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Divergent priorities in flood adaptation

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Abstract

Actions to reduce flood risk often appear to run counter to other societal goals, and resolving these conflicts is important as flood adaptations increasingly transform settlements and societies. Here, we evaluate the tensions between flood risk reduction and other priorities in the context of voluntary buyouts of flood-prone properties in the United States—a controversial flood response to restore land to open space, but with trade-offs. We apply a nation-wide systematic review (133 literature references, 1983–2023) to assess goals stated for buyouts and combine it with a comprehensive media analysis (281 media articles, 1993–2023) to compare those goals to the experiences and results perceived by buyout implementers, residents, and other practitioner groups. Across the systematic-review literature, flood risk reduction dominates goals expressed for buyouts (62.6% of documented goals), and local government predominates in this goal setting (61.7% of documented goals). However, involved and affected actors—especially residents—perceive outcomes beyond flood risk reduction, most notably in the experiences of buyout implementation itself (35.5% of documented resident perceptions) and in results impacting social and economic priorities (49.5%). Despite the difficulties of buyouts, the systematic-review literature largely reflects positive perceived outcomes (79.4% of outcome sentiments, weighing each buyout location equally), but nonprofit organizations and residents perceive largely negative outcomes. Media coverage related to buyouts is more negative than positive but with improved sentiments through time. Our findings point to the importance of designing, implementing, and evaluating flood adaptations not just as flood control measures given their consequences for other societal objectives. The uneven documentation on buyouts also implies opportunities to learn from contexts where buyouts have been integrated into everyday life with little fanfare, through mechanisms either novel or perhaps routine, yielding insights into making ambitious climate adaptations a common, more ordinary, and increasingly imperative occurrence.

1. Introduction

Under intensifying climate change, resolving the conflicts between flood risk reduction and other societal priorities is essential as flood adaptations increasingly transform built environments and landscapes (Clarke *et al* 2018, Glavovic *et al* 2022). However, evaluation of implemented adaptations to date suggests inadequate understanding of how much risk reduction is occurring and how it is affecting other priorities, along with

substantial potential for maladaptive and inadequate adjustments into the future (Berrang-Ford *et al* 2021, Magnan *et al* 2023). To ease adaptation implementation and effectiveness at scale, there is therefore a need to understand, first, what goals are involved in flood adaptation and how different actors perceive the effects of actions taken on these goals (Pringle 2011, EEA 2015, Mathew *et al* 2016). Perceptions of outcomes may differ from measured and monitored data, as well, given psychological and social factors shaping what data are collected and how they are interpreted (Bixler *et al* 2021). The portrayal of the tensions between goals in public narratives also influences policy design, implementation, and participation (Donald *et al* 2022).

Planned relocations and managed retreat from flood-prone areas are among the most controversial adaptation strategies (Mach and Siders 2021). Residents and participants often perceive these measures as pitting social goals of flood risk reduction, safety, and land conservation against other values such as community ties and place attachment (Binder *et al* 2023). In the United States, voluntary buyouts of flood-prone properties have been the most common mechanism of restoring land to open space, thereby reducing flood risk and enabling household relocations (FEMA 2024a). Buyouts do reduce flood risks and can support relocation to safer locations with social and economic opportunities for households. Buyouts, however, also involve many tensions, trade-offs, and conflicts. Most often, they occur post-disaster when households are experiencing emotional, financial, and other stressors; their implementation is often slow and can disrupt families and communities; and despite the requirement of voluntariness, they are sometimes perceived as forced or unfair (Mach *et al* 2019, Kraan *et al* 2021). This diversity of experiences is relevant for understanding how flood risk reduction runs counter to, or aligns with, other societal goals (Pringle 2011, EEA 2015, Mathew *et al* 2016). Understanding the full set of goals that buyouts are perceived as affecting, and how, is crucial for developing more nuanced policies, practices, and assessments.

In this study, we combine a nation-wide systematic review (1983–2023) and comprehensive media analysis (1993–2023) to assess the goals expressed for US property buyouts to date, as compared to the experiences and results perceived as buyouts occur. We compare these stated goals and perceived outcomes across buyout implementers, affected residents, and other practitioner groups. We hypothesize that the goal of flood risk reduction predominates in motivating buyouts—following from the legal, regulatory, and programmatic requirements for use of buyouts by government implementers. However, we anticipate secondary social, economic, and environmental goals also motivate buyouts and become increasingly important in the perception of outcomes, both beneficial and adverse. Further, we expect that buyout funders and implementers, residents, and researchers differ in their emphases and perceptions of buyout goals and outcomes. Our results support these hypotheses yet additionally underscore substantial inequalities in documentation of experiences across residents, buyout funders and implementers, and researchers; further, perceptions of the positives versus negatives of buyouts differ across research versus media articles. Below, we describe the methods of systematic review and media analysis, and we then present our findings for the range and prevalence of stated buyout goals, perceived outcomes, and sentiments about them across the public and private sector and civil society.

2. Materials and methods

Our analysis of flood risk reduction and other societal goals drew from documented examples of voluntary property buyouts across the United States. We combined a systematic review of peer-reviewed literature and studies on buyouts with a comprehensive analysis of media articles reporting on buyouts, while also assessing the geographic coverage of the available documentation.

2.1. Systematic review

At the start of our study, we developed a systematic review protocol adopting method recommendations for systematic reviews of climate adaptations (appendix A; Moher *et al* 2009, Berrang-Ford *et al* 2015, 2021). We used Harzing's Publish or Perish (version 7; Harzing 2007) to search Google Scholar and Web of Science each for the top 1000 English-language articles with the most impact on research (as defined by multiple metrics relevant to the articles and the authors, such as citations per paper and year, contribution to h-index, and search source result order rank; Harzing 2023). For our search terms, we used: (Flood OR Federal Emergency Management Agency (FEMA) OR Department of Housing and Urban Development (HUD) OR floodplain OR post-disaster) AND (voluntary buyout OR buyout OR property acquisition OR building acquisition OR land acquisition OR retreat OR resettlement OR relocation). The search was completed twice, at the start of coding in March 2020 and near its end in October 2023, and it was supplemented by literature previously compiled by the research team and, in some cases, forward and backward citation analysis (figure 1). Identified references were de-duplicated in Zotero (version 5; CDS 2024).

Screening of articles for inclusion in our study consisted of two phases (figure 1). First, SWIFT-Active Screener (version 1; Sciome LLC 2024), an active machine learning screening platform, was used, building

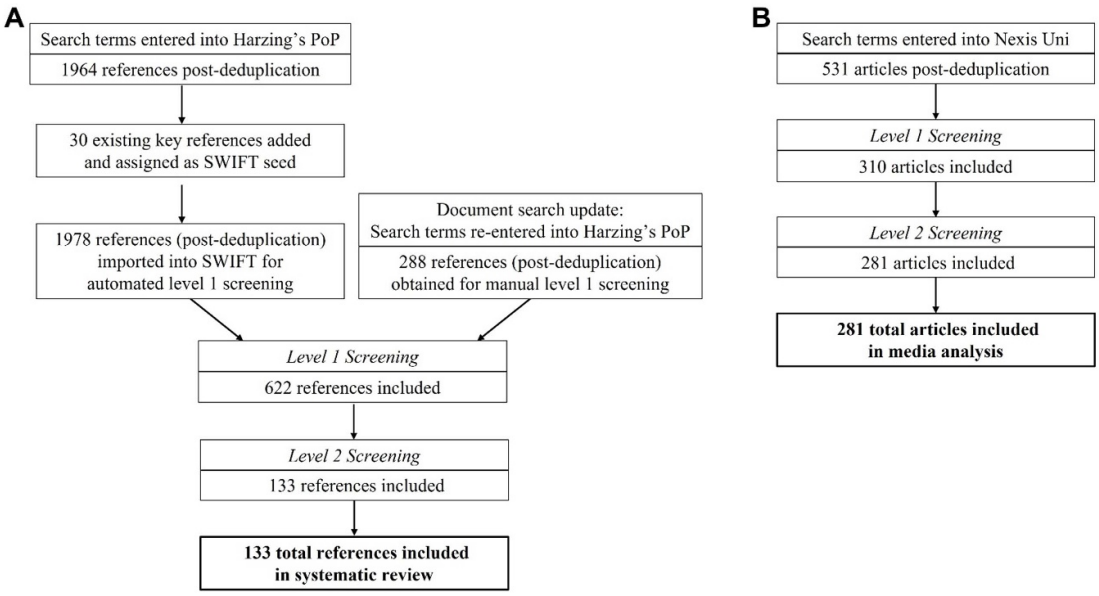

Figure 1. Search and screening process for research and media articles included in this study. (A) Research-literature search and screening process, resulting in 133 literature references included in the systematic review. (B) Media article search and screening process resulting in 281 articles included in the media analysis. Abbreviations: Harzing's PoP—Harzing's Publish or Perish; SWIFT—SWIFT-Active Screener.

