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3 **Socioeconomic Implications of National Flood Insurance Policy**

4 **Reform and Flood Insurance Rate Map Revisions**

5 by

6 Dr. Tim Frazier, Tim.Frazier@georgetown.edu

7 and

8 Elizabeth E. Boyden, eboyden04@gmail.com

9 and

10 Erik Wood, exw6@georgetown.edu (corresponding author)

11 +1 206 931 5271

12 <https://orcid.org/0000-0003-0531-6314>

13 in affiliation with Georgetown University

14 640 Massachusetts Ave NW, Washington, DC 20001

Abstract

Flooding exacerbated by climate change has resulted in more mandatory community participation in the Federal Emergency Management Agency (FEMA) National Flood Insurance Program (NFIP). The purpose of this research is social regulatory floodplain criteria that may have an impact on various socioeconomic factors at the county and sub-county level. Updated mapping can result in widespread changes to the NFIP Special Flood Hazard Area, while no socioeconomic vulnerability assessments are completed before changes in risk designation or subsidy elimination occurs. These changes can result in additional compulsory flood insurance policies, heightened policy costs, and ultimately produce socioeconomic barriers for lower-income residents. The objectives include demonstrating the potential nationwide implications of increasing community risk with these changes to national policy through a case study from Ada County, Idaho where FEMA began updating the floodplain maps in 2015. Ada County was chosen for being reflective of other communities that may be suffering similar impacts from NFIP policy. A sequential explanatory mixed-methods approach was employed using semi-structured interviews, spatial analysis, and the Spatially Explicit Resilience-Vulnerability (SERV) model to assess potential community impacts. Results indicate increased vulnerability in the revised floodplain. Total annual sales volume, employee numbers, industry sectors, and overall community vulnerability are higher in the revised floodplain. Interviews with community leaders corroborated these results. This case study provides a foundation for further research on the impacts of flood insurance on communities across the United States while discussing the social injustice of a national program that is likely promoting the upward distribution of wealth county by county.

Keywords: NFIP, FEMA, flood insurance, socioeconomic, community vulnerability, SERV-model, social justice

1. Introduction

Floods accounted for approximately 43 percent of natural disasters between 1994 and 2013, with significant increases in reported losses in recent years (Guha-Sapir et al., 2013; CRED, 2015). These events affected a greater proportion of the global population than all other types of natural disasters combined (CRED, 2015). For the period 1993 to 2013, flood losses totaled more than US\$636 billion, accounting for 25 percent of all reported natural disaster-related economic losses (CRED, 2015). In the United States (US) alone, the federal government paid out over US\$50 billion in flood insurance claims from 1978 to 2015 (FEMA, 2016). Featuring sixteen different billion-dollar events, 2017 was the costliest year on record for meteorological and climate force multiplied disasters (Smith, 2018). Beyond monetary payouts, floods have a myriad of impacts on affected communities. Floods regularly cause property and content damage, population displacement, loss of life, direct and indirect business interruption, neighborhood instability, and regional economic losses. “Higher premiums can also increase the real costs associated with owning property in flood-prone areas, thus affecting the ability of income challenged property owners to realize reasonable returns on investment should they wish to relocate to less flood-prone locations.” (Shively, 2017). Such impacts are expected to increase over the next century due to an increase in the frequency and magnitude of flood events coincident with climate change and development in flood-prone areas (IPCC, 2013; Lo, 2013). “Climate change will increase the frequency and severity of flooding due to several factors including more frequent and violent storms, extreme precipitation events accelerating sea level rise, and greater storm surge, resulting in increased flooding and subsequently flood losses”

(Mcshane and Yusuf, 2019). The NFIP attempts to transfer most of the risk from flooding away from property owners and toward the Federal government with insurance as the vehicle. Nationally varied flood risks create an insurance premium pool that can, in theory, absorb the shocks to its system and remain solvent (Shively, 2017). “But where the risk, necessity, and cost of participation in such pools are likely to increase (e.g., climate change-forced flooding), this invokes important questions and concerns for social justice - primarily in a distributional sense - inordinately affecting income-challenged participants” (Shively, 2017). For the purposes herein, this paper defines social justice as an equitable distribution of (and access to) resources, programs, and opportunities that add to community resiliency. This concern about socioeconomically discriminating NFIP mapping updates in the face of climate change is common in recent literature (Adger et al., 2013; Shively, 2017; Smith 2018; Mcshane and Yusuf, 2019; Pralle, 2019).

The widespread risk of floods is a result of historical development in physically-vulnerable locations. Often, settlement occurred in flood-prone areas to exploit fertile land and to take advantage of waterways as transportation corridors and commercially strategic locations (Frazier et al., 2010). Coincident with population growth and development in floodplains, flood losses increased through the 20th century. As a result, the US Congress instituted the National Flood Insurance Act (NFIA) of 1968 to create and empower the NFIP which facilitated the installment and adoption of flood insurance in communities that voluntarily adopted and enforced floodplain management ordinances for new development within the 100-year floodplain, also known as the Special Flood Hazard Area (SFHA) (Kunreuther and Roth, 1998).

