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ORIGINAL PAPER

The social geometry of collaborative flood risk management: a hydrosocial case study of Tillamook County, Oregon

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Abstract

Coastal and riparian flooding are costly and disruptive natural hazards and already a regular part of life in some areas of the USA. Flooding events caused by sea-level rise and climate change are expected to increase in frequency and severity in the future, creating social, ecological, and economic problems at local, city, state, and federal levels. It is clear that normative, infrastructure-oriented, and strictly hydrological solutions to flooding have not appropriately met these challenges, nor have they adequately addressed relevant sociopolitical factors which shape hydrological processes. Using the case study of Tillamook County, this study draws upon qualitative interview data to identify and explain social factors which have influenced the outcome of a collaborative, socially engaged flood management project. These include previous flood experience; emotions and feelings; interests and concerns; preferred management strategies; barriers to community-scientific engagement; and perceptions of a mediation process. This situation is further explored within the framework of social geometry, which is used to explain changes in social position and relationships through an interactive, collaborative process. In this case, mediation is shown to decrease both relational space and differences in status between the two primary actor groups, leading to mutually agreeable outcomes but not without dispute. Flood managers and researchers may find this case study useful when analyzing qualitative data related to flood risk management, and/or planning flood management strategies, particularly in disaster-prone regions.

Keywords Social geometry · Hydrosocial · Flood risk · Disaster management · Adaptation

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1 Introduction

Flooding is a costly and damaging natural hazard, routinely impacting coastal and riparian communities across the USA (Cigler 2017; Du et al. 2010; Pistrika and Jonkman 2010; Tyler et al. 2019). The frequency, intensity, and socio-ecological costs of flood events are projected to increase in the coming decades, compounded by climate change, sea-level rise, and land use change, among other factors (Brody et al. 2007; Gough and Grace 1998; Kirshen et al. 2008; Liu et al. 2015). These trends are apparent in insurance claims coverage provided by the National Flood Insurance Program (NFIP), operated by the Federal Emergency Management Agency (FEMA). Coverage through the NFIP has topped $1 billion each calendar year since 2006, and the figures are rising (FEMA 2019). Prevention and mitigation can be cost-effective alternatives to reimbursing insurance claims after a natural disaster. However, public non-compliance with such initiatives may interfere with project success. Solutions proposed by FEMA include property buy-outs, building elevation, or managed retreat (i.e., relocation), all of which may be personally disruptive to those involved (Highfield and Brody 2013; Kick et al. 2011). Government-funded initiatives depend on individual willingness to support and pay for projects that may or may not succeed, so public trust is integral to coastal flood risk mitigation and community adaptation. Yet, agencies at different levels often find themselves at odds with one another and/or members of the public (Kapucu et al. 2010; Kick et al. 2011; Sadiq et al. 2016; Scolobig et al. 2015).

The case study of Tillamook County represents a socially contentious hydrological arena, where destructive, large-scale flooding has occurred with regularity. On the one hand, local ranchers have historically favored flood mitigation and no net loss of land, while federal agencies have favored retreat for restoration. In 2006, the Governor of Oregon arranged for third-party mediation in Tillamook County to bridge divergent hydrological interests, elevating local voices to the level of powerful agencies. The resulting Southern Flow Corridor (SFC) plan and process are central to this study. The case is unique in that it illuminates social dynamics and change in a disaster-prone context, with disparate parties ultimately coming together to respond to a common problem through adaptive, transformative action.

Using qualitative interview data, this study takes a hydrosocial perspective, applying the theory of social geometry to explain social movement, and addresses the following questions: (1) *What social factors influenced the outcome of a collaborative flood management project in Tillamook County?* (2) *How did social position (i.e., social geometry) change in response to third-party mediation?* (3) *What lessons from this case study can be transferred to other contexts, and what is unique to this case?* Regarding research question #1, the "outcome" of this process refers to a change in social position or social geometry experienced by participants in the collaborative flood management process. Specifically, concepts from social geometry such as dyad relationships, status, and relational distance are used to position actors conceptually within a social field and to characterize their movements in response to third-party intervention. Based on findings, we argue that social data *matter* and should be considered when planning for flood adaptation and risk management. Furthermore, we argue that social positions (geometry) are not fixed, but can change given proper engagement or socio-ecological conditions. Directing attention to critical social factors in similar cases may enhance the efficacy, longevity, and appeal of federal flood management projects in general, particularly in disaster-prone environments.

This research is meaningful given the incalculable role of human social factors in hydrological processes and the practical importance of understanding those factors. This case illustrates the explicitly social nature of a seemingly ecological or biophysical issue (flooding), with implications for both scientific understanding and adaptation planning. Firstly, we demonstrate that social factors influence perspectives on flooding and flood management; flooding is not a strictly biophysical phenomenon, though it is often treated as such in practice. Secondly, in the case of a stalemate between internal and external actors, we see that changes in social position are possible under the right circumstances. Internal actors can reach higher status in negotiations, and external actors may familiarize themselves with local conditions through interaction. This study fills gaps in practical understanding regarding mediated flood risk management in a disaster-prone region and contributes to scantly developed theory of social geometry within that same context. Furthermore, study results reveal qualitative, individual perspectives which are typically excluded from high-level hydrological studies, adding to evolving, collective knowledge of hydrosocial dynamics.

1.1 Social factors in flood risk zones

Popular approaches to flood risk management overwhelmingly draw on hydrological data to predict, prevent, or ameliorate potentially harmful flooding. Historic and projected flows, water levels, and spatial attributes may help planners identify high-risk areas, predict likely events, and intervene to protect people, property, natural resources, or infrastructure (for example, Aerts et al. 2013; Kesel and McGraw 2015; Lastra et al. 2008; Zerger and Wealands 2004). Structural adjustments to the physical landscape are common prescriptions, including dikes, levees, dams and seawalls, as well as riparian dredging, channel modification, bank stabilization, and wetland, riparian or coastal restoration (Brody et al. 2010; Calder and Aylward 2006; Calil et al. 2015; De Wrachien et al. 2011; Tyler et al. 2019). These interventions exhibit varying degrees of success in reducing or preventing damage long term, while some have been shown to exacerbate the likelihood of flooding, or generate additional, unforeseen ecological consequences (Gergel et al. 2002; Munoz et al. 2018; Todhunter and Rundquist 2008). Further opportunities for flood management include managed retreat and limiting development in high-risk zones (Ajibade, 2019; Highfield and Brody 2013; Kick et al. 2011). These solutions require transformative action on the part of those involved and may be less attainable than the aforementioned physical modifications. Unfortunately, given the social and financial difficulty of implementing any of these solutions at a large scale, federal agencies and communities still find themselves reacting to flood events, rather than adapting to them (Cigler 2017; Consoer and Milman 2018).