from a 'seed' of highly relevant buyouts literature compiled by the research team. This first level of screening retained a paper or study if its title or abstract contained a relevant term: voluntary buyout, buyout, property acquisition, land acquisition, retreat, resettlement, relocation, or US FEMA and/or HUD program for mitigation, flood risk management, floodplain, resilient land use planning, or mitigation strategies. If none of these terms appeared or if the study focused on an area outside of the United States or on a hazard other than flooding, it was excluded. This phase of screening aimed to retain all articles that could be relevant to our systematic review, supported through SWIFT-Active Screener's minimum agreement threshold of 95% (Howard *et al* 2020, Liu *et al* 2024). Second, each retained reference was then manually inspected in full to determine whether it contained substantive information relevant to our coding, including one or more of the following: funding source(s), cost, or size of a buyout project; buyout geography or timeframe; description of methods applied to evaluate buyouts; actors involved in the buyout project; or identified goals or outcomes for the buyout project. In this phase, papers were excluded if there was no specific example of a voluntary buyout project discussed per any of these information categories. This second phase of manual screening was required to definitively confirm the relevance of each paper to our study. Our literature search and screening process yielded 133 references from 1983–2023 (e.g. peer-reviewed scientific-journal articles, FEMA reports and case studies, dissertations, non-journal research studies; appendix B).

A series of questions guided data extraction from the 133 included papers and studies (appendix A). The questions focused on descriptive aspects of the buyout projects (e.g. funding and size, actors involved, geography and timeframe, type of flooding, and methods applied within the study) and on the goals and perceived outcomes relevant to each buyout project. We asked *who* set *what* goal for *whom, who* identified *what* outcome as an impact on *whom*, and *how* and *why* these goals/outcomes were able to be completed or not. The coding occurred at the scale of individual documented locations; a goal or outcome documented in literature sources for a given location counted as 1 documented goal or 1 documented outcome even if it was discussed multiple times in articles for the location. Where data were analyzed by actor, each documented goal or outcome was counted as 1 goal or outcome under each actor relevant (i.e. the actor setting a goal, perceiving an outcome, or being impacted by a goal or outcome). Documented outcomes included experiences occurring during the process and implementation of buyouts and results perceived once buyouts were completed. Perceived outcomes were categorized as positive (e.g. benefits or co-benefits), negative (e.g. adverse side-effects), or neutral. For each question guiding data extraction, codes were informed by existing scholarship and also iteratively developed and refined, allowing for additional themes to emerge (appendix C; Hsieh and Shannon 2005, Creswell 2012, Niemann-Morris et al 2025). A single coder (J.N.-M.) coded all of the data with examples and codes discussed and iteratively adjusted with K.J.M. The coded data were analyzed with chi-square goodness of fit tests.

2.2. Media analysis

Media articles on buyouts were identified through Nexus Uni. We searched four publication types (i.e. newspapers, web-based publications, blogs, magazines and journals) published in the United States through August 2023, via the following search string: flood! AND (home! OR building! OR propert!) AND (buyout! OR acquisition! w/s voluntary) AND NOT eminent. This search string, informed by iterative tests, aimed to identify a reasonable starting sample; 'w/s' required that the word 'voluntary' was within 25 words of a word related to buyout or acquisition, and articles with the phrase 'eminent' were eliminated because its presence resulted in a large number of eminent domain articles outside the context of flood response (e.g. bankruptcies, foreclosures, development-driven acquisitions).

Media articles were then screened for inclusion in our study in two phases and subsequently prepared for analysis (figure 1). First, the article title and preview text were examined for relevance to flood-related, voluntary buyouts or acquisitions of homes, buildings, or properties. Second, each retained article was inspected in full for reporting on flood-related buyout examples and experiences. The resulting 281 media articles spanning 1993–2023 (appendix B) were then cleaned and processed for content analysis. Hyperlinks, citations, advertisements, and email addresses were removed. Within R (version 3.6.1; R Core Team 2019), the quanteda and topicmodels packages were used to preprocess the text data (Grün and Hornik 2011, Benoit *et al* 2018). Stop words (e.g. the, and, is, or) were removed, stemming was applied (e.g. flooding, flooded, and floods all converted to flood), collations were implemented (e.g. New York converted to New_York), and punctuation, numbers, and symbols were deleted.

The processed articles were analyzed through latent Dirichlet allocation (LDA) topic modeling and sentiment analysis. We considered terms occurring with a minimum frequency of 1% across the collective body of text. The number of topics (k), 5, was selected after examining results from the four standard metrics for LDA k selection in the R package LDAtuning (Griffiths and Steyvers 2004, Cao *et al* 2009, Arun *et al* 2010, Deveaud *et al* 2014, Murzintcev 2015, 2020) and coherence measures in the R package topicdoc (Boyd-Graber *et al* 2014, Friedman 2022), combined with qualitative inspection of the top 15 words for each topic, across models generated for 2–20 topics. Significant term and concept overlap occurred for models with more than five topics. We ran the topic model 5 times to increase confidence in generated results. The sentiment analysis applied preset positive and negative terms from the English Opinion Word Lexicon (Hu and Liu 2004), assessing their relative frequency across media articles through time and by topic.

2.3. Geographic coverage

To understand the coverage of buyouts documented in research and media articles, we compared the locations of buyouts included in our study to places where FEMA has funded voluntary property buyouts. In ArcGIS Pro (ESRI 2020), the counties of buyouts in our systematic review and media analysis were compared to buyout locations specified in the OpenFEMA Hazard Mitigation Assistance Mitigated Properties dataset (FEMA 2024b; accessed in April 2024). In this dataset, buyouts were identified as entries marked as acquisition/demolition or acquisition/relocation in the property action field. Buyout locations were classified by county, and buyouts were considered as a whole and for properties where occupants were renters. The occurrence of buyouts was compared at the county level across the data sources through regression analysis. FEMA is not the only agency that funds buyouts, so this dataset underrepresents buyout prevalence. We use the data not to present a complete report of buyout occurrences but rather to illustrate the geographic spread of buyouts relative to studies and media coverage.

3. Results

3.1. Documentation across buyout locations

Diverse buyout locations are reflected in the 133 systematic-review references and the 281 media articles (figure 2; supplementary figure 1). FEMA-funded buyouts from 1989–2023 include 48 190 properties, 2503 of which are rental properties, spanning 1181 counties across 49 US states (all but Hawaii), as well as Puerto Rico, the US Virgin Islands, and Guam. The 133 systematic-review references from 1983–2023 cover buyouts in 185 specific counties and 41 states, and the 281 media articles from 1993–2023 cover buyouts in 100 specific counties and 27 states (including some references and articles focused on entire states but excluding nationwide sources in these tallies).