The NFIP has undergone period legislative amendments and changes since FEMA assumed control in 1979. The most significant change to the program was the requiring of flood

insurance for federally-backed properties located in the SFHA. Recent amendments and regulatory changes to the program, such as the 2012 Biggert-Waters Act and 2014 Homeowner Flood Insurance Affordability Act, have resulted in increased flood insurance premiums for both residential and commercial properties. These and future increases in premium rates are expected to bring insurance policies in line with true actuarial rates that more accurately reflect flood risk.

Outdated Flood Insurance Rate Maps (FIRMs) were prohibited following the Biggert-Waters Act. FIRMs delineate the SFHA and risk premium zones in communities and form using Flood Insurance Studies that compile flood risk data such as river flow, storm tides, climatological and meteorological conditions, topography, flood-control works, and more (FEMA, 2011). FEMA was therefore required to remap SFHAs across the country. Property owners located in the updated SFHA are now required to purchase flood insurance where they were not required to do so beforehand. Previous research showed that properties located in the SFHA could experience depreciated values, which in turn can decrease the overall community tax base and possibly even drive population displacement (Nance, 2015; Shively, 2017). “Where FEMA declares the floodplain to lie can directly influence the valuation of homes” (Howard, 2016). Despite these potential impacts on communities, little attention has been paid to either policy reforms, floodplain revisions, or updates relative to the potential socioeconomic impacts.

In 2010, FEMA Region X determined that the Lower Boise Watershed, located in the southwest corner of the State of Idaho, was eligible for a Physical Map Revision through its Risk Mapping, Assessment, and Planning program (Risk MAP). Risk MAP is the primary means employed by FEMA to provide communities with updated and revised flood data and information. The Risk MAP process began in the Lower Boise Watershed following recent flood insurance claims in low-risk flood areas. Further prompting the revisions were scattered Letters

of Map Amendments (LOMAs; issued when a property was inadvertently mapped in the floodplain), and a study performed by the US Army Corps of Engineers (USACE) that found no federally-compliant levees. These factors significantly altered the SFHA for portions of the watershed, however, there was little analysis on the potential impacts stemming from the revisions in conjunction with recent flood policy reform to the communities within the watershed.

The case study research presented here aims to analyze how revisions to the SFHA impacts communities. This effort focuses on the socioeconomic impacts of vulnerable populations through a case study in Ada County, Idaho. Research presented here analyzed the spatial differences between the former SFHA and revised SFHA within the county, and hypothesized that the revised SFHA would show large additions throughout the study area, with increases in socioeconomically-vulnerable populations and businesses located in the floodplain. To address this hypothesis, this case study addressed the following questions:

- What revisions were made to the SFHA along the Boise River in Ada County, Idaho?
- What populations and businesses were exposed in the former and revised SFHA?
- What are the changes in economic sectors between the former and revised SFHA?
- What are the changes in socioeconomic vulnerability between the former and revised SFHA?
- How do community leaders and businesses perceive the potential impacts of the SFHA revisions?

For our work, researchers developed a framework employing a Geographical Information System (GIS) to evaluate the community impacts of the SFHA revisions. This research used multi-scalar economic datasets to assess potential impacts on specific economic sectors and

industries within the county, and employed the Spatially Explicit Resilience-Vulnerability (SERV) model developed by Frazier et al. (2013) to assess community vulnerability. Finally, stakeholder engagement through semi-structured interviews explored how community leaders perceived impacts from the floodplain revisions.

2. Background

2.1 The National Flood Insurance Program & Regulatory Floodplain Revisions

The NFIP made flood insurance available to communities that agreed to adopt and enforce floodplain management ordinances, which were often implemented through hazard mitigation planning, site design, construction standards, and land use regulations. The NFIP was based on the premise that populations located in flood-prone areas (e.g., the SFHA) should bear a substantial portion of the cost to reduce community vulnerability, and should likewise bear responsibility for most of the losses should the community experience a flood disaster (Kunreuther and Roth, 1998). By stipulating community mitigation efforts and offering flood insurance at full-risk (i.e., full actuarial) rates for properties located in flood-prone areas, the NFIP was originally thought to limit construction in the floodplain and reduce uneconomic uses of flood-prone areas by increasing costs (Burby, 2001). However, creating the FIRMs has continuously proven to be an almost insurmountable task. Due to the level of effort, cost, and time involved in the initial mapping, federal officials questioned the economic and temporal feasibility of full-risk flood insurance, resulting in subsidized insurance premiums for those with properties built before the implementation of a FIRM. Owners of these pre-FIRM structures were not required to pay the full actuarially risk premiums, and it was initially believed that these subsidies would decline over time (Burby, 2001), but this has not happened.