Emergent literature from the fields of political ecology, geography, and hydrology points to the role of social factors in shaping hydrological processes and outcomes. Hydrosocial scholars posit that factors such as politics and history, power and decision-making structures, and interpersonal or intergroup dynamics have as much of an impact on the hydrological cycle as biophysical factors (Linton and Budds 2014; Sivapalan et al. 2012; Swyngedouw 2009). Numerous research studies have successfully framed hydrological processes within a social context, with many specifically focusing on the relationship between society and hydrological hazards (for example, Haeffner et al. 2017; Krause 2016; Mark et al. 2017). Research suggests that trust and public support for hydrological management increases potential for long-term project success and community resilience. On the other hand, pushback or lack of public support can impede a federally or regionally desired

program (Berke et al. 2014; Koontz and Newig 2014; Langridge 2016; Paul and Milman 2017). It is not uncommon for conflict to emerge around hazard risk management, including hydrological risk. When those in charge are unequipped to recognize or respond to social issues, such conflict can result in failed or impositional projects, intergroup hostility or mistrust, and a lack of understanding between parties (Ansell and Gash 2007; Strother 2018). Differences in ecological understanding, divergent cultural or economic interests, and situated group identity are some of the obstacles that may inform hydrological outcomes and foil federal efforts at flood risk mitigation (Cigler 2007; Linton and Budds 2014; Strother 2018).

Despite these advances in interdisciplinary research, flood risk assessment and response are frequently guided by natural scientists and/or techno-scientific perspectives. These rely primarily on quantitative data, and geomorphologic, hydrological, and hydraulic modeling, to the exclusion of qualitative or social data. This influence is apparent in flood planning procedure nationwide and in copious literature on flood risk management (for example, Ernst et al. 2010; Zhou et al. 2012). Public non-compliance has demonstrated power to prevent or limit amelioratory federal flood initiatives. Therefore, researchers and practitioners must better understand the social conditions and dynamics that inform hydrological cycles and decision making. Furthermore, they must consider the ways in which social barriers or opportunities might be addressed for flooding adaptation and resilience.

One way to frame this particular hydrosocial situation—conflict in decision making around flood risk mitigation—is through the lens of social geometry. This theory, based on the work of Georg Simmel (1964a) and developed by Donald Black (1995), examines social position and characteristics as an explanation for social behavior and perspective. In other words, from Simmel's point of view, observing how these relations form and contract tells us how society is produced and reproduced in a constantly changing world. The basis of Simmel's approach is that relations between individuals and groups create society. These relations create social formations such as politics, family, social classes, and the like. As Pyyhtinen (2010:4) puts it, "The world is made through ongoing interactivity." If the world is made of social interactions, then we can discover how these interactions impact the environment and how the environment changes our interactions. Observing small-scale individual interactions can help us turn the lens to understand geometric forms of group properties and the dynamic processes they undergo as they change. Interactions are the link between personal perception and societal action.

Black (1995) focuses on distance as a core concept, which may be both geometrical (physical) and metaphorical (Ethington 1997). Typically, the greater the distance between parties, the greater the difficulty in smoothly resolving a conflict (Black 1995). Relationships begin between two parties (dyad), but may be subject to the introduction of a third-party (triad) which shifts social dynamics, positions, and behaviors of those involved (Simmel 1964b). According to Black, all parties in a geometry occupy both a vertical and horizontal position; this position informs their behavior generally and dictates how each group will respond to conflict with the other (Black 1995; Campbell and Manning 2018). In the theory, vertical position is a reflection of status, while horizontal or relational distance explains the distance in understanding or experience between the parties. A change in geometry, either by the introduction of a third-party or through other means, represents a shift in this position (Campbell and Manning 2018). Theoretically, groups in conflict may reach consensus by reducing or eliminating the distance between them, bringing their positions and perspectives closer together. This change may successfully occur through the imposition of a social control: mediation in the form of third-party intervention (Campbell and Manning 2018).

2 Study area and methods

2.1 Study area: hydrosocial background

Tillamook County is located in northwestern Oregon, with 37.3 miles of coastline along the Pacific Ocean. The county sits at the confluence of five rivers—the Miami, Kilchis, Wilson, Trask, and Tillamook Rivers—and has historically experienced frequent and disruptive flooding (Fig. 1). Built on wetlands, estuaries, and salt marshes, Tillamook County, population 26,076, is home to a regionally important dairy industry which has seen much of the area converted to agricultural land (American Community Survey 2018). Tillamook Bay experiences near-annual flooding, leaving nutrient-rich soils ideal for agriculture, but also causing millions of dollars in damages (for example, $53 million in February 1996).

Federal interest in flood damage reduction has historically been met with distrust in the Tillamook community. Local interests include a strong multi-generational farm cooperative with a "no net loss of farmland" policy. To this group and many other locals, losing

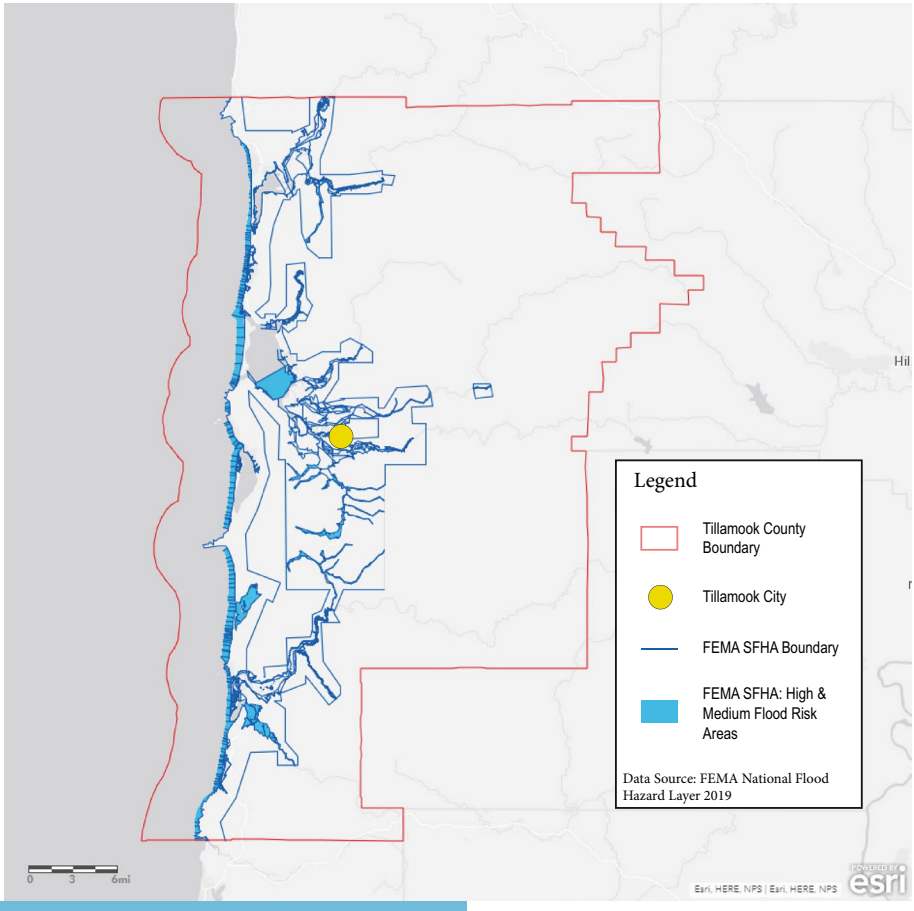

Fig. 1 Map showing FEMA Special Flood Hazard Area (SFHA) boundary, and high- to medium-risk flood areas in Tillamook County; the city of Tillamook (county seat) is shown for reference