Locations with more buyouts are better represented in the research literature and media articles on buyouts (figure 2). For the systematic-review literature, the average number of articles for a county increases by one for every 222 FEMA-funded buyouts in the county; for media articles, the average number of articles for a county increases by one for every 263 FEMA-funded buyouts in the county ($p < 0.001$ for both regressions). Much of the systematic-review literature pertains to buyouts in individual counties (median number of counties per paper is 1, with mean of 3.1 and range of 1–119; figure 2; supplementary

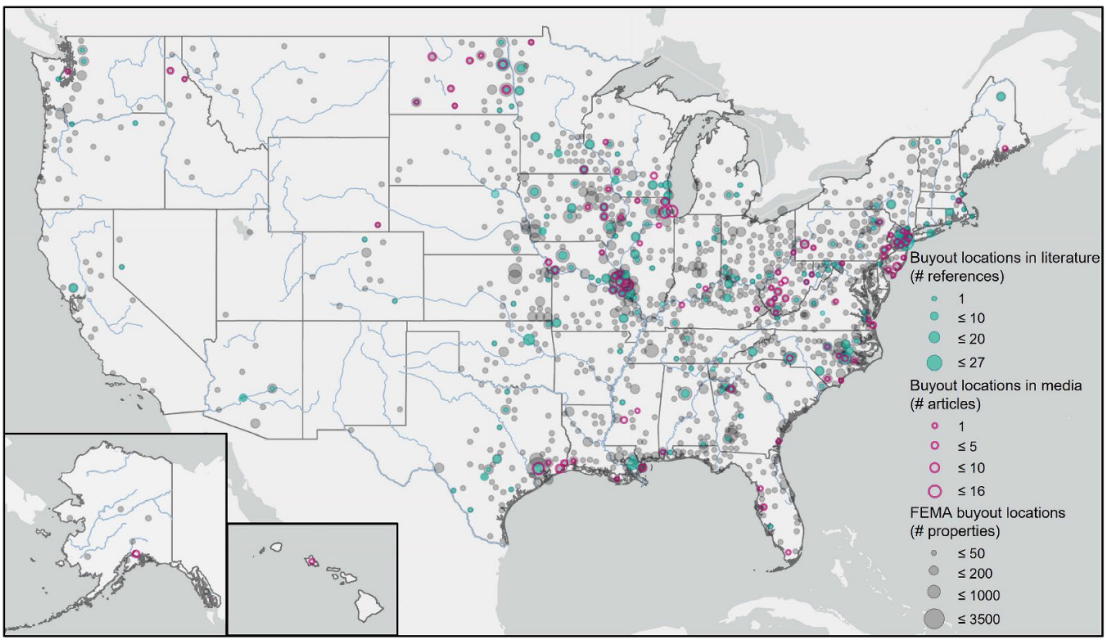

Figure 2. US buyout locations, comparing analyzed documentation to FEMA data. The coverage of buyouts in the systematic-review literature references (blue) and the media articles (pink) is compared, at the county level, to the occurrence of FEMA-funded buyouts (gray). This visualization excludes 11 literature references and 36 media articles that relate to buyouts at a state-wide or national scale.

figure 2(A)). By contrast, 8 counties are covered extensively, with more than 10 systematic-review references for the county (figure 2; supplementary figure 2(B)). The number of systematic-review references for a county is not correlated with the number of media articles for the county ($p = 0.16$). Findings in the sections below therefore reflect research literature and media articles across 250 distinct counties and 45 distinct states, with more representation of locations where more FEMA-funded buyouts have occurred.

3.2. Buyout goals and outcomes in the research literature

Across the systematic-review literature, we document the goals expressed and the outcomes perceived by different actors (figures 3 and 4). Goals are defined as priorities motivating a buyout process from the start: the outcomes that an actor hopes a particular program or buyouts in general will achieve. We refer to goals set as priorities that are articulated or described, not necessarily as goals formally documented at the outset of any given buyout process. Outcomes herein are the outcomes that were actually achieved. Outcomes could directly connect to an initial goal or they could go beyond those initial goals—representing a co-benefit or adverse side-effect not initially anticipated, for example. In the results presented below, we distinguish between who sets a goal versus who is targeted by that goal (e.g. a local government could set a goal relevant to itself or to the experiences of residents) and between who perceives an outcome versus who is impacted by the outcome (e.g. a researcher conducting site observations could perceive an outcome impacting a local government or residents). Wherever a researcher in a systematic-review article directly quotes an actor participating in a buyout process, the expression of a goal or the perception of an outcome is attributed to that actor rather than the researcher. The occurrence of any given goal or outcome in literature sources for a documented location counts as one documented goal or outcome in the tallies reported below, weighing each buyout location equally to correct for varying literature coverage (figure 2; supplementary figure 2). On average, each documented location included reflects 2.0 documented goals (range: 0–14) and 4.9 documented outcomes (range: 0–40).

Across the research literature, goals for buyouts are most often articulated by governments initiating the process, especially local government (61.7% of documented goals set by local government, 15.9% by state government, and 6.1% by federal government, across the systematic-review literature; figure 4(A)). Resident goals for buyouts are much less frequently described in the available systematic-review literature documentation (13.9% of documented goals; figure 4(A)). Here residents include property owners and renters participating in buyouts as well as other residents in affected neighborhoods whether they participate in the buyout or remain in place. Although residents are least likely to articulate goals in the literature, residents are most often the target beneficiaries of the goals that are articulated by others (for 49.6% of all

