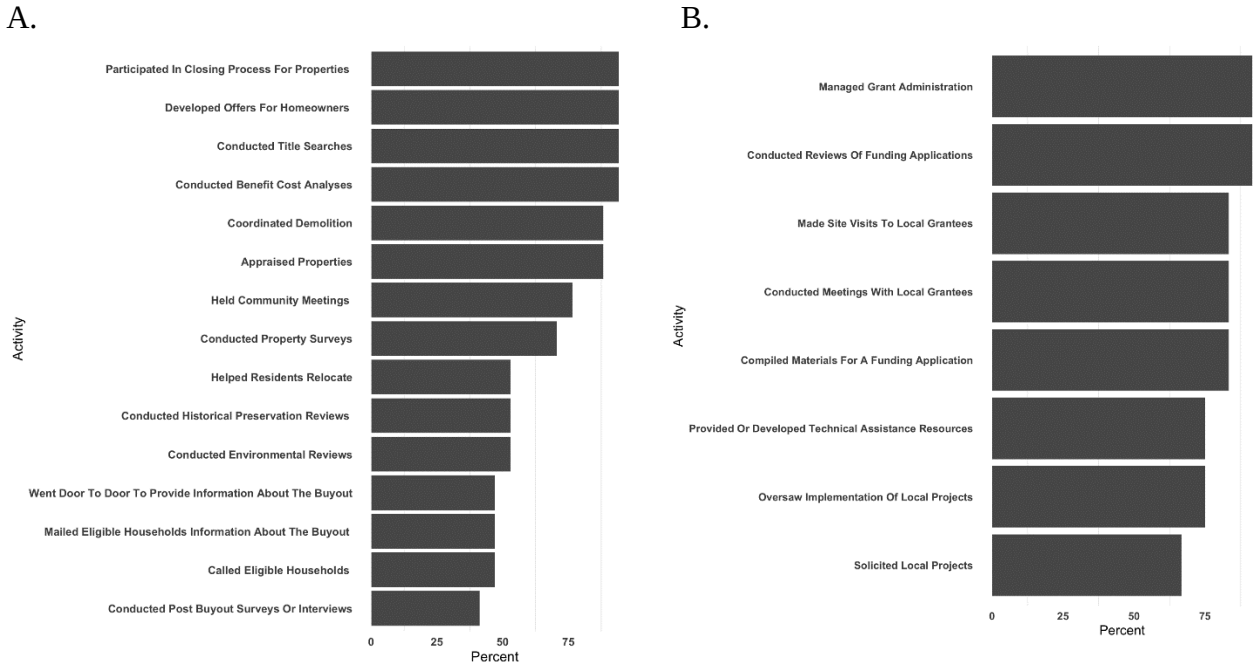
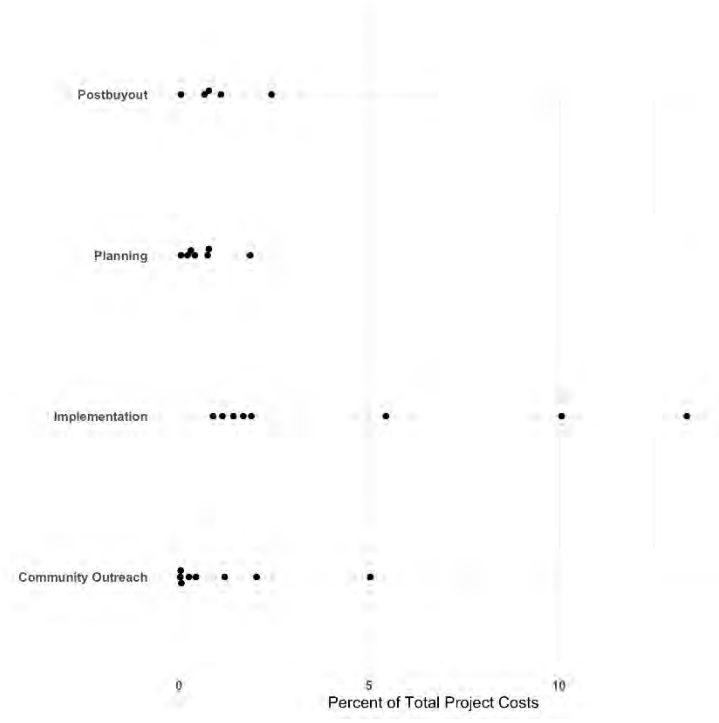