Following Hurricane Katrina in 2005, the NFIP paid out more claims than it paid out over the lifetime of the program up to that point and there was considerable public pressure for NFIP reforms (Strother, 2018). These payouts put the program into debt, which was then deepened by Hurricane Ike in 2008 and Hurricane Sandy in 2012. In December 2013, the NFIP was \$24 billion in debt (Kousky, 2013). In 2017, despite Congress cancelling \$16 billion of what the NFIP owed, that debt figure still exceeded \$20 billion (Horn and Brown, 2018). Growing concerns regarding the program's ability to map flood hazard areas – which were allowed to lapse for as long as two decades before an update – challenged the effectiveness and efficiency of the NFIP, while an increase in development in flood-prone areas in recent years challenged the adequacy of flood insurance as a means to regulate development in the floodplain (Nance, 2015). In response to these concerns, FEMA shifted towards map modernization through the adoption of various acts and amendments (such as the Biggert-Waters Act of 2012 and the Homeowner Flood Insurance Affordability Act of 2014). Yet the results of a 2017 FEMA audit by the DHS Office of the Inspector General concluded that “FEMA is unable to assess flood hazard miles to meet its program goal and is not ensuring mapping partner quality reviews are completed in accordance with applicable guidance” (DHS-OIG, 2017). This DHS assessment took place after the current New, Valid, or Updated Engineering (NVUE) metric for determining if active flood mapping is either valid or unverified was implemented (DHS-OIG, 2017).

The lack of socioeconomic assessments prior to the adoption of policy with far-reaching program changes has resulted in a patchwork understanding of how regulatory changes combined with new and updated flood maps will affect communities. For example, the Biggert-Waters Act mandated the review of community flood maps every five years to assess the need of revisions and updates based on the more current conditions in a particular area. These updated

flood maps often result in redrawn flood zone boundaries, changes in flood zone, and/or different base flood elevations, which correspond to changes in the populations required to purchase and maintain flood insurance. This act also raised premiums by 25 percent a year for non-primary residences, severe repetitive loss properties, and business properties until the premiums reflect more accurate flood risk. Discount rates for single-family households with lapsed policies, sold properties, substantially flood-damaged or improved properties, and new policy purchases were eliminated (Kousky, 2013). Finally, grandfathering rights that allowed homeowners to maintain old premiums post-map revisions that reclassified the property to a higher risk area were phased out (Kousky, 2013; CBO, 2017). In response, the Homeowner Flood Insurance Affordability Act was enacted to slow, but not entirely eliminate, the effects of the Biggert-Waters Act (Nance, 2015). The Homeowner Flood Insurance Affordability Act reestablished the grandfathering rights program, instituted lower rate increases for some policies, and instituted a surcharge on all policyholders.

Consistent across these recent policy reforms is an increase in flood insurance premiums coupled with concerns of affordability (Nance, 2015). Increased insurance rates corresponding to updated and revised flood risk maps can have significant impacts on local communities. Examples include increased mitigation expenses to offset flood insurance premiums, abandonment of properties, reduced property values (both residential and commercial), stalled real estate markets, increased blight, and increased out-migration (Nance, 2015; Shively, 2017). Despite these concerns, little to no research to date has assessed the potential community impacts from both flood insurance reforms and revised floodplain mapping.

2.2 Impacts of Policy Changes & Floodplain Revisions on Socioeconomic Vulnerability

Of particular concern, with regard to floodplain revisions and policy changes, are the impacts on socially vulnerable populations. Vulnerability is often defined as the potential for loss (Cutter et al., 2003; Turner et al., 2003; Adger, 2006; Frazier et al., 2013). Socioeconomic vulnerability is composed of those demographic, social, and economic factors that predispose an individual or community to harm. To better understand vulnerability, the definition presented by Frazier et al. (2013) is adhered to here. It summarizes that vulnerability is a function of exposure, sensitivity, and adaptive capacity. Though broad, this definition provides for the inclusion of multiple avenues of loss, including loss of life, economic and property losses, and environmental and resource loss (Cutter 1996; Wu et al., 2002; Adger et al. 2003; Fussel 2007). Sensitivity is the degree of impact a hazard can have on an individual or community, while adaptive capacity is the ability of an individual or community to respond to, cope with, and moderate potential damages (Burton et al. 2002; Frazier et al., 2013; Fuller et al., 2014). Finally, socioeconomic vulnerability cannot exist in the absence of exposure, which is the proximity, magnitude, and frequency of a hazard in relation to a population (Birkmann et al., 2013; Frazier et al., 2014).

Floods and socioeconomic vulnerability are intrinsically linked. Structure damage caused by floods often affects high-income populations more so than lower income populations (CRED, 2015). However, lower income populations disproportionately experience higher mortality rates (CRED, 2015). Multiple vulnerability studies demonstrate that marginalized populations are less able to protect themselves from flooding, to return home or work after a flooding event, and to access pre and post disaster social safety nets (Collins, Grineski and Chakraborty, 2018). Mandated flood insurance is directly tied to exposure, while the ability to purchase flood insurance modulates adaptive capacity and sensitivity. Nance (2015) showed

NFIP policy reforms disproportionately impact low-income and minority populations (i.e., vulnerable populations), and posited further unintended consequences for pre-existing vulnerabilities. The absence of additional literature on the impacts of NFIP policy changes and floodplain map revisions on vulnerable populations necessitates further research to more fully understand potential impacts.