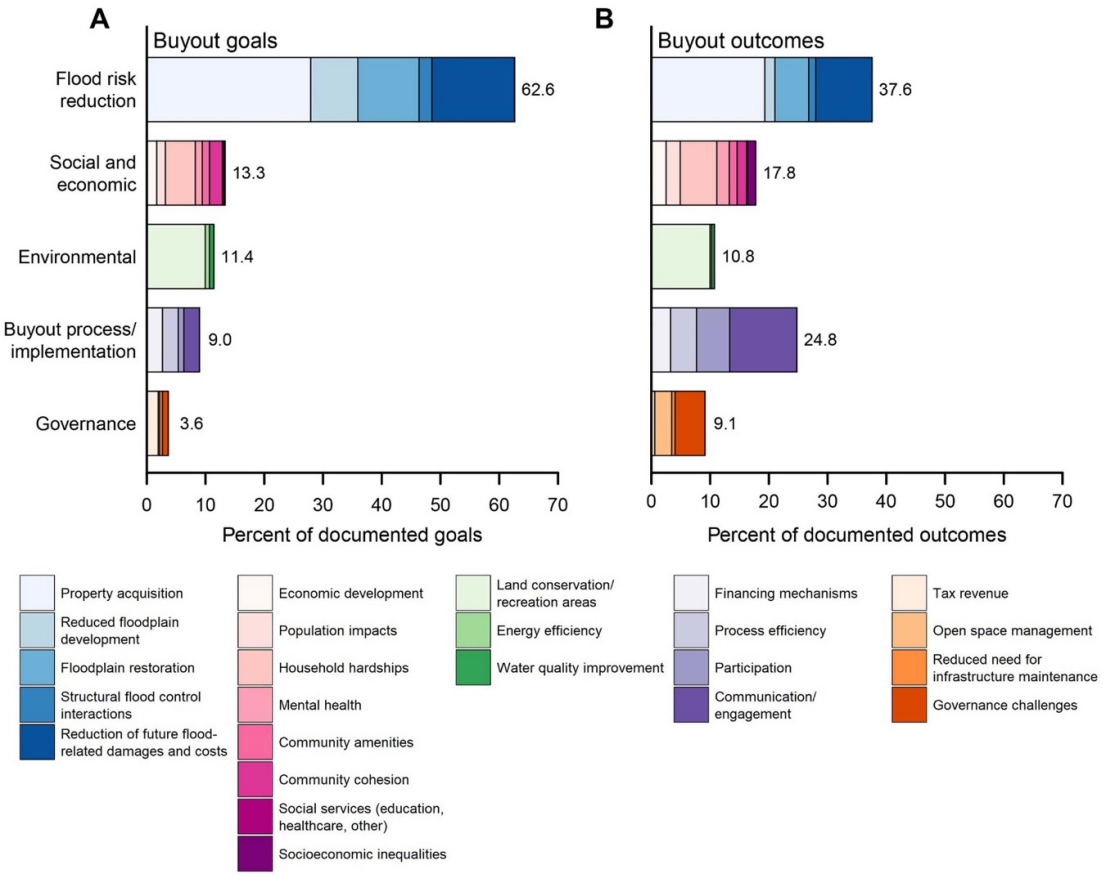

Figure 3. Documented buyout goals and outcomes. Buyout goals expressed (A) and outcomes perceived (B) as documented in the systematic-review literature are categorized as relating to flood risk reduction, social and economic aspects, environmental aspects, buyout process and program implementation, and governance. Percent of documented goals expressed (A) and outcomes perceived (B) is shown across all analyzed references, with a total of 412 documented goals and 1041 documented outcomes. Color gradations (defined in legend below panels) correspond to goal and outcome sub-categories, for which counts and percentages are given in table 1 (see also appendix C). For example, the flood risk reduction category includes subcategories of property acquisition, reduced floodplain development, floodplain restoration, interactions between buyouts and structural flood control measures, and reduction of future flood-related damages and costs.

documented goals, 29.5% arising from local government goalsetting), followed by local government itself (as target beneficiary of 42.1% of all documented goals).

In available documentation, the outcomes of buyouts are most frequently perceived by researchers (i.e. study authors) and the federal government (48.9% and 25.7% of perceived outcomes, respectively; figure 4(B)). This predominance is unsurprising because the case-study information contained in the systematic-review literature is collected and analyzed through methods often initiated and interpreted by researchers or the federal government, including interviews (38.3% of the 133 literature references, each of which could involve one or more methods), quantitative analyses (30.1%), document review (24.1%), surveys (15.0%), direct accounts (13.5%), site visits (6.8%), focus groups (2.3%), and workshops (1.5%). Importantly, though, the actor perceiving any given outcome may not be the actor impacted by it. For outcomes perceived, the actors most frequently impacted, by contrast, are residents and local governments (49.0% and 40.1% of documented outcomes, respectively; figure 4(B)).

Flood risk reduction dominates both the goals articulated for buyouts and the outcomes perceived (figure 3 and table 1). Across the 133 systematic-review references, buyout goals and perceived outcomes differ in their relative prevalence across the categories of flood risk reduction, social and economic aspects, the environment, buyout process/implementation, and governance (supplementary table 1). Flood risk reduction is more prevalent than all other buyout goal and perceived-outcome categories (62.6 and 37.6% of documented goals and outcomes, respectively, figure 3; $p < 0.001$ for all post-hoc pairwise comparisons, supplementary table 1). The predominance of flood risk reduction as an expressed goal for buyouts emerges across actor groups—for example, as 62.0%, 61.5%, and 70.0% of the goals articulated by local, state, and federal government, respectively, and 60.3% of those stated by residents. The goals expressed and outcomes perceived for flood risk reduction closely tie to the buyout process: acquiring flood-prone properties,

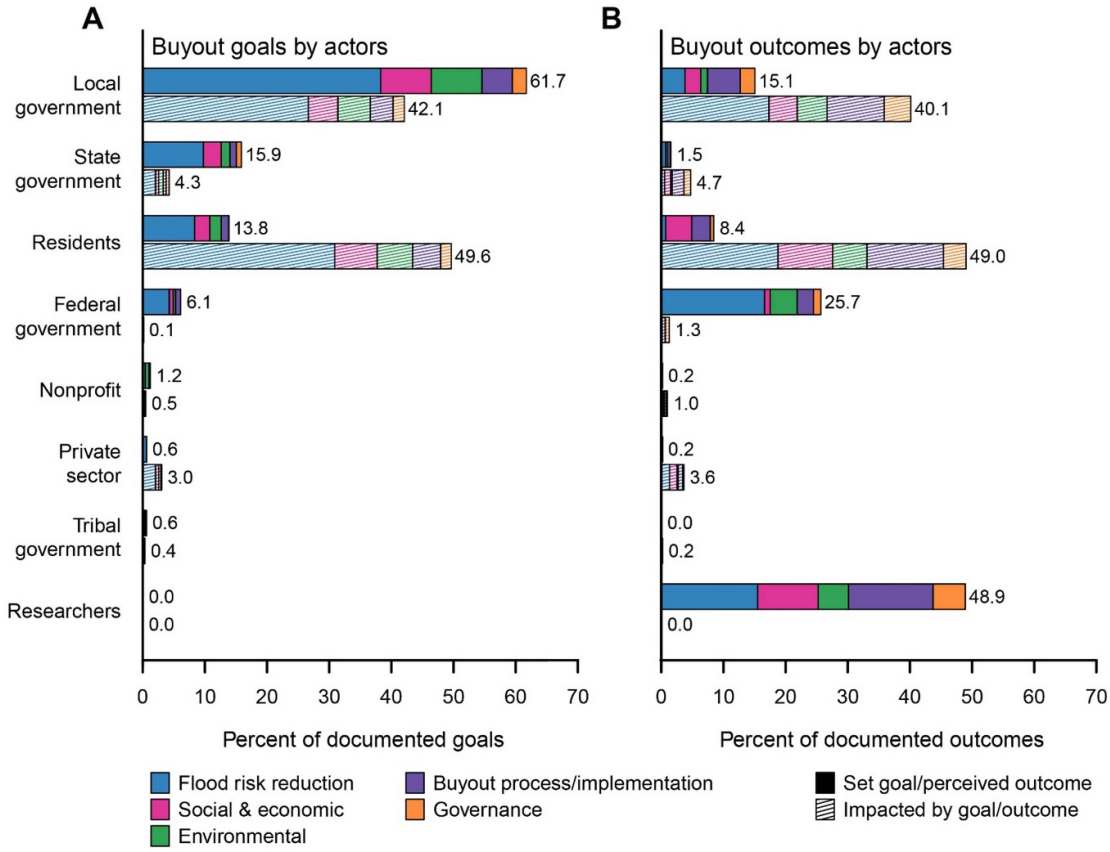

Figure 4. Buyout goals and outcomes across relevant actors. (A) Documented goals across the systematic-review literature, organized by the actors setting the goal (full color), as compared to the actors who would be impacted by the goal (hatched color). (B) Documented outcomes across the systematic-review literature, organized by the actors perceiving the outcome (full color), as compared to the actors impacted by the outcome (hatched color). One or more actors can express, perceive, or be impacted by any given goal or outcome. For example, a local government could articulate a goal relevant to both local government and residents and then perceive outcomes also impacting multiple actors.

including those that repeatedly flood; relocating residents, properties, or even entire communities; reducing the number of people in flood-prone homes and the amount of development in the floodplain; restoring land to an undeveloped state with improved floodplain functions; reducing reliance on flood control structures and improving stormwater management performance; and reducing future flood damages, insurance costs, and post-disaster spending (table 1; appendix C).

Other priorities beyond flood-risk-reduction goals become more prevalent in perceived outcomes, especially for buyout process/implementation and social and economic priorities (24.8% and 17.8% of perceived outcomes, respectively; figure 3(B)). In these perceptions, the shift in focus is apparent for individual actors (figure 4(B)). For example, 34.9% of outcomes perceived by local government pertain to the buyout process and implementation, even though this topic constitutes only 7.9% of goals initially expressed by local government. For residents, perceived outcomes focus heavily on social and economic aspects of buyouts (49.5% of outcomes perceived by residents) and on the experiences of the buyout process itself (35.5%).