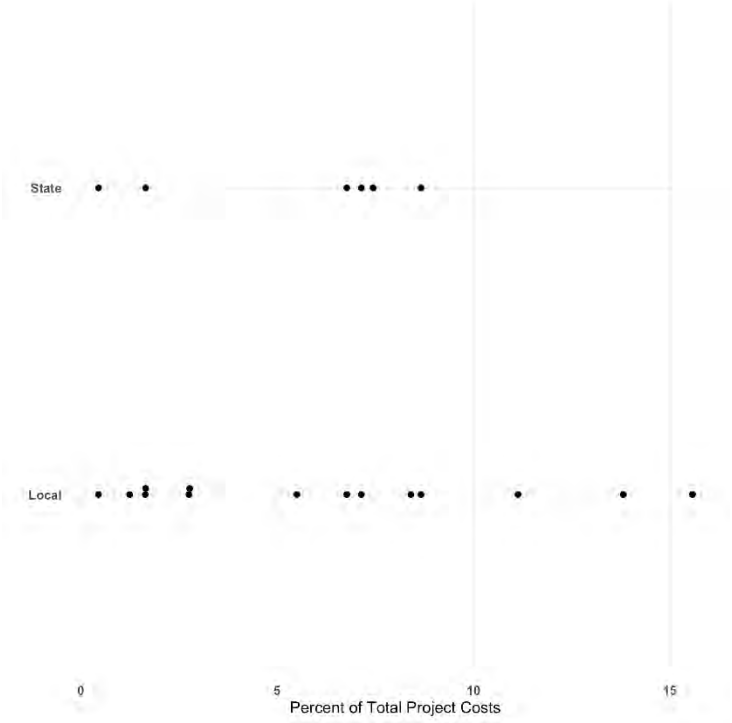
Figure 5: Percent of Total Project Costs Devoted to Local Government Activities, by Buyout Phase



This does not account for the costs incurred at the state level, which ranged from less than 1% to more than 8% (mean = 5.5%; Figure 6). These local and state activity cost estimates, however, do not capture the full extent of total buyout project activity costs. We were unable to measure costs incurred by federal

agencies and by individuals interested in participating in a buyout, yet we know that the vast majority of floodplain buyout funding originates with federal agencies, and that prospective buyout participants incur significant time costs as they acquire information about buyout opportunities and complete various buyout processes. These figures also are likely underestimates because some respondents did not know the costs of some of the activities that were completed as part of their buyout projects.

Figure 6: Percent of Project Costs Devoted to Local and State Activities



A3. Exploring Private Sector Funding and Implementation of Buyouts

In peer review as: Tibor Vegh, Todd BenDor and Jonas Monast. Alternative Mechanisms for Financing Floodplain Buyouts and Aligning Stakeholder Interests. *Land Use Policy.*

We created a typology characterizing private sector involvement in buyout programs, including forms of public-private partnerships (with firms as service providers [common today] and as partners for running buyout processes), and forms where governments incentivize floodplain acquisitions through a fully privatized buyout market. We found that a variety of environmental finance mechanisms could be employed under each of these market structures.

To proactively move people out of harm's way, floodplain buyout programs need to be scaled up and expanded into high risk areas. To expedite this process, in the context of buyouts, large investors could establish a "portfolio" of floodplain buyouts, where the conservation of floodplains is adequately capitalized and sufficient funds can be mobilized for the acquisition of new buyouts. The conservation of floodplains can be considered capitalized at a sufficient rate when all high-risk properties that are targeted by buyout programs (1) can be acquired in a timely manner, and (2) at buyout prices high enough to ensure buy-in from property owners.

We found that, under the assumption of variable transaction costs associated with implementing floodplain buyout programs, private market involvement can, in some circumstances, result in efficiency gains. However, it is clear that there would continue to be a need for coordination of the private sector

with broader public sector infrastructure plans that may affect private buyout decisions. These considerations may include the locations of desired buyouts, acknowledging that these locations depend not only on flood risk, but also on plans for levees, drainage, and other flood control structures. Also, buyout programs must take into consideration new construction and land use policy such as zoning decisions. Furthermore, governments' unique abilities to help relocated households in ways the private sector cannot (e.g., tax abatements, temporary housing subsides) suggests that continued government involvement will be absolutely key in moving forward with any proposed alternative buyout program structures.