A possible reason for this literature gap is the difficulty of assessing socioeconomic vulnerability (Frazier et al., 2013). Socioeconomic vulnerability is influenced by numerous factors, ranging from physical to social, from political to economic, and from institutional to ecological (Cutter et al., 2008). The multitude of factors that influence socioeconomic vulnerability make quantification difficult, though numerical models and assessment frameworks have been developed. These models and frameworks provide the opportunity to assess linkages between NFIP policy changes and revised floodplain mapping (Wisner et al., 2003; Cutter et al., 2008; Polsky et al., 2007; Frazier et al., 2014). Such models include the Spatially Explicit Resilience-Vulnerability (SERV) model developed by Frazier et al. (2013). The SERV model advanced vulnerability frameworks by addressing the statistical limitations of previous models (e.g., the Social Vulnerability Index developed by Cutter et al., 2003). Where traditional vulnerability models did not account for spatial autocorrelation, the SERV model incorporated a Moran's I measure of the input variables. Additionally, the SERV model incorporated scale and location-specific variables appropriate to the analyzed areas (Frazier et al., 2013a; Frazier et al., 2013b). By incorporating these scale and location-specific components and analysis, the SERV calculates localized census block-level exposure, sensitivity, adaptive capacity, and vulnerability to a specific hazard (Frazier et al., 2013a; Frazier et al., 2013b). In contrast, traditional models

are static in both the components analyzed and method of analysis, resulting in location-agnostic and statistically inaccurate measures of vulnerability.

2.3 Impacts of Policy Changes & Floodplain Revisions on Businesses & Economic Sectors

Commercial properties holding federally-backed loans are subject to the same rules and regulations as residential properties located in the regulatory floodplain. Therefore, NFIP policy reform and floodplain revisions can impact businesses and their respective economic sectors by mandating the purchasing of flood insurance for businesses not previously located in the 100-year floodplain. Likewise, those commercial property owners with current flood insurance policies can experience an increase of at least 25 percent in their premium rate (Strother, 2018). Additionally, properties designated within the 100-year floodplain rating demonstrated measurable loss in market value while the 500-year designation shows no loss in value - indicating the NFIP insurance requirement is the discount trigger (Howard, 2016). These changes translate into increased operating costs that are passed on to consumers in the form of price increases of goods and services. NFIP policy and floodplain revisions can significantly impact disaster recovery from a business perspective, as business recovery and continuation are vital to community recovery in the post-disaster period (Green et al., 2008; Corey and Deitch, 2011).

Businesses are vital to local economies by providing jobs, goods and services, and tax dollars. Businesses are especially vital throughout the recovery process after a loss-inducing flood event (Corey and Deitch, 2011). The loss of local business can result in the abandonment and reduction of residencies reliant on the jobs and goods/services they provide (Green et al., 2008; Corey and Deitch, 2011). Previous literature has shown that if businesses come back on-

line shortly after a major flood event, the proximate residential population is more likely to move back and maintain residency, which helps to prevent long-term neighborhood abandonment and instability. Purchasing flood insurance can help increase business resiliency and help reduce the length of time to reestablish business operations. However, no literature assessing the potential impacts of updated flood maps and NFIP policy reform on commercial properties appears to exist. This research attempts to provide insight into these impacts on exposed businesses and populations, and possible adjustments at the individual and community scales to adapt to present and future flood-specific regulatory changes.

3. Data & Methods

3.1 Case Study Region

Ada County falls entirely within the Lower Boise Watershed, which encompasses the primary reaches of the Boise River and its tributaries. Located in the southwest area of the State of Idaho (Figure 1), the county is home to the state's capitol city of Boise and the incorporated areas of Garden City, the City of Eagle, the City of Kuna, the City of Meridian, and the City of Star. The county's population was estimated at 426,174 people in 2015, and is notable for substantial population and economic growth in the recent decades (US Census, 2010). The primary flood risk within the county is the Boise River, which runs east-west for approximately 63 miles across Ada County. There have been more than 25 recorded flood occurrences between 1955 and 2008. Previously mapped in 1993 by FEMA, the county was included in the Lower Boise Watershed Discovery project initiated in 2010. Due to the extensive revisions of the floodplain along the Boise River, this research focused on the City of Boise, the City of Eagle, and Garden City.

Figure 1. The study area encompasses the cities of Eagle, Garden City, and Boise, located in north Ada County, Idaho. [Color figure]

3.2 Models & Analysis

To assess the impacts of changes in the regulatory floodplain on Ada County and its communities, a mixed-methods approach was employed. A spatial analysis using a Geographic Information System (GIS) was conducted to determine the properties of additions and deletions between the former and revised 100-year floodplain. The data employed in the spatial analysis was provided by FEMA Region X. Population counts, business counts, and annual sales volume and employee numbers were also included in the spatial analysis. Population data was sourced from the US 2010 Census, while business information was sourced from Infogroup data.