farmland to wetland acquisition or any other mechanism is seen as a threat to the traditional way of life and agricultural identity. This has resulted a generalization of two main camps regarding flood risk management: those who advocate wetland restoration and/or managed retreat and those who wish to pursue mitigation without land use change or loss of private property. The former position is typically held by actors external to the community, including environmental organizations and federal agencies such as FEMA, the U.S. Fish & Wildlife Service (USFWS), and the National Oceanic and Atmospheric Administration (NOAA). The latter position is more typical of Tillamook agriculturalists and other local groups. Tillamook County residents are primarily white (92.5%) with a median household income of $47,500 (American Community Survey 2018) (Table 1). A majority possess at least some college education (58.8%), and more than half are adults over 45 years of age (American Community Survey 2018) (Table 1). Though there have been multiple attempts with various agencies to reconcile these differences and address flooding in Tillamook County, the focus of this study is on one initiative that is generally regarded as a success: the Southern Flow Corridor (SFC) project.

2.2 The Southern Flow Corridor project

By the time heavy rains caused flooding, landslides, and erosion in 2005, a federal flood reduction feasibility study had cost over $3 million with no tangible results, exacerbating local frustration. State Senators and Representatives convened with local community members to resolve the tension. After more floods caused 100 homes and businesses to be evacuated in 2006, the State Governor designated mediation and facilitation services as a community governance model under the Oregon Sustainability Act of 2001. Local mediators were contracted to intervene, a 34-member Project Team was assembled, and $1 million of State funds were appropriated to address the problem. This process involved unprecedented local engagement at the insistence of the public, who were invited to scrutinize proposed future plans. The first plan, called “Project Exodus,” would have allowed the government to acquire 184 acres of farmland and was deliberated over the course of two years. The community eventually offered a counter-proposal, renamed "Southern Flow Corridor—the Landowner Preferred Alternative" (Fig. 2). This plan was approved, with acquisitions and restoration projects completed in 2017. It is predicted to reduce water levels up to 1.5 feet, up to a 100-year flood event, over 3,000 acres, with 540 structures and an estimated $9.2 million saved over 50 years. This project is broadly regarded as an example of effective community-scientific engagement and collaborative risk management.

2.2.1 Key actors and dynamics

Using the language of social geometry, the social field of SFC negotiations may be conceptualized as a dyad arrangement. That is, two main actor groups were engaged in conflict with one another (Simmel 1964b). The first group, which we refer to here as “internal actors,” includes those individuals and sub-groups who are local to Tillamook County. Internal actors with a stake in local flood management included the Tillamook County Creamery Association (TCCA), the Tillamook Farm Bureau, and the Tillamook Bay Habitat and Estuary Improvement District, as well as individual dairy farmers, landowners, business owners, and local government employees (Levesque 2013). Organized farmer groups such as the TCCA held and hold a relatively high degree of power within Tillamook County, particularly when compared to individual landowners. However, even

Table 1 Socio-demographics of Tillamook County cities and towns (data obtained from the US Census Bureau American Community Survey 2018 5-year estimates)

Town/city	Population	Median age	Median household income	% White	% With high school diploma or higher	% With bachelor's or higher
Bay City	1514	47.1	$ 50,769	90	93.5	18.1
Beaver	110	64.6	$ 83,489	100	100	67.3
Cape Meares	88	69.2	$ 70,000	100	100	51.9
Cloverdale	396	34.5	Data not available	98.5	96.4	16.5
Garibaldi	864	53.8	$ 41,083	98	90.3	12.7
Hebo	159	63.8	$ 45,430	100	94.5	4.8
Manzanita	333	66.6	$ 52,917	97	100	58.6
Nehalem	481	26.9	$ 49,821	95.6	82.5	11.8
Neskowin	187	69	$ 50,195	100	100	61
Netarts	792	59.6	$ 47,500	95.5	96.4	42.8
Oceanside	352	64.8	$ 61,823	100	100	44.5
Pacific City	1037	40.1	Data not available	98.1	81.9	15.1
Rockaway Beach	1213	52.6	$ 44,167	98.4	90.6	25.8
Tillamook	5176	36.6	$ 32,949	92.5	86.8	12.4
Wheeler	327	62.4	$ 42,375	88.1	95.1	25
Tillamook County	26,076	48.0	$ 47,500	92.5	90.3	21

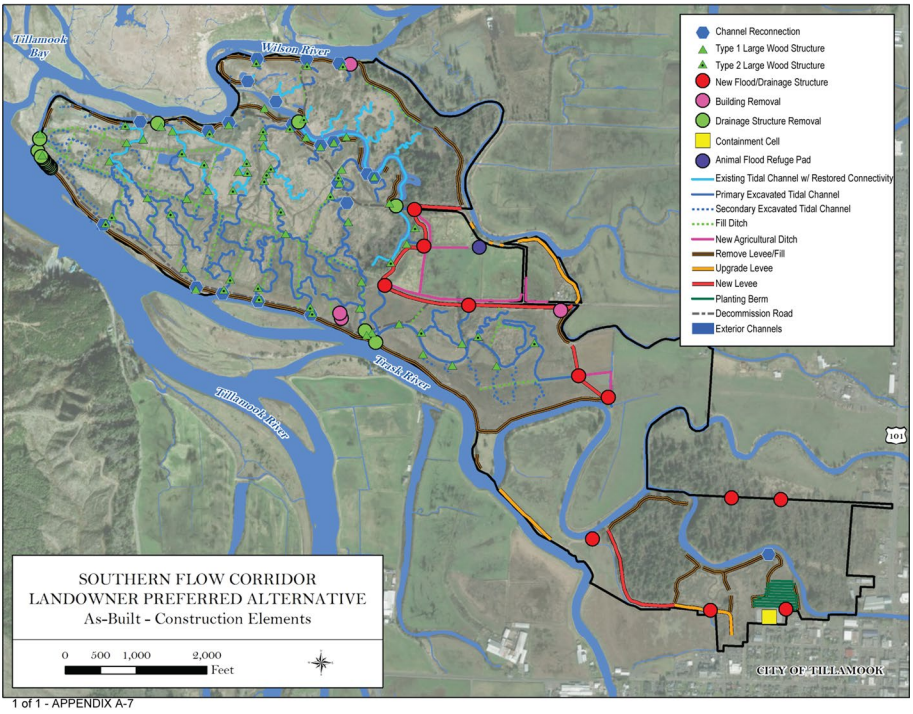

Fig. 2 Map showing the Southern Flow Corridor Landowner Preferred Alternative. This is the final project plan that resulted from the mediated SFC process. Adapted from Allen et al. (2018) Southern Flow Corridor Landowner Preferred Alternative Management Plan

locally powerful organizations occupy a "lower" status than multi-scale government agencies. “External actors,” or those without a personal stake in local affairs, included FEMA, NOAA, USFWS, the Oregon Department of Fish & Wildlife (ODFW), and the Army Corps of Engineers, as well as other state and federal actors (Levesque 2013).