Finally, we discovered a variety of legal hurdles to implementing alternative buyout processes. For example, the US Stafford Act currently authorizes buyout grants to states, tribes, local governments, and certain nonprofit organizations (42 U.S.C. §5170c(b)&(C); 44 C.F.R. § 206.434) only after a presidential disaster declaration. The law does not provide for pre-disaster buyouts or the involvement of investors or other third-party intermediaries. Amendments to the statute and implementing regulations would be necessary to permit the use of federal funds to support privatized or semi-privatized markets for buyouts, provide guidance for private sector involvement, specify any limitations on the use of federal funds, and establish measures to protect property owners from fraud.

Although private sector involvement in floodplain buyouts would be new, improving efficiency and reducing administrative costs for buyouts would be consistent with other provisions in the Stafford Act. For example, a recent amendment required FEMA to develop a plan for administrative cost reduction for disaster assistance, and FEMA regulations define "hazard mitigation" as "[a]ny cost effective measure which will reduce the potential for damage to a facility from a disaster event." (42 U.S.C. § 5165e; 44 C.F.R. § 206.2)

B. Buyouts, Physical Risk Reduction and Development in Floodplains

In preparation for peer review as: Miyuki Hino, Todd K. BenDor, Jordan Branham, Nikhil Kaza, Antonia Sebastian, and Shane Sweeney. One step forward, two steps back: managing floodplain development in North Carolina.

In preparation for peer review as: Miyuki Hino, Mai Nguyen, Sarah Riley, Nora Schwaller, and Todd BenDor. Improving Livelihoods through Managed Retreat: Lessons from Housing Policy.

In North Carolina, widespread development in floodplains has far outpaced removal of flood-prone property through voluntary buyouts. Since 1996, 3,721 properties were acquired in North Carolina as part of a buyout, while housing has been newly constructed on over 47,000 floodplain parcels. In fact, the sum total of state buyout efforts was offset by floodplain construction in a single year, with 3,639 floodplain parcels developed in 2005 (Figure 7).[5]

In addition, we found that the construction of housing in floodplains is more likely to occur in communities with small populations (under 5,000 people; Figure 8). Interestingly, our results indicate that the more flood-prone houses a community acquires, the less likely it was to observe development in floodplains. Many of the communities with disproportionately high amounts of floodplain housing have not done any buyouts, and several of them have done fewer than 10 buyouts. Finally, floodplain housing patterns differed between inland and coastal communities and as a function of property values.

[5] These are preliminary findings that are subject to change upon peer review. The total number of buyouts has been in flux due to our changing methodology for gauging the certainty of past buyout data.

Figure 7: New floodplain construction far outpaces removal of floodplain property through buyouts in North Carolina. While floodplain housing construction dropped during the real estate market crash of 2008, floodplain construction rates are rising again. (these are preliminary findings that are subject to change upon peer review)

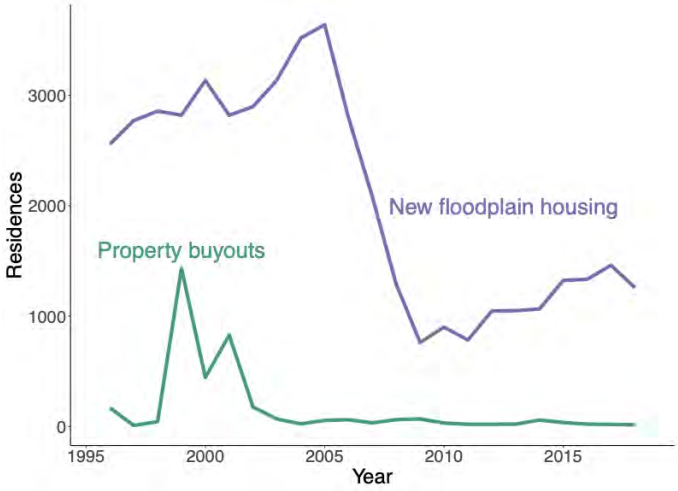
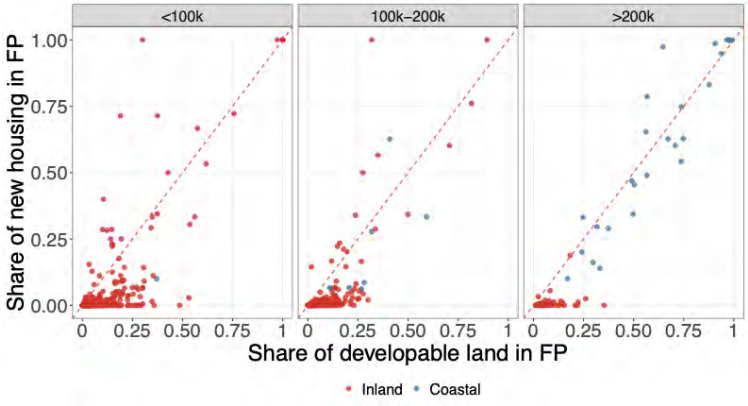