The SERV modeled was employed to assess census block-level sensitivity, adaptive capacity, flood exposure, and flood vulnerability. Following the framework and methodology in Frazier et al. (2013), socioeconomic vulnerability was quantified for the former and revised 100-year floodplain in Ada County. Flood exposure was calculated as the proportion of the census block located in the 100-year floodplains, with zero-population census blocks removed from the analysis. Adaptive capacity and sensitivity were calculated using the indicators listed in Table 1. When necessary, these indicators were converted to the proportion of census block sums. Spatial autocorrelation was assessed using a Moran's I calculation of each indicator. The average Moran's I measure of all indicators was used as a gamma rotation in the global principal component analysis (PCA). Sensitivity and adaptive capacity were then calculated using factor analysis, with vulnerability calculated using the following equation:

$$Vulnerability = (Exposure + Sensitivity) - Adaptive Capacity.$$

Adaptive Capacity	Sensitivity
No High School Diploma	Pop Female
College	Pop Below Poverty
Age Dependent	Race White
Owner Occupied Households	Race Minority
Female Head of Households	Disability
Not Single Sector Employment	Age Dependent
Sales Volume	Renter Occupied Households
Employee Number	Female Head of Households
Pop Below Pov	Critical Facilities
Health Insurance	Essential Facilities
Labor Force	Dependent Population Locations
Female Employees	Public Venues
Critical Facilities	Overnight Venues
Essential Facilities	Sales Volume
Median Income	Employee Number
	Median Income

Table 1. Economic and demographic indicators employed in the SERV model to assess socioeconomic vulnerability.

An economic exposure analysis was conducted to determine which businesses and their corresponding industries were located in the former and revised 100-year floodplains. IMPLAN (implan.com) and Infogroup (infogroup.com) data were employed in the analysis, where IMPLAN data provided county-level comprehensive economic sector information and Infogroup data provided point-level business information. IMPLAN data is unique in that it is developed economic input-output models and includes industry details such as total industry output, employment, employee compensation, property income, and tax information. Provided at the county-scale, the spatial resolution of the IMPLAN data was too coarse for the floodplain spatial analysis. To overcome this limitation, IMPLAN data was spatialized by identifying individual businesses cataloged in the Infogroup data with the corresponding industry sector based on NAICS code. The resulting dataset provided more comprehensive business information than previously available. Summary statistics of the changes were calculated to better characterize both the local and county-wide impact of the regulatory floodplain revisions.

Finally, semi-structured interviews assessed community perception regarding the changes to the regulatory floodplain within the communities of Boise, Eagle, and Garden City. Business property owners located within both the former and revised 100-year floodplain were identified and contacted for interviews. Interview recruitment of these businesses was unsuccessful. However, these contacted businesses stating changes in the regulatory floodplain would not directly affect operations. In contrast, interview recruitment of 11 community officials and stakeholders was successful, and multi-topical questions regarding flood impacts and changes in the regulatory floodplain asked throughout the interview process. Interviews were then analyzed for content using the nVivo coding software. This coding identified codes and sub-codes to

emergent themes, and organized interview responses into analytically-relevant categories to aid effective integration with the quantitative analysis.

4. Results

4.1 Changes in Area, Population, & Businesses

The former and revised 100-year floodplain are shown in Figure 2, with additions and deletions highlighted to show the spatial distribution of changes in the regulatory floodplain. The former 100-year floodplain composed a total area of approximately 12.2 square miles (31.6 square kilometers), whereas the revised floodplain composed a total area of approximately 15.7 square miles (40.6 square kilometers). The percent difference was approximately 28.7 percent. Areal deletions totaled approximately 1.6 square miles (4.1 square kilometers), while areal additions totaled approximately 4.9 square miles (12.7 square kilometers).

Figure 2. The 100-year floodplain in Ada County, ID. The deletions are visualized in red, and the additions are visualized in green. Blue indicates the unchanged floodplain.

The difference in the population count using the 2010 US Census statistics totaled 8,324 individuals, a 47.4 percent increase in population located within the 100-year floodplain. Where the former floodplain encompassed a population of 17,549, the revised floodplain encompassed 25,873 persons.

4.2 Changes in SERV

Changes to the regulatory floodplain in Ada County drive changes in the magnitude and spatial extent of socioeconomic vulnerability. Distinct spatial patterns of vulnerability are apparent in both floodplains. In the former floodplain, census blocks in both the eastern and western extents mostly exhibit average vulnerability, with below and well below average vulnerability interspersed. There is a notable cluster of census blocks with above and well above average vulnerability in the central reaches of the study area, where Garden City is located. In comparison, the revised floodplain shows a reduction in the magnitude of vulnerability in this area, with a shift from well above average to above average vulnerability. The spatial extent of vulnerability increases, however, and additional census blocks vulnerable to flood are apparent along the entire reach of the Boise River.

The percent change in the number of census blocks classified by the SERV model are shown in Table 2. Notably, each jurisdiction sees a decrease in the number of well above average vulnerable census blocks, with an overall reduction of 57 percent. However, the overall number of census blocks with above average and average vulnerability increases approximately 170 and 35 percent, respectively. Boise and Garden City exhibit the most significant increases in vulnerable census blocks (235 and 309 percent, respectively). Eagle is the only jurisdiction to see a decrease in above average vulnerability. A majority of the jurisdictions exhibit a decrease in the number of census blocks with below average vulnerability, with an overall 67 and 31

percent reduction in the number of census blocks classified as well below and below average, respectively. These changes indicate a shift towards average vulnerability across the study area.