For decades past, external actors were empowered by the state to set and implement a flood management agenda for Tillamook County, with minimal requirements for public (“internal”) input. Conventional solutions, such as riparian restoration and river channel modification applied a utilitarian approach, meant to mitigate flooding and reduce costs to the greatest extent possible. However, many of these solutions necessitated the voluntary surrender of property and were met with resistance from local landowners (Levesque 2013). Some attempts by powerful actors to engage communities and solve conflicts between themselves had proven ineffective and served to frustrate all involved. Although internal actors had historically not been given much say in flood management, their resistance was enough to shift local power dynamics, particularly given the apparent futility of collaborative efforts, and the disturbing recurrence of flooding disasters (Levesque 2013).

Dynamics were altered with the introduction of an additional actor group, transforming the social field from a dyad to triad arrangement. This third-party mediator—Oregon Solutions—was enlisted by the Governor of Oregon to facilitate negotiations and cooperation between internal and external actors. Oregon Solutions was established under the Oregon Sustainability Act of 2001 as a state program staffed by experts in mediation to work with

communities. The involvement of Oregon Solutions led to a redistribution of power, and for the first time, local, internal actor perspectives were given weight in the flood management planning process to those of state and federal agencies.

2.2.2 Negotiation process

Negotiations between internal and external actor groups, mediated by a designated third-party (Oregon Solutions), began officially in 2007. The 34-member Oregon Solution Project Team, representing a variety of internal and external interests, was assembled to work through and provide comment on proposed flood management plans (Levesque 2013). The Project Exodus plan was developed by a consulting firm and presented two possible alternatives for review by the Project Team. This plan and its proposed alternatives included models, benefits, costs, and real estate needs, among other relevant calculations (Levesque 2013). Members of the Project Team met to discuss the options in person and were also given the chance to pose concerns to the consulting firm for clarification. All plans and data generated during this process were continually presented for public feedback as well, through Team member organizations, the media, and public meetings. Ultimately, specific plan details were put to a vote by the Project Team (Levesque 2013). One direction of Project Exodus, the Southern Flow Corridor project, was selected as an agreeable way forward, though the plan was again put through a process of project comment, revision, and voting (Levesque 2013).

Once this plan of action had been tentatively selected, County representatives began speaking with key landowners about the possibility of land acquisition. While some farmers changed their stance on a "no net loss of land" policy, many were not open to losing farmland. They were, however, amenable to levee modification on their property (Allen et al. 2018). As a result, the SFC was altered again to correspond with landowner wishes; the output of that final negotiation was the Southern Flow Corridor—Landowner Preferred Alternative (Levesque 2013). This plan includes many of the original elements seen in Project Exodus, which had been agreed upon by the Oregon Solutions Project Team, such as new floodgates, levee removal, drainage improvements, and habitat restoration (Levesque 2013). However, it also incorporated individual-level interests to the extent necessary for project implementation with community support and notably reduced the need for property acquisition. The SFC—Landowner Preferred Alternative represents a departure from a utilitarian emphasis on maximum benefit and instead caters to community voices which were elevated by the SFC process.

2.3 Research design and methods

Twelve narratives were formally recorded in Tillamook County between August 2018 and July 2019. Participants were selected using a socio-technical system sampling method, including individuals that represented vertical and horizontal positions from local, city, County, and State levels. Within each, snowball sampling was used to identify others who might be willing to participate. Questions were asked in a semi-structured manner to allow respondents to discuss themes in the way that was the most authentic for the respondent. For consistency, the interviews were not considered complete until the respondent answered questions about their role in the organization, their perspectives on collaborative decision making around flood and vulnerability issues in Tillamook, and their perception

of the role of science in partnerships (see Supplementary Materials). Interviews lasted between 60 min and 1 h and 45 min.

Interviews were deidentified and transcribed using Rev.com and coded by the first author to determine thematic categories that were noteworthy and meaningful for the respondents. Recognizing single coder bias as a limitation of this study, the following steps were used to ensure trustworthiness and authenticity. First, the first author kept reflective notes after each interview to record assumptions, expectations, and surprises. The primary data collection was conducted in 2018, and data analysis continued over a year to allow for multiple rounds of coding and for new perspectives to arise. The research team also collected the following materials to inform the analysis, including: 120 newspaper articles about flooding in Tillamook County, 26 maps and geospatial datasets, 13 technical reports, 228 flood photographs, 16 other records (e.g., permit applications, Senate bills, outreach materials, etc.), site visits, and meetings with the third-party mediator until we felt we reached data sufficiency. Participants were contacted to clarify and check comments, and many offered materials to be used on a project website. Finally, participants received a report of the findings, in which at least one respondent commented: "[We] feel "heard" by the research and appreciate the website for truthfully documenting Tillamook communities' flood history, stories, research, projects, plans, and flood preparedness".

2.3.1 Study participants

Ultimately seven women and five men were interviewed for this study, all ages 35 and above. Three were farmers, three represented industry/agencies, one was a Mayor, three were County employees in different departments, and two worked for the State of Oregon. All were asked to participate due to their expert knowledge of the site, community, and local flooding. Below, we use a numbering system [#1–12] to attribute quotations, as a way to maintain confidentiality in a small, tight-knit community. It is important to note that a 100% response rate was not achieved. Of those who responded, nearly all responded immediately and enthusiastically. From a sociological point of view, the response experience indicates a degree of sensitivity around flood management decision making in the area.

3 Results

Establishing social parameters around the SFC project, including past and current conditions, is critical to elucidating the hydrosocial nature of this case and the geometry of this particular field. This study revealed a variety of social attributes which have informed hydrological processes and decision making in Tillamook County, as well as multi-scale responses to proposed interventions and perceptions regarding the SFC project. Relevant concepts are arranged thematically, listed in the following sections, and developed with supportive interview quotes to address the first research question: *What social factors influenced the outcome of a collaborative flood management project in Tillamook County?*

3.1 Previous flood experience

All interview participants reported some personal experience with flooding, living, or working in Tillamook County at the time of at least one major flood event. Flood events of 2015, 2007, 2006, and 1996 were commonly referenced, with the most recent three having

been personally experienced by a majority of respondents. Many in the community identified the major flood of 1996 as a notable event and something of a turning point. Some individuals had been directly involved in flood mitigation, preparation, and/or disaster response efforts. Others, particularly those affiliated with the agricultural industry, reported that they had been personally affected by flooding, sometimes on multiple occasions.