The complexities of buyout implementation and lived experiences likely cause the shift from the goals expressed to the outcomes perceived (figures 3 and 4). For example, some goals articulated relate to the buyout process, including shortening its duration (2.2% of documented goals), increasing resident participation (0.7%), meaningfully engaging residents and resolving conflicts (1.5%), and developing financing mechanisms beyond federal funding (1.2%; table 1; appendix C). Outcomes perceived include successful achievement of these goals, but also failures to do so: lengthy buyout processes, lack of offers or replacement housing, or low participation or high attrition (4.7% of documented outcomes) and complaints, negative media coverage, or mistrust of government actions (3.1%; table 1; appendix C). Similarly, aspirational goals for social and economic aspects include supporting economic revitalization or new businesses (1.2% of documented goals), maintaining the population (1.5%), reducing the stress of flooding impacts (1.2%), improving quality of life and revitalizing neighborhoods (1.2%), and supporting sense of community and social networks (2.2%; table 1; appendix C). In many cases, these goals are met, but

Table 1. Buyout goals and perceived outcomes. Categories of goals expressed and outcomes perceived are specified, based on the systematic review of 133 literature references. Goal and outcome prevalence was coded at the granular level specified (appendix C). Note that some perceived outcomes can be negative (e.g. failure to achieve a goal set). The total number of documented instances is given for each expressed goal (n_G) and perceived outcomes (n_O) sub-category, with the corresponding percent of documented goals or outcomes represented by the sub-category specified parenthetically (figure 3).

Buyout process and program implementation			
Sub-category	Granular examples	n_G	n_O
Financing mechanisms	Creation of non-federal financing mechanisms; auction for flood-damaged homes; acquisition with local-government revenues	11 (2.7)	34 (3.3)
Process efficiency	Reduced duration of (versus lengthy) buyout process; replacement housing not available in time for relocated participants; cost-efficiency and cost-effectiveness of interventions	11 (2.7)	46 (4.4)
Participation	High (versus low) participation in buyout program; buyout process initiated by residents (versus by government); buyout implementation supported by community; shortage of buyout offers/funds; initially interested homeowners do not complete buyout process; grant funds returned after acquisition attempts unsuccessful	4 (1.0)	59 (5.7)
Communication/engagement	Meaningful public engagement/deliberation/resolutions; incorporation of local knowledge systems; positive (versus negative) feedback on buyout program; positive (versus negative) media coverage/influences; mistrust of government by residents; actions to reduce political backlash and criticism; increased knowledge of (or knowledge sharing about) buyout process/implementation	11 (2.7)	119 (11.4)
Flood risk reduction			
Sub-category	Granular examples	n_G	n_O
Property acquisition	Acquisition of flood-prone properties (or repeatedly flooded properties); relocation of residents (or properties or community/town); acquisition through land swaps (or lease backs)	115 (27.9)	201 (19.3)
Reduced floodplain development	Fewer people in flood-prone homes; new development outside floodplain; floodplain development restricted (versus not restricted); flood-prone properties purchased for redevelopment; relocation to non-flood-prone areas encouraged; relocation to flood-prone areas	33 (8.0)	18 (1.7)
Floodplain restoration	Restoration of undeveloped land; acquisition of contiguous land (versus not); levee built around holdout properties; floodplain functions improved	43 (10.4)	60 (5.8)
Structural flood control interactions	Reduced reliance on flood control structures; enabling development of flood control structures; supporting integrated flood management systems	9 (2.2)	12 (1.2)
Reduction of future flood-related damages and costs	Reduction of future flood risks and damages; changes in flood insurance costs; reduced needs for future post-disaster spending; gaining and sharing knowledge for future disaster risk reduction	58 (14.1)	100 (9.6)

(Continued.)

Table 1. (Continued.)

Governance			
Sub-category	Granular examples	n_G	n_O
Tax revenue	Maintenance or increase of tax revenue; loss of tax revenue	8 (1.9)	6 (0.6)
Open space management	Planned management of open space; poor, inefficient management of open space	1 (0.2)	30 (2.9)
Reduced infrastructure maintenance	Needs for road maintenance reduced; needs for public utilities maintenance reduced	2 (0.5)	6 (0.6)
Governance challenges	Flexibility for future adjustments; coordination of government (horizontal or vertical); balance of different stakeholder priorities; inaccessible or poor documentation; low landlord participation	4 (1.0)	53 (5.1)
Social and economic aspects			
Sub-category	Granular examples	n_G	n_O
Economic development	Economic revitalization/growth enabled; new businesses and economic opportunities; economic decline; loss of original businesses; properties built with improvements; increase (versus decrease) in property value from new open space; lower accessibility to city center for new homes	7 (1.7)	26 (2.5)
Population impacts	Population retention; population growth; population loss; eventual population recovery	6 (1.5)	25 (2.4)
Household hardships	Fair compensation to homeowners; compensation lower (versus higher) than home value; adequate (versus inadequate) flood-disaster recovery assistance; adequate (versus inadequate) availability of affordable replacement housing; provisions for renters and residents who are not landowners; residents in serious debt after relocation	21 (5.1)	65 (6.2)
Mental health	Reduction of flooding and disaster emotional stress and mental health impacts for residents; reduction (versus increase) of emotional stress and mental health impacts from buyout process and relocation	5 (1.2)	22 (2.1)
Community amenities	Improvement in quality of life from open public space; community-gathering amenities developed; neighborhood revitalization; neighborhood aesthetics declined	5 (1.2)	14 (1.3)
Community cohesion	Maintenance or increase (versus decrease) of sense of community; support of social networks; loss of sense of feeling at home	9 (2.2)	17 (1.6)
Social services (e.g. education, healthcare)	Availability of social services; social services reduced for residents who relocated; schools absent or inadequate in relocation area	1 (0.2)	2 (0.2)
Socioeconomic inequalities	Exacerbation of social and economic inequalities; support of socially vulnerable individuals; relocation to more socially vulnerable areas; most socially vulnerable neighborhoods targeted for property acquisition	1 (0.2)	14 (1.3)
Environmental aspects			
Sub-category	Granular examples	n_G	n_O
Land conservation/recreation areas	Land conservation or preservation; land converted into recreational area	41 (10.0)	104 (10.0)
Energy efficiency	Energy efficiency of new buildings/development	3 (0.7)	3 (0.3)
Water quality improvement	Improved water quality	3 (0.7)	5 (0.5)