	Well Below Average	Below Average	Average	Above Average	Well Above Average
Boise	-33.3	-50	235.5	30	-33.3
Eagle	-100	-62.5	63.6	-75	-100
Garden City	-	80	308.7	57.7	-75
Total	-66.7	-31.4	169.7	35.1	-57.1

Table 2. Percent change in census blocks exhibiting vulnerability.

Similarly, sensitivity and adaptive capacity exhibit distinct spatial patterns and magnitudes. The highest sensitivity in the former floodplain is found proximate to Garden City, and adaptive capacity is lowest in this area. Overall, most census blocks exhibit average sensitivity, whereas adaptive capacity is more dispersed across the former floodplain with notable concentrations of above average census blocks in Eagle and Boise. The revised floodplain sees the addition of census blocks with average and above average sensitivity, with no reduction in sensitivity across any of the jurisdictions. In contrast, changes in adaptive capacity varies across the study area. Boise sees an increase in both the number of census blocks with well below and well above adaptive capacity, while Eagle sees a decrease in well below but no increases in above or well above average. Notably, however, Garden City is experiencing the highest increase in well below average adaptive capacity.

4.3 Changes in Economics

Businesses located in the floodplain increased from 522 businesses to 1,025 businesses, a 96 percent change across Ada County. This translates to an overall increase of two percent of the county's total number of businesses located in the regulatory floodplain. Additionally, the

401 total annual sales volume exposed increased from \$871,798,202 to \$1,687,788,824, while the
402 number of employees increased from 3,318 to 6,079 persons. This translates to a 93.6 percent
403 and 83.2 percent increase in annual sales volume and employees, respectively, and an increase of
404 2.2 percent and 1.5 percent of the county's total annual sales volume and employees,
405 respectively. Ultimately, 4.6 percent of the county's annual sales and 3.2 percent of the county's
406 employees are located in the revised 100-year floodplain. The revised floodplain encompassed
407 an additional 13 economic sectors across Ada County, with a majority of sectors exhibiting
408 increased total annual sales volume, number of employees, and number of businesses within the
409 revised floodplain. The following sectors are exclusive to the revised floodplain:

- 410 • Agriculture and Forestry Services
- 411 • Beverage and tobacco
- 412 • Textile products
- 413 • Leather and allied
- 414 • Wood products
- 415 • Printing and related
- 416 • Plastics and rubber production
- 417 • Machinery manufacturing
- 418 • Computer and other electronics
- 419 • Electrical equipment and appliances
- 420 • Gasoline stations
- 421 • General merchandise stores
- 422 • Broadcasting
- 423 • Finances trusts and other institutions

- Museums and similar

Table 3 details the industry sectors with the largest changes. Notably, seven sectors see an increase of more than 1,000 percent in sales volume, two sectors see an increase of more than 1,000 percent in the number of employees, and one sector sees an increase of more than 1,000 percent in the number of businesses within the revised floodplain. The repair and maintenance sectors see increases of more than 1,000 percent across all three factors. Five sectors experience decreases across all three factors; however, it is notable that no sector sees more than a 100 percent decrease in any one factor. Finally, two of the three cities see an increase in the number of economic sectors located in the floodplain. Boise sees an increase of 15 sectors (from 33 to 48), and Garden City sees an increase of 19 sectors (from 44 to 63). The number of economic sectors exposed in the floodplain within Garden City decreases from 30 to 21.

Industry Sector	Percent Change		
	Sales Vol	Employees	Businesses
Educational services	4472	733	133
Repair & maintenance	3660	1333	1420
Religious, grantmaking, & similar orgs	2093	5	12
Personal & laundry services	1484	200	111
Electronics & appliances stores	1216	19	50
Rental & leasing services	1133	1500	600
Furniture & home furnishings	1006	800	133
Rental & leasing services	1133	1500	600
Repair & maintenance	3660	1333	1420
Insurance carriers & related	-8	-2	-6
Utilities	-30	-50	-25
Nursing & residential care	0	0	-33
Data processing, hosting and related	-22	-25	-50
Oil & gas extraction	-100	-100	-100
Information services	-100	-100	-100

Table 3. The industry sectors with the largest percent changes in sales volume, number of employees, and number of businesses in the revised floodplain.

4.4 Interviews

The interviews of community officials and stakeholders provided context to the quantitative analysis. The hierarchy chart of the coded nodes showed the prominent themes within the interviews. Table 4 shows the parent nodes and corresponding references across all interviews:

Theme	Number of References
General NFIP and Other Insurance	25
Existing Conditions	41
Impacts on the Community	208
Issues and Concerns with NFIP	22
Model Uncertainty	9
Potential Adjustments	39
Risk Perception	112

Table 4. Emergent themes and the number of references across all interviews.