Figure 8: High rates of floodplain development are common among wealthy coastal communities and low-wealth inland communities. Panels show the share of new housing in the floodplain relative to the share of developable land in the floodplain, where each point is an incorporated municipality or the unincorporated portion of a county. Points toward the top-left corner indicate high rates of floodplain housing relative to flood exposure. Communities are grouped based on the average assessed property value (< $100k, $100k-$200k, and >$200k). (these are preliminary findings that are subject to change upon peer review)



6. Recommendations and Management Actions

A. Estimating Full Costs of Buyouts and Identifying Funding Opportunities

A1. Identifying Federal, State and Local Funding Mechanisms for Buyouts

Our analysis suggests possibilities for improving the interface between federal and state/local buyout funding programs. As buyout financing strategies continue to evolve, monitoring and evaluation of federal programs can help ensure equitable access to buyouts across communities of different size, wealth, and geography.

While our analysis does not indicate a link between community wealth and program establishment, it is possible that increased self-financing of buyouts by states and municipalities could eventually lead to disparities in the communities that are able to access federal funds; smaller and lower-income communities might find it more difficult to impose a new sales tax or issue a bond, remaining heavily reliant on federal funds, but with limited local matching funds. Additional research investigating the geographic, socioeconomic, and political drivers of use of these non-federal buyout funding mechanisms could also inform these concerns.

While our analysis can inform communities interested in exploring alternative funding for buyouts, the suitability of bonds, stormwater utility fees, or local taxes will depend on local context. Like any infrastructure program, communities inevitably vary in their ability to generate funds for buyouts and in their capacity to administer a buyout program. State and local governments might also consider using tax incentives and credits to promote buyouts. Tax incentives and credits have been used to motivate conservation programs. For example, the Arkansas Wetland and Riparian Zone Creation, Restoration, and Conservation Tax Credits Act (1995) grants a state income tax credit to taxpayers who develop, restore, or conserve wetland and riparian zones [99]. Qualifying activities include establishing permanent vegetation, stabilizing stream banks and controlling erosion, and installing water control structures. To our knowledge, such mechanisms have not yet been used explicitly in the context of floodplain acquisitions.

Recommendation 1: The State should explore a wide variety of funding mechanisms that could smooth and speed buyout processes, including municipal/green bonds, revolving loan funds, local option sales taxes, and stormwater utility fees. Special attention should be paid to the inclusive and equitable use of these funding mechanisms at the state and local scale.

A2. Creating a model for estimating costs of designing and implementing a buyout

The lack of systematic cost information to date, and the challenges associated with aggregating such information from alternate sources, such as departmental budgets, also points to the need for better financial data collection standards by FEMA, HUD, and states themselves. Over time, such data would allow for comparison of buyouts across funding mechanisms, support transaction cost evaluations of projects, and enable governments prospectively considering buyouts to better plan and budget for their estimated expenses.

Recommendation 2: The transaction costs associated with buyouts vary widely across the State and around the United States, but they can be substantial. These costs are likely absorbed by municipalities and landowners under current buyout processes. The State's Office of Recovery and Resilience (NCORR) could be instrumental in helping to limit these costs, along with efforts to prioritize and plan for future buyouts across the State.

Recommendation 3: Are communities "subsidizing" federally-funded buyouts through their organizational capacity and staff time? Our research reveals how bad past data are on this topic and

suggests that the State is the only entity in a position to accurately and consistently answer this question. All spending on federal buyout grants – by federal, state, and community sources – should be tracked in detail by the State to better understand transaction costs associated with buyouts and find ways of streamlining buyout processes.

A3. Exploring Private Sector Funding and Implementation of Buyouts

Recent evidence suggests that total spending on buyouts may be large relative to property costs, due to the high transaction costs associated with current buyout programs. Beyond our work in this project, there is also limited information on buyout program efficiency, or lack thereof, including assessing the full costs of floodplain buyouts, and of meeting targeted community, habitat, and hazard mitigation objectives, with respect to federal hazard mitigation programs.

Recommendation 4: Additional work needs to explore the legal hurdles to implementing alternative buyout processes and evaluate how those processes would ensure stronger equitable and environmental outcomes.