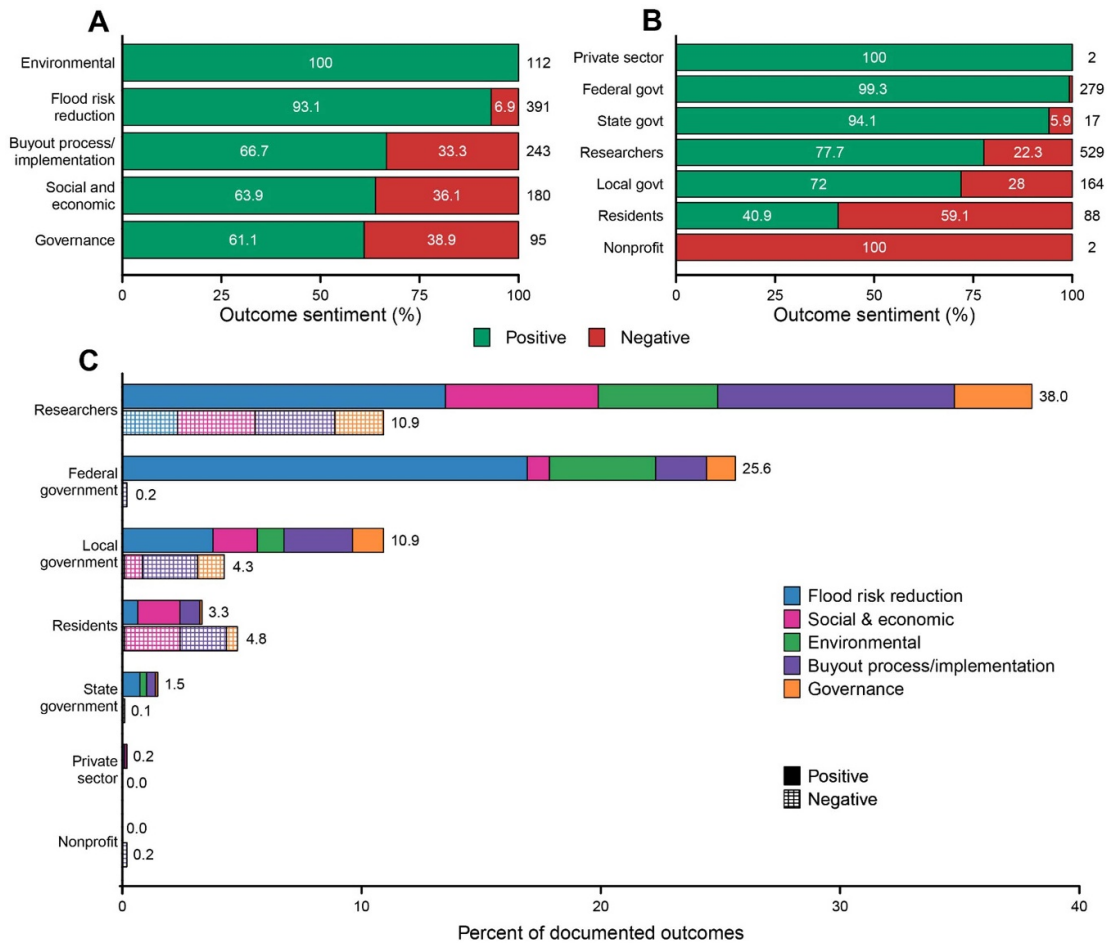

Figure 5. Sentiments associated with buyout outcomes. The occurrence of positive versus negative perceived buyout outcomes across the systematic-review literature is specified for (A) different categories of buyout outcomes, (B) different actors involved with and affected by buyouts, and (C) both actor and outcome categories. The percent of positive versus negative sentiment is specified (white font and *x*-axis) for all outcomes relevant to each category (A) and actor (B); the total number of outcomes relevant for each category or actor is specified at the end of each stacked bar (A), (B). The relative occurrence of positive versus negative sentiment is delineated by both actor and outcome category in (C). A small number of neutral outcomes is excluded from this figure. For example, of the 1041 documented outcomes relevant across categories in (A), 20 neutral outcomes are excluded in the visualization from the social and economic and buyout process/implementation categories. Further, one or more actors can perceive any given outcome (B), (C).

in others they are not, and instead outcomes perceived involve economic decline or decreases in property values (0.6% of documented outcomes); population loss (0.7%); inadequate compensation, assistance, or affordable housing (2.1%); or increased stress from flooding and relocation, decreased sense of community and home, or exacerbated social and economic inequalities (2.0%; table 1; appendix C).

A range of enablers and barriers explain how expressed goals and other co-benefits from buyouts materialize in some cases but not in others (supplementary table 2). These factors include the occurrence of buyouts, most often, in the urgency of the post-disaster window yet through a lengthy buyout process; the importance of multi-step financial interactions and the sometimes-realized potential for incentives to address challenges; the key role of government engagement, informational resources, relationships, community support, and aligned versus misaligned perspectives and priorities; opportunities for planning, policies, and implementation support; a frequent lack of adequate replacement housing; the diversity of possible land uses post-buyout; and the ways in which learning by doing through time and across contexts supports improved buyout processes (supplementary table 2).

The systematic-review literature largely reflects positive sentiment in perceived outcomes (79.4% of outcome sentiments; figure 5(A)). However, notable differences in sentiments exist across categories of outcomes and across actors (figure 5). The sentiment about perceived outcomes is overwhelmingly positive for environmental aspects and flood risk reduction (100.0% and 93.1% of outcome sentiments in these categories; figure 5(A)). It is mixed for the other categories of buyout process/implementation (66.7% positive sentiment), social and economic aspects (63.9%), and governance (61.1%). These differences in outcome sentiments link, additionally, to the actors perceiving the outcomes. In documented perceptions

Table 2. Main topics in media articles about buyouts. Five topics were identified across the 281 media articles through latent Dirichlet allocation topic modeling. Topics are listed by their rank in the media collection overall (with percent of the corpus of text relevant to the topic) and by the number of articles with the topic as primary topic (with percent of the articles). The top 15 words for each topic are specified.

Topic, with top terms			Rank within media collection (% of corpus)	# Articles with this primary topic in media collection (% of articles)
Topic 1(voluntary property buyout program process)			1 (28%)	91 (32%)
Buyout	Home	County	Property	Fund
City	Homeowner	Grant	Flood	Program
State	FEMA	Damage	Purchase	Voluntary
Topic 2 (people and relationships to staying/leaving)			2 (22%)	58 (21%)
Home	House	Flood	Resident	Live
Move	People	Buyout	Leave	Buy
Neighborhood	Offer	Place	Stay	Family
Topic 3 (flood control and risk management)			3 (18%)	43 (15%)
Flood	Project	River	Water	Build
Levee	Rain	Park	Lake	Creek
Floodplain	Engineer	Plan	Flood control	Solution
Topic 4 (flood insurance)			4 (18%)	37 (13%)
Property	Flood	FEMA	Community	Flood insurance
Program	Cost	Policy	Mitigation	Government
Reduce	Loss	Claim	Pay	Rate
Topic 5 (flood-risk plans and strategies)			5 (15%)	52 (19%)
Community	State	City	Storm	Coastal
Plan	Fund	Project	Risk	Infrastructure
Impact	Climate change	Development	Protect	Rebuild

across actors (figure 5(B)), local governments perceive positive outcomes 72.0% of the time, researchers 77.7% of the time, state and federal government 94.1% and 99.3% of the time, respectively, and the private sector 100% of the time (although it is less represented; figure 5(C)). By contrast, nonprofit organizations, also much less well represented (figure 5(C)), reflect only negative documented perceptions of outcomes, and residents perceive negative outcomes 59.1% of the time.

3.3. Buyout topics and sentiments in the media

The media articles about buyouts reflect five main topics related to buyout experiences and flood responses (table 2, supplementary table 3). The five main topics of interest, both across the media text overall and as the primary topics within articles, are (1) the voluntary property buyout program process (most prevalent across all media text; primary topic of 32.4% of media articles); (2) people and their relationships to staying or leaving through buyouts (second most prevalent; primary topic of 20.6% of media articles); (3) flood control and risk management (third most prevalent; primary topic of 15.3% of media articles); (4) flood insurance (fourth most prevalent; primary topic of 13.2% of media articles); and (5) flood-risk plans and strategies for both recovery and future preparedness (fifth most prevalent; primary topic of 18.5% of media articles). The topics can be illustrated as follows:

- The first topic pertains to the steps of the buyout program process (e.g. applications, grants, offers and purchases, demolition), and the actors involved (e.g. homeowners and residents, government from local to federal levels). For example, media article 2 discusses 'an associate planner in [St. Charles] county's Planning Department…preparing an application to the FEMA for a grant to finance the program' for buyouts (supplementary table 3).
- The second topic includes the residents involved in and impacted by buyouts and their experiences and relationships to the decisions they make. For instance, media article 20 explains, 'The grief is not limited to those left behind…People who moved were faced with difficult choices as well' (supplementary table 3).