The coding process indicated that interviewees were most concerned about impacts of the proposed Boise River floodplain revisions on the communities. “Impacts on the community” was defined as primarily socioeconomic impacts (i.e., loss of purchasing power or reduction in home value). Impacts on the community had nearly double the references compared to risk perception, the second highest referenced theme. “Risk perception” was defined as a subjective determination of an individual’s severity of exposure to risk from a hazard – like flooding. Existing conditions and potential adjustments fell within two references for third, while general NFIP and other insurance, and issues and concerns with the NFIP placed fourth. Finally, model uncertainty was referenced the least.

5. Discussion

Communities will be impacted by both recent and future NFIP policy changes or amendments in conjunction with floodplain revisions. These revisions remap flood-prone areas

along waterways and, given more accurate mapping methods and technology, may increase the number of people and businesses located in the regulatory floodplain that require flood insurance. The elimination of subsidies for flood insurance policies to reduce NFIP debt and to reflect true flood risk will increase the monetary burden of flood insurance, notably on marginalized and vulnerable populations (Howard, 2016). Despite such impacts, no socioeconomic assessment occurred before widespread NFIP reform, such as those enacted by the Biggert-Waters Act and the Homeowner Flood Insurance Affordability Act. Similarly, there is a lack of research that analyzes post-reform community impacts. This study attempts to rectify this gap in knowledge by analyzing the changes in socioeconomic vulnerability and economics along the Boise River in Ada County, Idaho.

FEMA is remapping the Boise River through its Risk MAP and Discovery process. Formerly mapped in 1993, the 100-year regulatory floodplain was revised in 2011 through a combination of LiDAR data collection, engagement of local stakeholders, and levee and flood protection structure assessments. The areal extent of the SFHA increased by approximately 28.7 percent, translating to a 47.7 percent increase in population and a 96 percent increase in businesses newly exposed in the regulatory floodplain. These results show that floodplain revisions can annex significant additional populations and commercial properties that might then be required to purchase flood insurance if they maintain federally-backed loans. Results showed an overall increase in socioeconomic vulnerability. Vulnerable groups – such as the elderly, racial and ethnic minorities, and individuals living below the poverty line – are especially at risk to changes in floodplains and flood insurance policy given the additional cost of flood insurance premiums (Collins, 2010; Nance, 2015; Thaler et al., 2018). These costs can translate to increased monthly mortgage payments or rental payments, which can be especially burdensome

if the property is newly mandated to maintain flood insurance. Additionally, when FEMA initiates a change to a county or sub-county level floodplain designation, there is a 90-day appeal process that can require time to complete forms or expert input and is therefore economically discriminating. “To file a credible challenge, individuals, businesses, or developers may spend hundreds—sometimes thousands—of dollars to hire land surveyors or engineering firms” (Pralle, 2019). Furthermore, it is important to note that an owner’s insurance policy will not cover a renter’s personal property. An owner/landlord is under no obligation to disclose to their renters that the subject property is located in a FEMA designated floodplain. Renters who, for example, relocated from another area, may not be aware of the area’s flood history and are subject to higher rents (owner covering their higher flood insurance costs) while being more vulnerable after a flood event by not having insurance in place. Additionally, renters who may be attempting to save towards a longer-term equity stake in a community (i.e., first-time home-buyer) may be able to save less with higher rents, thereby contributing to a more transient nature in that area.

It is not farfetched to hypothesize that these marginalized populations (especially those on fixed incomes or living below the poverty line) will not be able to withstand the additional monthly cost of flood insurance or the cost of organizing an appeal. Middle-class populations with properties in the new floodplain will likewise take on additional monetary burdens driven by floodplain revisions. Results from the interviews corroborate this notion as neighborhoods perceived to be most affected by interviewees were those with a high prevalence of middle-class populations and first-time homebuyers (e.g., Boise City and Garden City). These properties that move from either no previous designation or a 500-year flood rating into the 100-year flood risk category are immediately likely to experience a noticeable loss in value (Howard, 2016).

Next, commercial properties holding a federally-backed loan now required to maintain a flood insurance policy are likely to pass the cost to consumers in the form of increased prices on goods and services. For example, price increases can reduce a business's ability to compete with same-sector businesses outside the floodplains. These impacts will vary based on the health and characteristic of both the individual company, their corresponding economic sector, and the effects on proximate residential neighborhoods. Impacts from these changes will likely include population displacement and migration, gentrification, property abandonment, and the closure or movement of businesses outside the regulatory floodplain (Burby, 2001; Nance, 2015; Shively, 2017). Individuals and families unable to withstand the additional monetary burden of new or increased flood insurance cost may voluntarily migrate from the floodplain additions, leaving a swath of lower-value properties behind. Such migration can result in neighborhood blight and the shortage of housing units outside of the floodplain. The possibility of increased mortgage payment might additionally force homeowners to sell quickly (Nance, 2015). However, as the property is now located within the regulatory floodplain and has the attachment of a flood insurance requirement, it may be difficult to sell (MacDonald et al., 1987; Shively, 2017). If a homeowner is unable to sell and is forced to incur the additional monthly cost on a budget that cannot absorb it, the probability of foreclosure increases. Foreclosures often negatively impact neighborhood property values (Rogers and Winter, 2009). As the number of foreclosures in a neighborhood increases, the likelihood of community destabilization increases, and property values are likely to decrease, which then introduces the possibility of gentrification (Rogers and Winter, 2009). Out-migration of marginalized populations might also facilitate gentrification, as affluent people suddenly have the opportunity to redevelop abandoned and low-cost properties

located near the floodway. “A clear message emerges that social justice needs to be embedded in current flood strategies and decision-making” (Thaler et al., 2018).