> "Oh boy, really have gone through a lot of floods. The early 40s, I can't tell you which year it was but it was there was a bad one. I remember the Kilchis River was jammed up with wood at the time […] Anyway why, '64 was really bad, '72 was really bad, '88; and there were lots of small floods in between" [#7].

For individuals who were not personally impacted by flooding (i.e., were not displaced or did not suffer property damage or injury themselves), the consequences of flooding were notable. Numerous respondents referred to neighbors, friends, or other community members who had suffered disruptions or damage. For example, as this respondent explains: "…if you can't afford food, how are you going to afford your flood insurance that goes up to be $10,000 a year? It's more than your mortgage for some of these people" [#5].

3.2 Emotions and feelings

Contrary to the technical scientific perspective that hydrological phenomena are strictly physical, interview participants revealed varying degrees of emotional response to their experiences with flooding. Those interviewees involved in response and recovery used words like "frightening," "terrible," "scary," "fear," and "panic," to describe the experiences of a disaster scenario. One participant who had personally experienced flooding used the word "traumatized."

Furthermore, there appears to be considerable emotion around local, state, and federal response to flooding, or lack thereof. The word "frustrating" was used repeatedly in this context, and several participants referred to lack of public trust or feelings of mistrust regarding government agencies. In some cases, negative feelings have served as the impetus for greater community involvement in the processes of flood preparedness and mitigation. On the other hand, a positive relationship to community and a sense of civic engagement may also help explain why individuals choose to participate in disaster mitigation.

3.3 Interests and concerns

As previously noted, the debate in Tillamook County regarding appropriate flood management has been heated, with various groups emphasizing specific concerns. For private property owners, particularly those working in the dairy industry, there exists predictable concern about flooded land, property damage, and loss of livestock. However, it is also in the economic interest of this group not to lose access to those working lands. Furthermore, there is a cultural interest in preserving a traditional way of life by maintaining agricultural practice. Therefore, powerful agricultural interests in the region push for a "no net loss of farmland" policy. However, it is worth noting that farmers are not a homogeneous group and do not all share in this position.

> "Several farmers got bought out, some of them lost land. Obviously some of them weren't real happy. Some of them were real happy cause they wanted out of business anyway and we bought them out" [#1].

Other local residents are reportedly concerned with issues such as water quality and fish populations, flood insurance, housing (re)location, development, public health and safety. At higher social levels—namely city, county, state, and federal governments—the primary concern is limiting flood-related damage to both infrastructure and people, and reducing the cost of flood events. FEMA, for example, has invested in building elevation and managed retreat through buyouts in Tillamook as a means to reduce flood insurance payouts. County and city employees "worry about streets and sewers," the function and accessibility of major roads, sewer lines, and water sanitation systems. Like FEMA, several environmental organizations support the idea of managed retreat in Tillamook. However, the concerns of such groups are often motivated more strongly by a desire to restore ecosystems and wildlife habitat. These groups are noted by some participants as having interests contrary to those of the local farming community.

> "The Nature Conservancy went to restore this area and there was a significant amount of public interest in opposition to that proposal. The main concern was in the hydrologic impacts, that the proposed restoration would raise the water table in the area, […] increased salinization of arable farm lands in that area, and, and also other things like displacing ungulates on to pasture land […]" [#9].

Involving the right people at the right time was a sentiment that was echoed by many of the respondents for any successful flood management, land use change, or emergency management project. Political, scientific, and academic advocates from outside the community were named as important to the processes. Some major players, like FEMA, were felt to be important to the success or failure of flood management projects, and their absence or presence was perceived to drive the degree of success in projects. For example, one respondent reflected that they felt FEMA worked with the County "really well" in the past as opposed to the present [#3], while another respondent said that they think the County "suffered some pretty serious consequences" more recently from weak collaboration with FEMA including costly project delays [#6].

3.4 Preferred management strategies

Actor groups in Tillamook County have historically used and currently prescribe varying flood management strategies in accordance with their interests and access to resources. Many agricultural landowners use small-scale levees to mitigate flooding. The preference is to maintain that land for farming purposes but limit flood damage where possible. Ideally, this strategy directs water away from critical resources and limits floodwater depth, though it does not always work as planned.

> "So levees can be your friend and they can be your enemy sometimes depending on where you are on the floodplain. As long as the water stays on the right side of it you're good but soon as it comes over it, they actually probably work negatively for you. They don't let the water out" [#4].

The Army Corps of Engineers has also supported a physical infrastructure approach to flood management. It has helped to install larger levees along Tillamook Bay, as well as tide gates and pumps, and provided permits for the use of rip-rap. FEMA has historically operated by identifying areas of high flood risk (as through the development of floodplain maps) and responding with financial assistance in the aftermath of a disaster. Related prescriptions include buying out high-risk properties, regulating future development, restoring

agricultural land back to wetlands, and restoring natural riparian flows by removing tide gates, levees, and fill.

3.5 Barriers to community-scientific engagement

Prior to the SFC project, multi-scale efforts to tackle flooding in the region had failed, arguably due to a disconnect between the public and scientists, technicians, and researchers. In order for the SFC to succeed, partners on both sides had to overcome several barriers; these may have either emerged in the community in response to past experiences or were the result of relational distance between groups. Those noted here include poor science communication, research fatigue, and distrust.

Poor science communication was identified as a concern for community participants. The interview respondents in this study are end users of data: "I rely on them [Weather Services] a lot of the time for most of the data" [#1]. Data from NASA, NOAA, or other sources (e.g., seasonal weather predictions, stream gauge readings, etc.) are used by community members as well. Personal observation found that scientists often presented their findings as they would for an academic conference, without changing the language for the target audience. Community members use scientific data frequently, but just as frequently expressed frustration with the way scientists communicate their data.

Research fatigue is a serious issue in the Tillamook County community. The respondents have been involved in many past scientific studies, data collection efforts, and collaborative research projects. The recent memory of the multi-year SFC process was fresh in most respondents' memories. While the majority of respondents were satisfied or accepting of the outcomes, respondents talked about attending meetings up to five days a week. One respondent expressed how intensive this process was: "I literally felt like I had to become a water hydraulic specialist. I can't tell you how many nights I stayed up all night long before I got up to milk cows and read and read and read and read and read and read and try to understand" [#4]. One respondent who was not satisfied with the outcome expressed his disappointment with being heavily involved in the process but not feeling heard: "They hear you but don't listen… and boy that's frustrating. I've gotten to the point now where I'd rather not talk to somebody about it" [#7]. Another respondent remarked that they thought that expert, outsider knowledge prioritized while local knowledge had been dismissed.