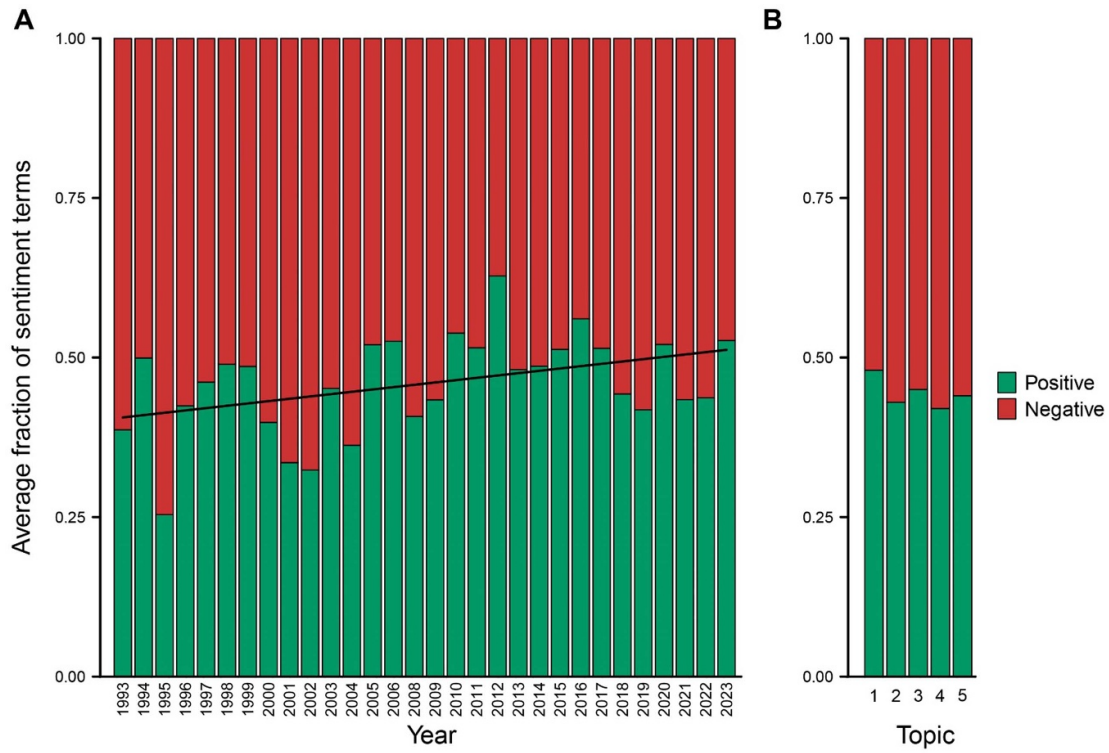

Figure 6. Sentiments in newspaper media articles discussing buyouts. (A) The average fractions of sentiment terms that are positive versus negative in media articles (1993–2023) covering buyouts. Regression line with slope of 0.0035 ($p = 0.02$) is shown. (B) The average sentiment for each identified topic in media articles covering buyouts. The topics are as follows (table 2): 1—voluntary property buyout program process; 2—people and their relationships to staying or leaving; 3—flood control and risk management; 4—flood insurance; 5—flood-risk plans and strategies.

- The third topic focuses on different types of flood hazards that can lead to property buyouts and the interacting options for managing the risks. As one example, media article 85 compares options: 'The "A" list includes installing a pumping station and drainage swales…. The "B" list includes acquiring homes in the flood plain either through voluntary buyouts or condemnation' (supplementary table 3).
- The fourth topic discusses the government agencies and processes shaping flood insurance with implications for buyouts. For example, media article 53 specifies that 'people who live in high-risk areas should no longer have their flood insurance subsidized by the government' (supplementary table 3).
- The final topic considers the range of planning and study processes relevant to flood recovery and future preparedness. In this topic area, past experiences often connect to longer-term future strategies. For instance, media article 271 states, 'Louisiana's Comprehensive Master Plan for a Sustainable Coast is a 50 year plan for reducing flood risk and preventing land loss, with six billion dollars allocated towards nonstructural flood risk reduction measures such as elevating homes, floodproofing commercial properties and buying out high-risk assets through voluntary acquisitions' (supplementary table 3).

Sentiments within media articles about buyouts are more negative than positive, yet have improved through time (figure 6). Whereas the sentiment analysis for buyout outcomes in the literature systematic review (see section 3.2) considers each outcome individually, the sentiment analysis for the media articles considers the presence of positive and negative terms across the media articles overall (see section 2.2). 60.1% of the media articles (169 articles) have more negative sentiment than positive (i.e. >50% negative sentiment), and the mean negative sentiment across all media articles is 53.1% negative sentiment (range: 0–100%). From 1993–2023, media articles have trended slowly towards increased positive sentiment over time (figure 6(A)).

An example of positive sentiment includes the characterization of media article 120: 'Greg Stone calls what's happening on Dunloup Creek "the most exciting watershed project in 30 years."…He recently met a family that included a wife who is pregnant with twins. The family has been living in a home with a mold problem from a previous flood. They were happy to be able to move away from any future floods' (supplementary table 4). By contrast, negative sentiments often reflect the experiences of both flooding and responses. For example, media article 89 states, 'Trying to get help after a flood is hard—maybe even harder than going through the flood itself, say metro residents who lost appliances, antiques, automobiles, wedding pictures, Persian rugs and homes as soggy remnants of hurricanes Ivan, Frances and Jeanne blew through

Georgia' (supplementary table 4). The media topics identified (table 2) do not significantly differ in their average relative sentiment, all reflecting both positive and negative sentiments and a bit more negative than positive (figure 6(B); supplementary table 4).

4. Discussion

As a central dilemma in flood adaptations to date, actions to reduce flood risk can, often inadvertently, appear to run counter to other societal priorities and objectives. We have examined the difference between expressed goals and perceived outcomes in the wide-ranging documentation available for voluntary buyouts of flood-prone properties across the United States (figure 2). In restoring land to open space, buyouts reduce flood exposures and hazards, but they also disrupt family and community well-being and ties—between people and the places they call home. We find, unsurprisingly, that flood risk reduction is the dominant goal expressed in the design and implementation of buyouts, across available documentation (figure 3(A)). Local governments initiating buyouts predominate in this goal setting phase (figure 4(A)). But residents at the center of the lived experiences of buyouts have different documented perceptions of outcomes in going through the entirety of the buyout process and the ways it can disrupt local economies, household finances, and the neighborhoods, communities, and services supporting daily life (figures 4(B) and 5, table 1). Our findings based on available literature and media articles have implications for (1) understanding differences in experiences between adaptation funders/implementers and residents, (2) managing multiple goals and adaptations that cause harms as well as benefits, and (3) reflecting on positivistic biases in available documentation and learned lessons that may be missed as a result. We discuss these three themes of differential experiences, multifaceted goals, and positivistic biases here in turn.

4.1. Differing experiences in flood adaptation

The different experiences of different actors involved in buyouts may explain how and why actions to reduce flood risk encounter obstacles. The differences interrelate with who designs and implements buyouts versus who experiences the results of those decisions, underscoring the importance of the buyout process and the participation of different actors across each stage. At the outset, different actor groups similarly express the goal of flood risk reduction as their primary aim for buyouts, across available documentation (figure 4(A)). Perceptions of the outcomes of buyouts, however, reveal much greater emphasis on social and economic, environmental, governance, and process aspects, for all actor groups except the federal government (figure 4(B)). There are also substantial differences in how well the perspectives of different actors are documented in the literature references focused on buyouts, which favor local governments, the federal government, and researchers (figure 4). The perspectives of residents, nonprofit organizations, the private sector, and tribal governments, by contrast, are much less well represented. This difference in documentation is notable given that resident perceptions of buyout outcomes (and the few nonprofit perceptions that are documented) are much more negative than the perceptions of other actor groups (figure 5). And it also may contribute to more negative than positive sentiment in media coverage discussing buyouts in the context of flood risks and responses (figure 6). Such differential experiences, interlinked with wealth and political influence, can also contribute to feedbacks in where infrastructure investments versus retreat occurs, leading to inequalities in flood exposure, disaster risk, and climate-related migration (Woodruff *et al* 2018, Siders and Keenan 2020, Shi *et al* 2021). In this study, we have evaluated goals expressed and outcomes stated—not attempting to compare these perspectives and perceptions to empirical data on each buyout context. For the predominating goal of flood risk reduction, existing estimates have underscored the losses and damages avoided and the cost-effectiveness of buyouts in many cases, at the same time that case-based evaluations indicate that some residents move to locations that are also flood prone, therefore not reducing flood risk at the household scale (FEMA and USACE 2000, FEMA 2001, 2013, 2017, White 2014, McGhee 2017). The comparisons of perceptions versus actualities are likely more complex across other societal priorities.