Professionals within Ada County and the cities of Boise, Eagle, and Garden City voiced concerns that the value of properties located within the floodplain revisions will fall, especially if a flood event were to occur. Concerns regarding older homes were raised throughout the interview process, as the construction of older homes often does not meet minimum floodplain regulations and standards, requiring significant improvements. The cost of these improvements can outweigh the benefit of buying the house as-is, causing older homes to languish on the market for more extended periods (Bin and Polasky, 2004; Bin et al., 2008; Posey and Rogers, 2010). This can result in increased List Price Reductions (LPRs), and ultimately stall the local real estate market. There is a concern that widespread inclusion of residences into the SFHA will reduce the community tax base, which in turn increases the uncertainty of tax revenue-dependent programs vital to community functions and long-term, socioeconomically diverse sustainability. Again here, little research has quantified the overall impact on community tax bases. Floodplain additions and deletions are spatially variable, and will, therefore, have differential implications for communities. However, it is critical to note for this paper that Garden City, which has the lowest adaptive capacity, is likely to be the most significantly impacted due to the increased spatial size of the SFHA. This is the crux of the socioeconomic discrimination concern, whereas some communities lowered their rating, the most vulnerable (in this case, Garden City) increased the most (Doorn, 2015, Howard, 2016; Pralle, 2019). “The outcomes of current flood risk management strategies in many situations are necessitating changes to the current social contract between state and society, requiring a re-design of the role of central government and individual citizens and communities in terms of sharing” (Thaler et

al., 2018). While these national policies arguably target the most vulnerable communities, it is also reasonable to assert that the same policies simultaneously encourage floodplain habitation and development by the wealthiest among us (Shively, 2017; Pralle, 2019).

6. Conclusion

Amendments to the NFIP program can have far-reaching impacts, though little research to date has attempted to quantify these impacts on communities across the United States. Changes to the NFIP have reduced or eliminated subsidies for flood insurance, while revised or updated Flood Insurance Studies drive changes in the Special Flood Hazards Area where flood insurance is mandatory for properties with federally-backed loans. These changes can impact many aspects of a community, from real estate to socioeconomically vulnerable populations, to property abandonment and blight to gentrification. Given the failure of the NFIP to stem development within floodplains and the likely increase in flood events due to urbanization and climate change, it is imperative that a comprehensive analysis of these impacts is developed.

This study attempts to quantify these impacts by analyzing the areal changes in the floodplain, assessing the changes in socioeconomic vulnerability using the SERV model, identifying the changes in economic industries located in a floodplain, and by interviewing public officials regarding their community's perception on the changes in the Ada County, Idaho case study. Our assumption is that since this case study is similar to many other American communities subject to NFIP policies that exist in or near floodplains and experience flooding based on commonly shared factors like severe weather, rainfall, and snowmelt, it could have broader national implications. In comparing the former and revised floodplains, this research showed significant increases in the population, businesses, and vulnerable populations located in the floodplain, and a qualitative analysis of the interviews provided local context and

perspectives on how these changes will further impact the county and its communities. This flawed process is not unique to Idaho. Areas like Syracuse, New York, for example, are also becoming more susceptible to flooding because of climate change but mapping designations that result in mandatory flood insurance are based on inaccurate, outdated, or economically discriminating map models (Pralle, 2019). “Some of the lower-income residents of Syracuse, New York felt that their flood insurance premiums were being used to bail out wealthy coastal homeowners” (Pralle, 2019). If the goal is to distribute resources in a fair or just manner, then logic would dictate that we must also distribute risk in the same fair or just way (Doorn, 2015). Disaster management professionals, legislators, and floodplain managers need to actively advocate for an improved national insurance policy (Mcshane and Yusuf, 2019) to help close the theory to practice cycle and stop increasing risk with policies intended to do the opposite.

7. Limitations

Although the SERV model provides a comprehensive and place-based framework to assess socioeconomic vulnerability, it lacks the ability to identify the indicators that most contribute to vulnerability. The use of geographic weights in the modeling framework can rectify this shortfall by identifying the underlying causes of socioeconomic vulnerability. Additionally, to better understand the impacts of NFIP policy changes and floodplain revisions, the real estate market should be analyzed using hedonic valuation. Similar to a geographically-weighted vulnerability model, hedonic valuation provides the means to analyze and understand the factors impacting property values (Posey and Rogers, 2010). Finally, a social accounting matrix (SAM) can be developed to assess the connections between businesses and economic sectors newly located in the floodplain and the impact increased flood insurance premiums will have on the local economy (Defourny and Thorbecke, 1984). These modeling frameworks can likewise be

used to assess potential losses using the revised floodplain, which can help inform local mitigation in larger study areas across the US.

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