> "What's interesting is the dichotomy between the anecdotal stories that you will hear from people that have lived here for 40 or 50 years, and have stood on the banks of the rivers and they know which way the water is flowing and when it's flowing and how it reacts. And the hydrologist that sits behind the computer runs a model and says, *'Well, this is what the computer modeling shows it's going to be doing'.* And those two schools of thought, which don't agree with one another and probably never will" [#10].

Distrust of scientists, researchers, and government agencies provides an additional challenge to a collaborative, engaged problem-solving process such as the SFC. Some interview respondents described themselves as intermediaries between members of the public and government agencies, while noting that those same agencies give individuals a reason to feel distrustful.

> "When you have a strong sense of government mistrust it makes that exercise even more challenging […] So you know, what we do too is: we all live here, we're all involved in our communities, they know us by name, we want that level of trust to

where we can say *'Look you know, we really really want to help you […] we really care about what you're trying to do and we want to help you get it done the right way.'* And some people respond to that and some people just never will […] and I think that many of those people have a right to feel that way" [#6].

Furthermore, some respondents have identified mistrust of scientists and scientific data, which might be used manipulatively to further one group's interests; for example, the interests of FEMA over those of local landowners.

"Our concern is that then it's [information] going to be misinterpreted and the data is going to be sort of the hammer, I guess, or a way to push somebody's personal agenda forward when the science doesn't back up their emotional investment in whatever the issue [#4]."

3.6 Perceptions of the SFC process

Outlets such as the USFWS, NOAA, and FEMA report on the SFC as a successful project with social, economic, and environmental benefits (see for example NOAA 2019; USFWS 2017). According to these sources, the mediation and engagement process was fair, the outcome equitable, and the resulting plan palatable to both local and federal actors. Interview responses collected for this study generally support this position, with most interviewees reporting positive perceptions of the SFC process.

"You get that many different federal agencies that are involved, your chance of pulling it off are not real good. And in this case having them all sit at the same table at the same time […] they got it accomplished. So all of those things have helped to a point where we can have some pretty decent flooding going on, but the effects are minimal because of the buyouts, elevation, the work is done to help get the flooding waters out of here" [#1].

One respondent expressed an explicitly negative view of the SFC process, noting: "I can only call it a disaster. Instead of local people that have been here all of our lives on the voting committee, it was all agency people." When asked about satisfaction with the outcome of the SFC project, the response was similarly negative:

Do you like how it turned out or do you think it should have turned out differently?
"Not especially, it started out as a flood issue, and as time went on, and that's what we wanted mainly was to get the flood out, get the waters out. Well as time went on it kept swinging back towards fish habitat and it ended up that's what they got, a lot of fish habitat" [#7].

3.7 Outcomes and aftermath

All in all, 34 federal, state, or local government assignees and local landowners were involved in the SFC project. Several steps appeared to influence the observed changes in social position and enabled successful collaboration within the Southern Flow Corridor project:

1. Define a problem statement that all participants can agree on.

2. Draft and sign a Memorandum of Understanding (MOU) that details the scope of the project.
3. Ensure all meetings are public.
4. Take time and care in selecting consultants who can work with diverse participants.
5. Create and use a consistent message (for example, in the Oregon Solutions project, the message was "we are never going to stop flooding" which was echoed by many other participants in the interviews).
6. Develop the team qualities to be nimble and entrepreneurial.
7. Be able to ensure funds and be creative.
8. Embody an attitude of "Getting to yes;" make sure the question is "Can you live with it?" rather than "Do you like it?" or "Do you like each other?"
9. Be prepared. One respondent shared that they succeeded because, in their words: "We had rehearsed it, we were ready to go" [#12].
10. Follow up. After the project is "completed," the messaging does not stop. In the words of one interviewee: "it is not a drive-by" [#11].

The SFC project was hydrologically completed in 2015. In the winter of 2017, a flood closed a major thoroughfare highway. Follow-up with interviewees revealed that many thought the project worked in that they still experienced flood but the project allowed the waters to move out much faster than before. However, some business owners, who were not a part of the collaboration, thought the storm affected them on the northside more, rather than on the farming-heavy southside as was historically common. Others felt that river channel cleaning was ignored and were disappointed that the project eliminated 521 acres of overbank storage waters. Meanwhile, the FEMA Community Rating Services (CRS) for flood insurance broadened the "Zero Rise" Flood Certification requirement and has raised floodplain/flood zone insurance costs for residents and businesses, raising concerns.

4 Discussion

This analysis has taken a hydrosocial approach to identify social factors present in Tillamook County which arguably have influenced decision making around flood risk management, as well as public response to proposed solutions. These factors produced a social environment in which actors were unable to internally resolve a conflict. In this case, a federally backed program of retreat and restoration was forestalled by public opposition, leading to the State-mandated intervention of a third-party mediator, and ultimately the successful SFC project. This situation and its outcomes have been framed according to the theory of social geometry. When considered together, the data presented in this study allow us to take a high-level view of a mediated negotiation process and group positions, but also to identify the qualitative, individual perspectives which have shaped them. This information advances theoretical understandings of social geometry and hydrosocial dynamics and has practical relevance as an example of collaborative flood management. Hydrosocial studies tell us that practitioners facing difficult hydrological scenarios must acknowledge, identify, and overcome social barriers (Haeffner et al. 2017; Krause 2016; Mark et al. 2017), and this case provides some guidance on what that exploration may look like. Our data reveal that social attributes do matter in hydrosocial decision making, and that sticky social positions can be shifted under certain enabling conditions.

4.1 Social factors that influence perspectives and positions

This study has identified several relevant hydrosocial factors in the case of Tillamook County, including previous flood experience, emotions and feelings, interests and concerns, preferred management strategies, and past experience with scientists and government agencies. These factors themselves, and their ability to impact the hydrological cycle, are not exclusive to this time and place. Indeed, factors such as past experience are likely to apply to any hydrosocial study. However, the specific details are more context specific; for example, repeated experience with FEMA-designated disaster flooding, strong socio-economic ties to dairy farming, and flood research fatigue. All of these help to explain local knowledge of and investment in flood management, pushback against the loss of farmland, and mistrust of government agencies seeking to intervene. The social context influenced actors to respond as they did, to hold certain positions regarding flood management, and helped create a conflict between insiders and outsiders. Likewise, these same interactions shaped the form and reformulation of societal features. Existing literature from the field of social geometry says little about disaster-specific contexts, so much of our assessment of this condition is exploratory.