4.2. Multiple goals and complex outcomes in flood adaptation

Coordination of climate adaptation increasingly involves attention to the multifaceted consequences of interventions (table 1; Mach *et al* 2022). For example, maintaining or restoring land to pervious surfaces through buyouts can yield a range of benefits; it can increase absorption of floodwaters, reduce asset exposure to flooding, mitigate urban heat islands, create recreational opportunities, support biodiversity, and improve mental health and emotional well-being (table 1; appendix C). Two challenges arise, however. First, adaptive measures such as voluntary property buyouts and managed retreat often entail a duality of both harms and benefits experienced differently across a population and even within individuals over time (figure 6, Mach and Siders 2021, McNamara *et al* 2018). For instance, restoring land to open space can also involve psychological, sociocultural, and economic harms to families who feel displaced from their homes or

communities or for neighborhoods that gentrify and no longer remain affordable for low- or moderate-income households (table 1, appendix C, Anguelovski *et al* 2016, Gould and Lewis 2018, Triguero-Mas *et al* 2022, Binder *et al* 2023, Anguelovski *et al* 2024). Second, the emergence of climate adaptation from agencies of government focused on emergency management, flood control, and public works has often biased adaptation design and implementation towards pre-existing institutions and skill sets relevant to post-disaster contexts and engineering projects and marvels (Mach *et al* 2022). Framing home buyouts and household relocation as a post-disaster, engineering-informed risk-reduction measure, however, means that implementation may not provide adequate human and social services responsive to the challenges of identifying and moving into new housing, neighborhoods, and healthcare and school systems, while retaining community attributes important to individuals and families and buffering the financial and psychosocial impacts of relocation. We observe modest improvements in sentiments in media coverage related to buyouts through time, potentially suggesting some progress in managing flood damages and the challenges of responses including buyouts (figure 6). The findings of this study align with an increasing emphasis on coordinating adaptive actions across agencies of government to more holistically design and implement actions that are desired by communities and that, on the whole and individually, advance the benefits over the harms (Brown *et al* 2012, Oberlack 2017, Lubell and Morrison 2021, Mach *et al* 2024). This coordination often requires innovations in institutional mandates and mechanisms, financing, and public–private collaborations (Vella *et al* 2016, Ruppert and Deady 2017, Martín and McTarnaghan 2018, Fastiggi *et al* 2021, McTarnaghan *et al* 2022).

4.3. Positivistic biases and their implications

Documentation on buyouts is highly uneven, with potential positivistic biases arising from what is known versus not (figure 2 and supplementary figures 1 and 2). Although buyouts have occurred in 1181 counties across the United States, in-depth study is available in only 185 counties, and media coverage in 100 counties (figure 2 and supplementary figure 1). Literature and media coverage generally increases with the number of buyouts that have occurred, but again unevenly, with 69.2% of documented counties having a single paper pertaining to the county, yet 4.3% having more than 10 studies focused on them and one location (Richmond County, New York) with 27 studies on it. Further, the experiences of renters going through buyouts, who may experience the process as involuntary, are also under documented (supplementary figure 1). Even in locations with research-literature or media coverage, only a limited number of perspectives is portrayed, and those perspectives may not be representative of the broader communities experiencing buyouts.

These types of biases in research and evidence are common across the climate risk and adaptation fields (Hansen and Cramer 2015, Berrang-Ford *et al* 2021), and they are important to interrogate in reflecting on the state of current understanding. For example, research on floodplain avoidance—proactive avoidance of development in floodplains—suggests that societal attention and adaptation research alike have often missed the greatest success stories, the places that avoided flood damages from the outset, instead paying disproportionate attention to the municipalities that built out their floodplains, experienced devastating floods, and then did better—or not (Agopian *et al* 2024, Siders *et al* 2024). And these largely missed floodplain-avoidance success stories may often reflect straightforward recipes for flood adaptation: consistent implementation over time of a few different types of common legal and regulatory tools (Siders *et al* 2024). Similarly for retreat, the existing biases in buyout locations studied versus not raise questions. Heavily studied locations and locations with intense public or media coverage are often unique for one or more reasons, for example because they are highly urbanized yet still chose retreat, have established a local funding mechanism independent of federal grants, have attracted unusual community support or organization, have involved an entire town relocating together through house-by-house buyouts, or have been exceptionally poorly received (de Jong 1995, Henze 1995, Conrad 1998, Fraser *et al* 2004, p 200, McCann 2006, de Vries 2007, Waite 2011, Binder and Greer 2016, Koslov 2016, 2014, Greer and Brokopp Binder 2017, Rohmer 2017, Salvesen *et al* 2018, Plastrik and Cleveland 2019, Pappas and Flatt 2021, Peterson *et al* 2020, Spidalieri *et al* 2020, Aidoo 2021, Enriquez 2021, Kodis *et al* 2021, Shi *et al* 2022, Cardwell 2023). It is possible, perhaps counterintuitively, that missing locations in current documentation may be more representative of experiences with buyouts to date, and experiences among those missing cases may be less divergent than the cases covered in this study. If in these locations buyouts have gone more unnoticed, they may also provide lessons on better integrating buyouts with the full range of goals and aspirations that exist.

5. Conclusion

In the years ahead, adaptations to intensifying flood hazards will increasingly transform built environments and ways of life. To ensure that societies desire the transformations and find them just, adaptations must address a core challenge limiting their effectiveness to date: actions to reduce flood risk have often appeared

to run counter to other societal goals. We have assessed the tensions between flood risk reduction and other social goals here in the context of voluntary property buyouts, a form of managed retreat often perceived to place goals of flood risk reduction and conservation above community well-being and place attachment. Based on available documentation, we find that the difference between goals expressed and outcomes perceived is stark for buyout funders and implementers versus the residents impacted—those choosing to take a buyout or those instead remaining in the neighborhood. Whereas government (federal, state, local), researchers, and the private sector have largely positive sentiments about the outcomes of buyouts, residents, nonprofit organizations, and broader media coverage do not. Instead, they emphasize the process of buyouts, which can be long and arduous, and the social and economic impacts of buyouts, which can adversely affect local economies and household finances, neighborhood aesthetics and community cohesion, and existing inequities in societies. These findings point to the importance of designing and implementing buyouts and flood adaptations not just as flood control measures, but instead as integrated housing, land use, government services, and climate resilience initiatives. They also underscore the need for multifaceted evaluation of flood risk reduction in combination with other objectives, both at project and at aggregate scales. The uneven availability of documentation on buyouts further suggests opportunities to study and learn from the myriad contexts where buyouts have occurred, often at modest scales outside of major urban centers. Understanding where and how buyouts have been integrated into everyday life, through mechanisms either novel or perhaps routine, can yield key insights into making ambitious climate adaptations a common, more ordinary, and increasingly imperative occurrence.

Data availability statement

The data that support the findings of this study are openly available at the following URL/DOI: https://doi.org/10.17603/ds2-87vc-b903. Data will be available from 1 August 2025.

Conflict of interest

KJM is a member of the Executive Editorial Board for *Environmental Research: Climate* and is blinded from reviewing or making decisions for the manuscript. The authors have no other competing interests or conflicts to declare.

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