Recommendation 5: As part of exploring alternative buyout processes, the State should identify improved methods of calculating avoided loss that include aggregate risk (beyond project itself; e.g., downstream impacts) to determine whether buyouts lower flooding risk and damage elsewhere nearby.

B. Buyouts, Physical Risk Reduction and Development in Floodplains

Our research has shown that development in floodplains continues to occur in North Carolina, even in communities that have participated in buyouts, thus putting more people and property at risk. Widespread development in floodplains has far outpaced removal of flood-prone property through voluntary buyouts. Thus, on the one hand, communities are acquiring and demolishing flood-prone homes to reduce the future risk of flooding. On the other hand, allowing new development in floodplains is counterproductive and sets the stage for future buyouts, in many cases, nearly next door to past buyouts. Our findings suggest that CRS scores (incentives) and existing regulations are only weakly associated with actual reductions in floodplain development. Additional efforts to limit floodplain development through incentives and regulation are needed to manage long-term climate risk.

Recommendation 6: The State should require communities that receiving federal or state grants for buyouts to restrict future residential development in flood hazard areas.

Recommendation 7: The State should take measures to improve its hazard mitigation data collection, management, and dissemination infrastructure. This will 1) facilitate evaluations of mitigation outcomes, 2) improve targeting of public investments to areas of greatest need, and 3) increase transparency and reduce demands on staff time.

Recommendation 8: The State should prioritize and fund establishment of FAIR data standards – ensuring data is *Findable, Accessible, Inter-operable, and Reusable* – for all buyout- and hazard mitigation-related data, creating policies and data use agreements to standardize and curate metadata, streamline researcher and community group access, and enhance accessibility to the public. As part of this, buyouts- and hazard-related data should be stored in a publicly accessible data repository (e.g., UNC Dataverse) that facilitates good user experiences, and easy and effective data dissemination. Ultimately, these actions will save staff time and dramatically lower costs in response to data requests.

7. Implementation Plan / Recommendations

1) The State of North Carolina should explore a wide variety of funding mechanisms that could smooth and speed buyout processes, including municipal/green bonds, revolving loan funds, local option sales taxes, and stormwater utility fees. Special attention should be paid to the inclusive and equitable use of these funding mechanisms at the state and local scale.
Priority: Medium. **Time frame**: Within next 2-3 years.

2) The transaction costs associated with buyouts vary widely across the State and around the United States, but they can be substantial. These costs are likely absorbed by municipalities and landowners under current buyout processes. The State's Office of Recovery and Resilience (NCORR) could be instrumental in helping to limit these costs, along with efforts to prioritize and plan for future buyouts across the State.
Priority: High. **Time frame**: Immediate

3) All spending on federal buyout grants – by federal, state, and community sources – should be tracked in detail by the State to better understand transaction costs associated with buyouts and find ways of streamlining buyout processes. Researchers at UNC can help the State create database tools to accomplish this.
Priority: High. **Time frame**: Immediate

4) Additional work needs to explore the legal hurdles to implementing alternative buyout processes and evaluate how those processes would ensure stronger equitable and environmental outcomes.
Priority: Medium. **Time frame**: Within next 2-3 years

5) As part of exploring alternative buyout processes, the State should identify improved methods of calculating avoided loss that include aggregate risk (beyond project itself; e.g., downstream impacts) to determine whether buyouts lower flooding risk and damage elsewhere nearby.
Priority: High. **Time frame**: Immediate

6) The State should incentivize communities that receive federal or state grants for buyouts to restrict future residential development in flood hazard areas.
Priority: Very high. **Time frame**: Within next 2-3 years

7) The State should take measures to improve its hazard mitigation data collection, management, and dissemination infrastructure. This will 1) facilitate evaluations of mitigation outcomes, 2) improve targeting of public investments to areas of greatest need, and 3) increase transparency and reduce demands on staff time. Researchers at UNC can help the State create database tools to accomplish this.
Priority: High. **Time frame**: Immediate

8) The State should prioritize and fund establishment of FAIR data standards – ensuring data is Findable, Accessible, Inter-operable, and Reusable – for all buyout- and hazard mitigation-related data, creating policies and data use agreements to standardize and curate metadata, streamline researcher and community group access, and enhance accessibility to the public. As part of this, buyouts- and hazard-related data should be stored in a publicly accessible data repository (e.g., UNC Dataverse) that facilitates good user experiences, and easy and effective data dissemination. Ultimately, these actions will save staff time and dramatically lower costs in response to data requests.
Priority: High. **Time frame**: Immediate