In Simmel's sociological point of view, the presence of conflict should not always be viewed as a purely negative social phenomenon, but should point us to group contrasts that need to be resolved (Simmel 2010: 13). Simmel does not see the world as a zero sum game where one must lose for another to win. Instead, conflict between individuals builds group synthesis around how to behave in conflict, and this builds community. To produce a social structure, conflict must be integrated with cooperation. Conflict, then, is a necessary component of society and can sometimes be the only means to resolve issues. This is not to say that injustice is necessary to society, only that cooperation and conflict co-exist. Simmel (2010) suggests that it is possible to take a step back from personal impulses and disagreements to diagram societal forms in order to recognize how group dynamics change over time and how they might transform under different conditions.

The socio-economic landscape of Tillamook County appears to have been an enabling factor with regard to SFC project success. The very fact that public resistance to the federal flood management agenda resulted in a state-funded, highly engaged collaborative process is unusual and points to particular influence among local actors. Furthermore, the most vocal local interest group in this case, dairy farmers, holds a relatively high-status position in Tillamook County, backed by a regionally powerful dairy co-op. The unique degree of public involvement and power in this case created an environment in which mediation and collaboration were more likely to occur, and perhaps more likely to be effective. Project initiation and success were also arguably helped by a supportive state government and the urgency related to disaster flooding conditions.

4.2 Social position change in response to third-party mediation

The diagram shown (Fig. 3) reflects the social geometry of Tillamook County, as gleaned from participant interviews and additional research over three periods in time: (1) prior to implementation of the SFC process, (2) during the SFC process, and (3) after the SFC process. For ease of modeling, major actors within the Tillamook County social field have been separated into two categories. The first group, labeled External Actors, represents federal agencies, conservation groups, and other high-level officials who favor managed

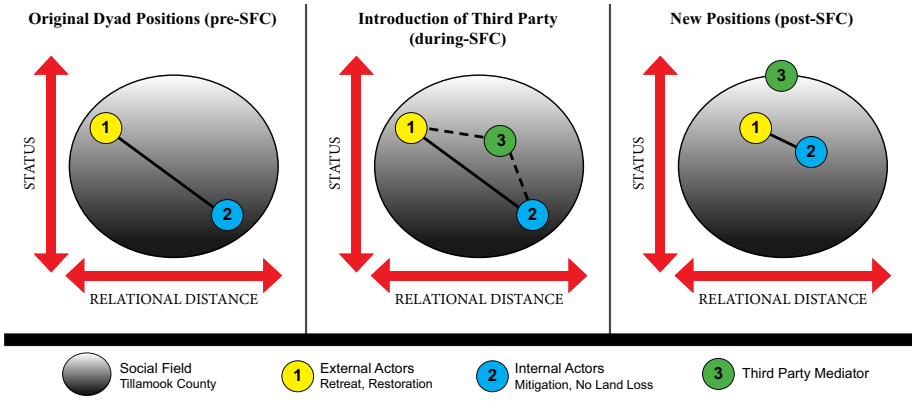

Fig. 3 Social geometry diagram showing changes from the pre-SFC to post-SFC period in Tillamook County, with regard to actor group positions on flood management

retreat and restoration as flood management strategies. The second, labeled Internal Actors, represents landowners and farmers who prefer a mitigation approach with no net loss of land. These groups are a heuristic simplification, and it should not be inferred that actors fitting either description are homogeneous in their interests. A third entity, representing the third-party mediator, Oregon Solutions, is also shown. Changes in social positions from period 1 to 3 can be understood within the context of this study as the "outcome" of the collaborative flood management process.

Prior to initiation of the SFC process, there existed in Tillamook County a dyadic geometry between groups 1 and 2 regarding flood management and decision making (Simmel 1964b). That is, two key groups were interacting with one another over the issue of flood management and engaged in a conflict as to what approach to take. At this time, group 1 occupied a higher-status position than group 2 (i.e., had greater social and political capital, resources, and decision-making power). The two groups experienced a wide relational distance, meaning they had minimal understanding of each other's needs, interests, experiences or perspectives, and had limited personal relationships with one another (Campbell and Manning 2018). This vertical and horizontal distance is accounted for in both the top-down approach normally used by FEMA and other federal agencies, as well as the inability for the two groups to communicate, compromise, and reach consensus.

During the SFC process, a third-party mediator was introduced into the field to provide a form of social control and resolve the conflict between groups 1 and 2. Having been appointed by the State government, this mediator held a relatively high-status position, but served as a relational go-between for groups 1 and 2. The introduction of this mediator transformed the social geometry from a dyad to triad (Simmel 1964b), wherein three actor groups were now interacting with one another. The presence of the third party changed the social geometry and group positions such that group 2 gained status (through increased decision making power), and both groups moved inward to reduce relational distance (through personal interfacing during the engagement and planning process).

Following the SFC process, the social field has been restored to a dyad, with groups 1 and 2 occupying their new positions. The positions are not identical; conflicts, differences of opinion, power imbalances, and oppositional interests still exist between these groups, though distances were reduced enough to achieve a mutually agreeable project outcome.

The third-party mediator is no longer a regular, active component of the social field, but occupies a position on the perimeter. The mediator is still in a position of authority and may provide oversight or accountability, re-entering the field to interact with groups 1 and 2 if needed.

Both groups 1 and 2 experienced a change in social-geometric position through the SFC process, apparently due to the introduction of a third-party mediator. In the diagram, group 1 moved inward toward group 2, while group 2 moved both inward and upward, gaining decision-making capacity and a better understanding of group 1. In reality, both groups experienced a change in their intellectual position (i.e., their perspectives on flood management). Group 1 cultivated a deeper appreciation for place-based, human needs and interests, while group 2 became more amenable to the idea of managed retreat and restoration. These changed positions are reflected in the final SFC plan, which resulted from the process.

Application of social geometry theory is a key piece of this study. Specifically, this case provides theory-building evidence of social geometry in a disaster scenario, including how positions change with the introduction of a third party. How did the social geometry of Tillamook County change with the SFC process, and what factors were involved in that transformation? The major entities in the social field have already been established: (1) external actors (pro-restoration and retreat), (2) internal actors (pro-mitigation and no land loss), and (3) the mediating entity. Initially, groups 1 and 2 occupied the social field as a dyad, in which group 1 held a higher status position, and both groups were relationally distant from one another. This means, for example, that federal agencies may not have anticipated or appreciated the lived experiences and needs of local farmers. It is theorized that a greater vertical distance between parties (difference in status) means that those groups will show greater disparity in their proposed responses to a problem, while greater horizontal (relational) distance is associated with harsher judgments and prejudice (Campbell and Manning 2018). Therefore, it is in the interest of conflict resolution to shift social position and geometry, reducing or eliminating vertical and/or horizontal space between parties.

Flood management had been an urgent problem for the actors in this field for years, but conflict between the two groups prevented action. Eventually, a third-party mediator was contracted to find agreement between the two parties. According to Donald Black (1998), mediation is a form of *settlement,* which represents one of four possible manifestations of social control; that is, any action meant to resolve a conflict (Campbell and Manning 2018). Other forms of social control include *avoidance, negotiation,* and *self-help;* notably, these three controls are typically instigated by one of two groups in a dyad, while only *settlement* involves the intervention of a third party (Black 1998; Campbell and Manning 2018). All other forms of social control had previously been attempted in Tillamook County, but failed to solve underlying problems with flood management. The use of a mediator or settlement approach has several advantages. It introduces an objective party into the social field, it provides oversight and accountability, and it places a relational intermediary between the two conflicting parties (Campbell and Manning 2018; Simmel 1964c). Theoretically, any new introduction into the social field will result in a change in overall geometry, as observed in this case (Simmel 1964b).

During and after the SFC process, high-status entities (federal and other government agencies) and local interest groups literally came together, physically reducing the space between them, to discuss flood management. Metaphorical vertical distance was reduced as local actors were given increased power to steer the decision-making process. Relational distance was also reduced, as both parties were able to interact, build personal relationships, hear each other out, and develop a deep understanding

of each other's needs, experiences, and perspectives. As positions in the metaphorical social field changed, so too did intellectual positions. Landowners who had previously insisted against land buy-outs came around to the idea, while federal agencies and conservation groups agreed to reduce the scope of their proposed restoration projects, accommodating the interests of local farmers.

This outcome is notable given the apparent stickiness of social geometry and social position in practice; people easily get stuck in their thinking, become inflexible, or refuse to budge in a conflict. This kind of inflexibility often frustrates efforts of flood risk management, as has previously been seen in Tillamook County. However, this case shows that, given proper conditions, social position can change. Position and geometry are not fixed, and it is possible to find an agreeable solution to seemingly intractable problems depending on the intervention strategy used and personalities involved. Again, the disaster zone factor may have contributed to the outcome in this case. The problem of disaster risk in flood management cannot be ignored. Therefore, the State saw fit to intervene with a mediator, and active parties may have enjoyed greater flexibility due to the urgent nature of the problem. It is not clear whether a mediator would have had the same effect on social geometry, or even been involved, had the situation been different; for example, if the parties were in conflict over a restoration project that was not tied to disaster conditions.

4.3 Lessons learned and next steps

It is notable that social positions did change during the course of the SFC process, with groups improving relations, and the formerly 'lower-status' group gaining some power. However, it should not be assumed that these new positions are any more fixed than the pre-SFC positions. Should social or ecological conditions change such that the federal government feels inclined to assert its full power or should local or federal interests change significantly, it is possible that the groups could revert back to their original positions, or at least move once again. Furthermore, groups may have changed position around one conflict, but remained distant around others. In other words, local farmers may have attained some power around flood risk management, but may still face impositional federal regulations in other areas.

The lessons learned here may be transferred to a similar context (i.e., highly flood-prone, rural-agricultural). Though Tillamook County possesses unique attributes which may have allowed the SFC project to succeed as it did, we have identified generalizable steps which were seemingly conducive to a positive shift in social geometry. Further study on the longevity and permanence of changes to social geometry may reveal the lasting impacts of collaborative processes and public-government relations, and the extent to which one change in geometry pervades the larger milieu. Understanding the shape of conflict, cooperation, and change in society allows us to observe when decisions are not just based on personal preference, but on group dynamics. Further investigation into the role that trust plays in flood management between individuals and organizations is needed. For example, knowing that conflict and cooperation dynamically shape these communities, we can assume that these relationships will influence whether or not residents will support or resist future flood mitigation proposals. These include managed retreat, increased flood insurance payments, or property buy-outs.

5 Conclusion

Conflict and cooperation shape individual perceptions and group dynamics, and both have real consequences for flood management support and compliance. This research has provided evidence in support of two key arguments: (1) social data matter and should be considered when planning for flood adaptation and risk management and (2) social positions (geometry) are not fixed, but can change given proper engagement or socio-ecological conditions. In this study, we have taken a high-level view of flood risk management in Tillamook County, establishing the perspectives and positions of key actor groups within the social field. However, through qualitative interview data, we have illuminated individual positions as well, further clarifying hydrosocial dynamics in this case. Specifically, we have identified social factors which influence local perspectives on flood management, and which informed the outcome of a collaborative flood management project with regard to social position. We have explored how perspectives and social positions shifted in response to a mediated, third-party negotiation process, resulting in the mutually agreeable SFC plan. Notably, the SFC process reflected a divergence from the normative, top-down, and utilitarian approach to flood risk management. The introduction of a third party bestowed greater status and influence upon local actor groups, while bringing all involved in closer relational proximity to one another.

Our arguments have been formulated specifically in the unique, socially contentious, disaster-prone context of Tillamook County flood management, but may provide lessons for future disaster mitigation or hydrosocial research. As with any small-n study, we should not assume that the narratives revealed in this study are universal to all those experiencing floods. Future research could take the themes elicited in these interviews to create testable variables on affect, trust, and social position to quantitatively explore linkages between willingness to comply or support flood mitigation strategies. Likewise, comparisons between interventions described here and communities without access to such interventions would likely elicit key factors in what contributes to success or failure of large-scale floodplain projects. Still, while acknowledging that this case possesses a unique and non-transferable blend of actors, experiences, resources, and environmental conditions, broader lessons learned may be applied elsewhere. Specifically, contributions to the theory of social geometry and change for a disaster context may be tested or developed by future researchers.

Despite the apparent success of the SFC process in Tillamook County, we do not suggest that such a mediated approach is necessary, appropriate, or feasible in all situations. The SFC project cost nearly one million dollars, took years to complete, and emerged from a political stalemate. Third-party mediation was not a first choice, but was employed only when other efforts at flood risk management proved inadequate. In this case, resistance against a top-down, utilitarian approach to flood management had been so severe as to warrant a negotiation that was not cost-efficient. The power of this resistance was amplified by the frequent and intense nature of disaster flooding in Tillamook County, a problem which urgently needed a solution. In non-disaster contexts, or those without adequate funding or resources, a mediated approach as used in this case may prove less attainable.

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for "people of Nekelim (or, Nehalem)". Some descendants of northern Tillamook are enrolled in the Confederated Tribes of Siletz or the Confederated Tribes of the Grande Ronde, while others are part of the federally unrecognized Clatsop Nehalem Confederated Tribes. We would also like to thank the two blind reviewers who provided feedback that improved this manuscript. We are grateful for the research assistants who helped with data collection and transcription: Shersten Finley, Emory Neer, Rikki Oden and Mathern Glass. Our department staff Sherie Huffman and Emma Spadaro were essential in managing behind-the-scenes paperwork.

Author contributions MH conceptualized the study, secured funding designed, and conducted research, processed data, drafted the manuscript, and provided editing support throughout. DH finalized the Introduction and Results sections, created the diagrams, and wrote the Discussion and Conclusion sections. Both authors contributed to manuscript concept development and framing.

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Compliance with ethical standards

Conflict of interest The authors declare no conflicts of interest.

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